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

### FACULTY OF ENGINEERING – BILBAO (345)

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Semester</th>
<th>Credits</th>
<th>Schedule</th>
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<tr>
<td>27315</td>
<td>Teoría de Mecanismos y Vibraciones Mecánicas</td>
<td>Annual</td>
<td>9</td>
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<tr>
<td>27323</td>
<td>Proyectos de Ingeniería</td>
<td>Annual</td>
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<tr>
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<td>Arquitectura de Redes y Servicios de Telecomunicación</td>
<td>Annual</td>
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<td>Sep. 2020- Jan. 2021</td>
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<tr>
<td>27318</td>
<td>Automática y Control</td>
<td>Sep. 2020- Jan. 2021</td>
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<td>27325</td>
<td>Materiales Estructurales: Comportamiento en servicio y mecánica de la fractura</td>
<td>Sep. 2020- Jan. 2021</td>
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<tr>
<td>27377</td>
<td>Redes y Servicios Móviles</td>
<td>Sep. 2020- Jan. 2021</td>
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<tr>
<td>27378</td>
<td>Cálculo de Máquinas</td>
<td>Sep. 2020- Jan. 2021</td>
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<td>Análisis de Circuitos</td>
<td>Sep. 2020- Jan. 2021</td>
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<td>27317</td>
<td>Elasticidad y Resistencia de Materiales</td>
<td>Sep. 2020- Jan. 2021</td>
<td>6</td>
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<tr>
<td>27389</td>
<td>Diseños basados en Microprocesadores</td>
<td>Sep. 2020- Jan. 2021</td>
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<tr>
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<td>Comunicaciones ópticas</td>
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<tr>
<td>27352</td>
<td>Automatización y Comunicaciones Industriales</td>
<td>Sep. 2020- Jan. 2021</td>
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<tr>
<td>26850</td>
<td>Sistemas de alta frecuencia</td>
<td>Jan. 2021- May 2021</td>
<td>6</td>
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<tr>
<td>27326</td>
<td>Despliegue y Gestión de Redes y Servicios</td>
<td>Jan. 2021- May 2021</td>
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<td>Sistemas de Radiocomunicación</td>
<td>Jan. 2021- May 2021</td>
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<td>27385</td>
<td>Campos Electromagnéticos</td>
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<td>27388</td>
<td>Radar y sistemas de navegación por satélite</td>
<td>Jan. 2021- May 2021</td>
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<tr>
<td>27390</td>
<td>Electrónica para la conversión de Energía</td>
<td>Jan. 2021- May 2021</td>
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<tr>
<td>27382</td>
<td>Tratamiento de Señales</td>
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<tr>
<td>27833</td>
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<tr>
<td>26047</td>
<td>Tecnología Mecánica</td>
<td>Jan. 2021- May 2021</td>
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<tr>
<td>27322</td>
<td>Cálculo Elástico de Sólidos</td>
<td>Jan. 2021- May 2021</td>
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<td>27380</td>
<td>Servicios Telemáticos Avanzados</td>
<td>Jan. 2021- May 2021</td>
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<tr>
<td>27421</td>
<td>Reactores Químicos y Biológicos</td>
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<tr>
<td>27440</td>
<td>Gestión Ambiental en la Industria</td>
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<td>27355</td>
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**FACULTY OF ENGINEERING – BILBAO (363)**

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<tr>
<td>27682</td>
<td>Mecánica aplicada</td>
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<td>Minería de datos</td>
<td>Sep. 2020- Jan. 2021</td>
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<td>Gestión de Proyectos</td>
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<td>Elástica y Resistencia de Materiales</td>
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<td>Cinemática y Dinámica de Máquinas</td>
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<td>Diseño de máquinas</td>
<td>Jan. 2021- May 2021</td>
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<td>26621</td>
<td>Estructuras y Construcciones Industriales</td>
<td>Jan. 2021- May 2021</td>
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<td>27706</td>
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<td>Jan. 2021- May 2021</td>
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<td>27712</td>
<td>Desarrollo Avanzado de Software</td>
<td>Jan. 2021- May 2021</td>
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**FACULTY OF ENGINEERING – BILBAO (364)**

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<th>Código</th>
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<td>27760</td>
<td>Seguridad y Legislación minera</td>
<td>Sep. 2020- Jan. 2021</td>
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<td>26589</td>
<td>Ingeniería y Morfología del Terreno</td>
<td>Sep. 2020- Jan. 2021</td>
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<tr>
<td>26595</td>
<td>Ingeniería Ambiental</td>
<td>Sep. 2020- Jan. 2021</td>
<td>6</td>
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</tr>
</tbody>
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1 SCHEDULE: Morning (M)/ Afternoon (A): begins at 13.30. By clicking the subject’s name, its Syllabus will appear.
A mechanical engineer has the capacity of designing machines and solving several mechanical problems. To do so, an engineer must have a deep theoretical and practical knowledge. In particular, he/she must be able to explain the relation between structural topology, geometry, forces and motion of mechanisms and machines. All these concepts are the target of study of the subject Mechanism Theory and Mechanical Vibrations.

The aim of this subject is to teach students how to solve common problems in Mechanism Kinematics, as well as understanding the approaches in Machine Dynamics for solid or deformable bodies. Besides, the basic concepts of mechanical design are explained so that the students are introduced to the synthesis of mechanisms in charge of carrying out specific mechanical functions.

The knowledge acquired in this subject are of great relevance in the professional world of an engineer, covering several fields such as vibration analysis of automotive suspension systems, vibration modes testing in structural models, design and development of mechanisms and industrial robots destined to aeronautical applications, motor vehicles manufacturing, object manipulation (Pick&Place applications), flight simulation, etc.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The main goal of this subject consists in acquiring:

- Knowledge and abilities for computing, designing and testing machines.

The learning skills of the subject are:

- Understand the structures of both planar and spatial mechanisms; that is, the elements and kinematics pairs forming the mechanism, the number of degrees of freedom and the concept of kinematic chain.

- Learn the fundamental theorems of planar motion, which complement the concepts already illustrated in prior subjects as Mechanics and Applied Mechanics, to achieve the theoretical basis for the analysis and dimensional synthesis of mechanisms.

- Achieve the ability to perform kinematic analysis of planar and spatial mechanisms basing on the analytic and matrix-based procedures respectively. Study of rotation capacity, singular position analysis and quality indicators related to motion and force transmission of mechanisms.

- Use the classical methods for planar mechanism dimensional synthesis: function generation synthesis, trajectory-based synthesis and rigid solid guidance synthesis. Design of mechanisms intended for specific applications.

- Perform direct and inverse dynamic analysis of planar mechanisms (rigid solid hypothesis) basing on the principles studied in Applied Mechanics and specific procedures for desmodromic mechanisms.

- Perform the dynamic analysis of deformable solids of one or more degrees of freedom. Characterizing the systems subjected to mechanical vibrations taking into consideration different types of excitations such as impulse-based input, ramp-based input, step-based input, harmonic input or general type input.

- Achieve the ability to analyze vibratory systems with various degrees of freedom. Understand the concepts of vibration modes, natural frequencies and natural coordinates. Solve the systems subjected to free or forced vibrations.

- Obtain the knowledge related to the experimental vibrations measurement, describing the components forming the same. Achieve the capacity to test and justify the results obtained from the experimental analysis.

THEORETICAL/PRACTICAL CONTENT

Part A: MECHANISM KINEMATICS

CHAPTER I: BASIC CONCEPTS ON MECHANISMS AND THEIR DESIGN

1.1. Basic concepts regarding mechanisms, machines and their design.

1.2. Classification of elements and kinematic joints.

1.3. Kinematic chains, mechanisms and inversions.

1.4. Grübler and Malishev criteria. Limitations.
1.5. Methods for structural synthesis of mechanisms.

CHAPTER II: PLANAR MOTION GEOMETRY
2.2. Aronhold-Kennedy Theorem or Three centers Theorem.
2.3. Hartmann's Theorem. Euler-Savary Formula.
2.4. Bobillier's Theorem.
2.5. Conjugate profiles, Generalisation of the Euler-Savary Formula.
2.6. Main circles: inflections, Bresse and return circles.

CHAPTER III: KINEMATIC ANALYSIS OF PLANAR LINKAGES
3.1. Introduction: general problems of mechanisms kinematics.
3.2. Position analysis resolution. Rotability analysis.
3.3. Quality indicators: transmission angle and mechanical advantage.
3.4. Analytical methods for kinematic analysis.

CHAPTER IV: DIMENSIONAL SYNTHESIS OF PLANAR LINKAGES
4.1. Function generation synthesis.
4.2. Trajectory generation synthesis.
4.3. Rigid body guidance synthesis.

CHAPTER V: KINEMATICS ANALYSIS OF SPATIAL ROBOTS
5.1. Representation of an object location: transformation matrices.
5.2. Matrix-based method.
5.3. Position analysis of spatial mechanisms.
5.4. Accelerations and velocities analysis.

Part B: MACHINE DYNAMICS

CHAPTER I: MECHANISM DYNAMICS (rigid body dynamics)
1.1. Introduction to Machine Dynamics.
1.2. Inverse dynamic problem.
1.3. Direct dynamic problem.
1.4. Flywheels.

CHAPTER II: THEORY OF VIBRATIONS (deformable body dynamics)
2.1. Introduction to Theory of Vibrations.
2.2. Modelization of mechanical systems.
2.3. Single degree of freedom systems I: free vibrations.
2.4. Single degree of freedom systems II: harmonic vibrations.
2.5. Single degree of freedom systems III: convolution integral.
2.7. Single degree of freedom systems V: vibrations isolation.
2.8. Multi-degree of freedom systems I: free vibrations.
2.9. Multi-degree of freedom systems II: forced vibrations.
2.10. Introduction to experimental measurement of vibrations.

METHODS

The teaching program of the subject is composed of theoretical lectures, practical lessons, seminars, practical lectures and labs.

The practical lectures reinforce and complement the knowledge acquired from the theoretical lectures and seminars, and constitute an essential part of the learning process. Practical lectures consist in using computational simulation software and experimental analysis systems to solve some practical cases of mechanical systems' analysis and design. In the first term, Part A, two practical lectures (each of 2.5 hours) using specific software are given. In the second term, Part B, one practical lecture of 2.5 hours is given in the mechanical lab.

These lectures are given in the computer rooms of the University, and in the labs belonging to Department of Mechanical Engineering.
TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Type 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>
<td>Classroom hours</td>
<td>45</td>
<td>7,5</td>
<td>30</td>
<td>5</td>
<td>7,5</td>
<td>3,75</td>
<td>2,5</td>
<td>3,75</td>
<td>2,5</td>
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<tr>
<td>Hours of study outside the classroom</td>
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<td>11,25</td>
<td>45</td>
<td>7,5</td>
<td>7,5</td>
<td>3,75</td>
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</table>

Legend:
- M: Lecture
- S: Seminario
- GA: Pract.Class.Work
- GL: Pract.Lab work
- GO: Pract.computer wo
- GCL: Clinical Practice
- TA: Workshop
- TI: Ind. workshop
- GCA: Field workshop

ASSESSMENT SYSTEMS
- Continuous assessment system
- Final assessment system

TOOLS USED & GRADING PERCENTAGES
- Practical work (exercises, case studies & problems set) 5%

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

According to the regulations of the University of the Basque Country, a continuous evaluation has been established, which consists in:

- Practicals in mechanical labs and laboratories. In order to pass the practicals the student must attend to all of them and present the corresponding report, adequately completed, in the established date.

- An exam related to the first part of the subject; Mechanisms Kinematics. To pass the exam the student must get a mark equal or higher than 5. Passing this exam implies that the student is released of the corresponding part of the subject during the current academic course.

- A final exam.

Notes about the final exam:

a) In the case of the students that have passed the exam of Mechanisms Kinematics, the final exam will consist of the remaining contents of the subject, that is, Machine Dynamics. To pass the exam the student must get a mark equal or higher than 5.

b) The students that have not passed the exam of Mechanisms Kinematics, they will have a final exam that covers the total programme of the subject. To pass the exam the student must get a mark equal or higher than 5.

c) If someone does not attend to the final exam, then the result will be "Not Attended".

Mark of the subject once the final written exam has been passed:

a) To those students that have passed the written exam related to Mechanisms Kinematics:
   - 95% arithmetic average of the 2 written exams (Exam of Mechanisms Kinematics and exam of Machine Dynamics).
   - 5% mark of the practicals.

b) To those students that have not passed the written exam related to Mechanisms Kinematics:
   - 95% final written exam.
   - 5% mark of the practicals.

Conditions to pass the subject:
Pass the written final exam and obtain a mark of the subject equal or higher than 5.

Attendance to exams:
In the face of any circumstance that does not allow the student to attend the exam, this fact will be regulated according to the current regulations of the UPV/EHU.

Claim of exams:
The marks are published in Egela and, in the case of the final exams, they are simultaneously published in GAUR system. Once the marks have been published, the students who want to claim the exam have to indicate it in the established
period of time. The claims of the students that do not indicate it, or that despite of indicating they do not come in the corresponding revision day at established timetable, will not be heeded. All this is done with the purpose of dedicating the necessary time to the revision process, and giving an equitable and fair solution to each claim.

Resignation:
As it is specified in the "Normativa Evaluación de Enseñanzas de Grado" any student that wants to resign from the continuous evaluation in order to do the final evaluation, then he/she has to present the resignation document to the teachers in charge of the subject in the period of 18 weeks counting from the starting of the course, according to the academic calendar of the faculty. The final evaluation implies a unique final exam which is the 100% of the final grade.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
According to the regulations of the University of the Basque Country, a continuous evaluation has been established, which consists in:

- Practicals in mechanical labs and laboratories. In order to pass the practicals the student must attend to all of them and present the corresponding report, adequately completed, in the established date.

- An exam related to the first part of the subject: Mechanisms Kinematics. To pass the exam the student must get a mark equal or higher than 5. Passing this exam implies that the student is released of the corresponding part of the subject during the current academic course.

- A final exam.

Notes about the final exam:

a) In the case of the students that have passed the exam of Mechanisms Kinematics, the final exam will consist of the remaining contents of the subject, that is, Machine Dynamics. To pass the exam the student must get a mark equal or higher than 5.

b) The students that have not passed the exam of Mechanisms Kinematics, they will have a final exam that covers the total programme of the subject. To pass the exam the student must get a mark equal or higher than 5.

c) If someone does not attend to the final exam, then the result will be "Not Attended".

Mark of the subject once the final written exam has been passed:

a) To those students that have passed the written exam related to Mechanisms Kinematics:
   - 95% arithmetic average of the 2 written exams (Exam of Mechanisms Kinematics and exam of Machine Dynamics).
   - 5% mark of the practicals.

b) To those students that have not passed the written exam related to Mechanisms Kinematics:
   - 95% final written exam.
   - 5% mark of the practicals.

Conditions to pass the subject:
Pass the written final exam and obtain a mark of the subject equal or higher than 5.

Attendance to exams:
In the face of any circumstance that does not allow the student to attend the exam, this fact will be regulated according to the current regulations of the UPV/EHU.

Claim of exams:
The marks are published in Egela and, in the case of the final exams, they are simultaneously published in GAUR system. Once the marks have been published, the students who want to claim the exam have to indicate it in the established period of time. The claims of the students that do not indicate it, or that despite of indicating they do not come in the corresponding revision day at established timetable, will not be heeded. All this is done with the purpose of dedicating the necessary time to the revision process, and giving an equitable and fair solution to each claim.

Resignation:
As it is specified in the "Normativa Evaluación de Enseñanzas de Grado" any student that wants to resign from the continuous evaluation in order to do the final evaluation, then he/she has to present the resignation document to the
teachers in charge of the subject in the period of 18 weeks counting from the starting of the course, according to the academic calendar of the faculty. The final evaluation implies a unique final exam which is the 100% of the final grade.

**COMPULSORY MATERIALS**

The work material of the subject that is available to the students, directly given by the teachers, is the following:

- The Student Guide of the subject.
- Guides for the preparation and accomplishment of the practical lectures of the subject.
- Simulation software for the computer-based practical lectures:
  
  GIM, software for kinematic analysis and simulation of planar mechanisms (COMPMECH Research Group: Hernández, A.; Altuzarra, O.; Pinto, Ch.; Petuya, V.; Amezua, E.; Macho, E; Corral, J.; Diez, M.; Urízar, M.; Herrero, S.; Campa, F.J.)
  
  User guide of GIM software (COMPMECH Research Group) Available in electronic format in Egela web site.
- ABB IRB 120 Robot.
- ADEPT Cobra e-vario 600 Robot.
- Parallel robot Physik Instrumente H-840.
- FANUC S-10 Robot.
- Work material for the lab lecture:

  Experimental system of one degree of freedom for the measurement of transmissibility.

  Digital signal analyser DI 2200, accelerometers, bending beam models and simplified building models, excitation table, signal generator and stroboscope.

**BIBLIOGRAPHY**

**Basic bibliography**

The teachers will use the following reading material to teach the subject:

- Compilation of exams. In Egela website.

**In-depth bibliography**

The students that are interested in studying some concepts in greater depth, have many books, journals, regulations and catalogs available at the university library and at the department of Mechanical Engineering. It is recommended to previously ask for advice to the teacher so that the student gets to know the best choice. A representative bibliography is the following:


**Journals**

- Mechanism and Machine Theory.
- Journal of Mechanisms and Robotics.
- IEEE Transactions on Robotics.
- Advanced Robotics.
- Robotica.
- Computer Applications in Engineering Education.
- Journal of Mechanical Design.

Useful websites

www.ehu.eus/compmech/software/
www.thinkmotion.eu
www.dmg-lib.org
http://kmoddl.library.cornell.edu
www.technologystudent.com
www.howstuffworks.com
www.biblioteka.ehu.eus
DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

The subject "Engineering Projects" is a common subject that is given in the Degree of Organization Engineering. The subject develops the capacity of the student to combine knowledge and attitudes acquired along the career to apply them in the develops of projects of engineering, having in counts especially the cost limitations, time, resources, organizational aspects, quality, risks and respect to the environment. Equally it develops the capacity of search of information. The topics of the theoretical part consist of exposing questions related to the managing and timing of projects of Engineering in its different phases. The practical part is about the application of the theoretical topics doing several individual and in group practices.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

M04IA1.- Knowledge, understanding and capacity to apply existing legislation in the development of projects in the field of environmental engineering.
M04IA3.- Knowledge and ability to participate in the design, project and execution of engineering solutions to environmental problems, including the evaluation of alternative strategies and control and safety criteria.
M04IA7.- Basic knowledge and application of environmental technologies and sustainability and assessment and correction of the environmental impact of human activities.
M04IA9.- Knowledge and skills to organize and manage projects. To know the organizational structure and functions of a project office.

Learning Results:
- Management of safety, quality, costs and environmental aspects in the development of industrial works.
- Environmental, safety, quality and cost management in the development of industrial and urban infrastructures.
- Acquisition of adequate knowledge regarding the legal protection of the environment.
- Acquisition of the capacity to analyse and interpret, individually and as a team, legal-environmental issues and their translation into professional activity.
- Understanding of the definition and methodology of a project development.

THEORETICAL/PRACTICAL CONTENT

1. THE PROJECT DEFINITION
2. PHASES AND DOCUMENTS OF THE PROJECT
3. PROJECT ASSESSMENT
4. BASIC AND DETAILED ENGINEERING
5. PROJECT ORGANIZATION AND MANAGEMENT
6. PROJECT TIMING
7. TECHNICAL REPORTS
8. TECHNICAL PROCEDURES AND INDUSTRIAL LEGISLATION
9. METHODOLOGY OF PRODUCT DESIGN
10. ERGONOMICS
11. ECODESIGN
12. EVALUATION OF ENVIRONMENTAL IMPACT
13. ENVIRONMENTAL MANAGEMENT OF THE COMPANIES
14. QUALITY MANAGEMENT. THE QUALITY IN THE PROJECT
15. QUALIT COSTS. TOOLS FOR PROBLEM SOLVING
16. STANDARDISATION, ACCREDITATION AND CERTIFICATION
17. LABOR RISKS PREVENTION
18. SAFETY IN THE PROJECT

METHODS

The theoretical part will be given in the first quarter and it consists of master classes and the resolution of individual exercises to help the comprehension of the given matters. The practical part will be during the whole course: the students will work with different tools in the area of the Projects of Engineering, and after will develop individual and in group works, where the acquired knowledge will be put into practice.
TOOLS USED & GRADING PERCENTAGES

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<td>M: Lecture</td>
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<th>Type of teaching</th>
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ASSESSMENT SYSTEMS

- Continuous assessment system
- Final assessment system

THE STUDENT ASSESSMENT WILL BE DONE WITH NEXT WEIGHTING PROCEDURE: FINAL THEORY EXAM 40 %, PRACTICES 60 %. IT IS NECESSARY TO OBTAIN POSITIVE ASSESSMENT IN BOTH ASPECTS SEPARATELY. THE WITHDRAWAL TO CALL IS REALIZED NOT APPEARING TO THE EXAM, AND IT WILL CONSIST OF "NOT PRESENTED".

THE Final THEORY EXAM OF THE ORDINARY CALL WILL BE REALIZED IN JANUARY.

The practices will be evaluated by the ongoing evaluation method. The student is able to renounce to this method, by asking for a final exam, according to the current normative rules.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

THE STUDENT ASSESSMENT WILL BE DONE WITH NEXT WEIGHTING PROCEDURE: FINAL THEORY EXAM 40 %, PRACTICES 60 %. IT IS NECESSARY TO OBTAIN POSITIVE ASSESSMENT IN BOTH ASPECTS SEPARATELY. THE WITHDRAWAL TO CALL IS REALIZED NOT APPEARING TO THE EXAM, AND IT WILL CONSIST OF "NOT PRESENTED".

In the case that the student does not have done the practices by the method of on-going evaluation, he or she is able to ask, previous communication, for a final exam including both theory and practices, according to the current normative rules.

COMPULSORY MATERIALS

The management of the subject will be necessarily across the platform egela.ehu

BIBLIOGRAPHY

Basic bibliography
- J. Caamaño, &#8220;Elementos básicos de Ingeniería de Proyectos&#8221;, Publicaciones de la ETSIB UPV/EHU, 2004
- PMI, &#8220;A guide to the Project Management Body of Knowledge (PMBok) 6th edition&#8221;, 2017
- A. González Marcos et. Al, &#8220;Ingeniería de Proyectos&#8221;, Dextra Editorial, 2014 - Capítulo 7
- UNE 157001:2014 Criterios generales para la elaboración formal de los documentos que constituyen un proyecto técnico, 2014

In-depth bibliography

Journals

Useful websites

REMARKS

- PMI, https://www.pmi.org/
- IPMA http://www.ipma.world/
- AEIPRO https://www.aeipro.com/es/
DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

Starting from the origins of Telematics, the course presents the fundamentals of the components of a communications system. It presents the need to establish communication architectures models stratified in layers and analyzes the concepts associated with these architectures as well as the interaction between layers and their application.

To that end, the most relevant applications and protocols are analyzed layer by layer so that the student acquires the necessary skills to analyze and diagnose the state of a network, identify connections and interpret the operation of the applications and the application, transport, network and link layer protocols from the information contained in a network trace obtained through a network protocol analyzer/packet sniffer software.

Likewise, contents that allow successfully designing network architectures and addressing schemes adapted to customer specifications are developed by selecting alternatives that optimize the number of addresses, networks, equipments, etc.

To successfully perform in this course students must become familiar with the tools and basic applications in telematics as well as with their usage such that they are able to further understand and apply the theoretical concepts of the course.

Contextualization in the curriculum:

In this course, which takes place during semesters S3 and S4, a global view of the architecture of telecommunication networks and services is provided. Therefore, the competences acquired through it are essential for access to jobs related to Telematics.

The contents of this course are related to other courses taught within the Bachelor of Science Degree in Telecommunication Technologies. Specifically, it provides the necessary foundations for other courses in the curricular lines of Telecommunication Networks and Telecommunication Services, being the axis from which they are structured: Network Planning and Modeling (common to the branch of Telecommunications during S5) and Networks Access, Transport Networks (backbone to the branch of Telematics Engineering during S6), Information Systems Architecture (common to the branch of Telecommunications during S6) and Advanced Telematic Services (backbone to the branch of Telematics Engineering during S6).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The approach of the course is oriented so that the student can acquire the following competences:

BASIC SKILLS That the students:
- Know how to apply their knowledge to their work or vocation in a professional way and have the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- Can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
- Have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

COMPETENCES OF THE DEGREE:
- Knowledge of foundations and technologies, which enables him to learn new methods and technologies, as well as giving him great versatility to adapt to new situations.
- Ability to solve problems with initiative, decision making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical and professional responsibility of the Telecommunication Technical Engineer activity.
- Ability to work in a multidisciplinary group and in a multilingual environment and to communicate, both in writing and orally, knowledge, procedures, results and ideas related to telecommunications and electronics.

COMPETENCES OF THE COMMON MODULE TO THE TELECOMMUNICATION BRANCH
- Ability to learn independently new knowledge and techniques suitable for the conception, development or operation of telecommunication systems and services.
- Knowledge and use of network architecture concepts, protocols and communication interfaces.
- Ability to differentiate the concepts of access and transport networks, circuit and packet switching networks, fixed and mobile networks, as well as distributed network applications and systems, voice, data, audio, video and interactive services and services, multimedia.
- Knowledge of the methods of network interconnection and routing, as well as the basics of planning, dimensioning of networks according to traffic parameters.
THEORETICAL/PRACTICAL CONTENT

1.-Basic concepts and foundations of telecommunication networks and services
What is a telecommunication network, elements, topologies, services, applications ...
Architecture of a telecommunications network:
- Terminal systems
- Access network: technologies, dedicated / shared link ...
- Network core:
  Switching functions (circuits / packets, connection oriented / non-connection oriented), multiplexing (FDM / TDM / statistics)
  Internet backbones, ISPs
  Protocol layers / Service models

2.-Application layer
Principles of network applications
Basic applications: web browsing, file transfer, email, name resolution, p2p applications

3.-Transport Layer
The transport layer and its services
Unreliable transport: UDP
Reliable transport: TCP, flow control, congestion control
Session capture and analysis of them.

4.-Network layer
Network functions, types of services
Service oriented connection (generic).
Non-connection oriented service: IP. Addressing, datagrams, basic procedures and associated procedures (ARP, ICMP, DHCP, NAT ...)

5.-Link layer
Link functions.
Point-point links: Simplified HDLC, PPP.
Multipoint links-LAN: Ethernet

6.-Network interconnection
Interconnection functions.
Interconnection at the physical level (repeaters, hubs), link (bridges, switches), network (routers), superior (gateway)

7.-Global vision of the course
Vision of telecommunication networks and services integrating all levels of communication

PROFUNDIZACIÓN

REVISTAS

DIRECCIONES INTERNET

EVALUACIÓN DE LA ASIGNATURA (INDICAR METODOLOGÍA DE EVALUACIÓN Y % SOBRE LA NOTA FINAL. P. EJ. EXAMEN ESCRITO 60%, INFORMES 10%.......).

METHODS

Teaching-Learning Methodology

The course consists of Lectures (M), Seminars (S) and Labs (PL) based on which the theoretical and practical contents are articulated according to the instructions M / S / PL for each one of them.

Regarding the organization/distribution throughout the course of the different modalities of classes, since it is an annual (fall+spring semester) course, the bulk of the lecturing hours are concentrated during the first semester so that the students have all the necessary theoretical background to make the most out of the lab sessions and seminars as soon as
possible.

### TYPES OF TEACHING

<table>
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<tr>
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### ASSESSMENT SYSTEMS
- Continuous assessment system
- Final assessment system

### TOOLS USED & GRADING PERCENTAGES
- Extended written exam 70%
- Practical work (exercises, case studies & problems set) 5%
- Practicas de Laboratorio en equipo con equipamiento de Red 25%

### ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The final grade for this course is computed as the sum of 4 aspects:

A. Continuous evaluation of the seminars: 5% of the grade
B. Labs: 25% of the grade
C. Minimum skill assessment: 20% of the grade
D. Theory/Assignment-practical exams (written): 50% of the grade

In order to pass the course, the following conditions must be met (BOTH):
- In section C, get at least 7 points (out of 10).
- In the weighted sum \(A \times 0.05 + B \times 0.25 + C \times 0.20 + D \times 0.5\), get at least 5 points (out of 10).

In case of not fulfilling one of the last two conditions, the qualification of the subject will be "Not passed".

Below is a breakdown of each of the 4 parts of the grade:

5% Continuous Evaluation Performance:
This part of the grade includes the evaluation of the activities related to the seminars held both individually and as a group, as well as the attitude, involvement and evolution of the student in these activities.

25% Labs
Evaluation modality to choose:
1) With compulsory attendance and continuous evaluation:
   - Evaluation of activities related to laboratory practices, performed both individually and in pairs (50%).
   - Individual partial tests, carried out at the end of each block of practices (50%).

2) Without compulsory attendance and without continuous evaluation:
   - Individual single test, carried out at the end of the course and whose date of completion will be notified once it has started (100% of the laboratory grade).
   Deadline to communicate the choice of one or another form of evaluation: up until Labs starting date.

20% Minimum skill assessment
Mastery of fundamental concepts of the course.

50% Exam
December / January: written exam on theory from the course (20%)
May: written exam on assignment exercises and practical questions (30%)

### DISCLAIMERS OF FOLLOW-UP EVALUATION:
Those students who wish to avail themselves of the right to renounce the continuous (or mixed) evaluation system and opt for the final evaluation, may communicate the aforementioned decision preferably via email to the teachers responsible for the subject at any time during the first 18 academic weeks of the current academic year.

### DISCLAIMERS TO THE CALL:
The resignation to the call will mean the qualification of not presented or not presented. In the case of continuous assessment, students may waive the call in a period that, at least, will be up to one month before the end date of the
teaching period of the corresponding subject. This waiver must be submitted in writing to the faculty responsible for the subject.

**EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT**

Evaluation of the Extraordinary Call
The evaluation of the extraordinary call will be made based on an examination final for 100% of the grade.

The exam will consist of 2 separate parts:
Y. Demonstration of minimum knowledge: 20% of the grade
Z. Examination of all the theoretical and practical aspects treated in the subject (lectures, seminars and laboratory practices): 80% of the grade

In order to pass the course, the following conditions must be met (BOTH):
- In section A, get at least 7 points (out of 10).
- In the weighted sum \( A \times 0.2 + B \times 0.8 \), get at least 5 points (out of 10).

Among the students that either did not take the exam or did not pass the course in ordinary call, those who:
- In section C they have obtained less than 7 points (out of 10), but
- In the weighted sum \( A \times 0.05 + B \times 0.25 + D \times 0.50 \) you have obtained at least 5 points (out of 10) in the extraordinary session you will only have to take the minimum knowledge exam (Y), being released in said call for the rest of the exam (Z).

The calculation of your final note in the extraordinary call will be the weighted sum \( A_{ord} \times 0.05 + B_{ord} \times 0.25 + Y_{extra} \times 0.20 + D_{ord} \times 0.50 \).

**COMPULSORY MATERIALS**
- Slide bundles with material for lecture classes (available eGela).
- Self-assessment questionnaires for knowledge assimilation (available in eGela in online format and / or pdf)
- Wiki and final report on expected minimum knowledge required for each of the theoretical topics (available in eGela)
- Assignments (exhibitions and resolution of exercises individually, or through different group dynamics) for seminar classes.
- Guides for the realization of labs (includes questionnaires prior to practice, script of the proposed practice for its development in the laboratory, questionnaire to be completed for the preparation of the final report of the practice based on the skills acquired during the realization Of the same).

**BIBLIOGRAPHY**

Basic bibliography

In-depth bibliography

Journals

Useful websites
- Kurose, on-line resources: http://wps.aw.com/aw_kurose_network_5/
- Stallings, on-line resources: http://williamstallings.com/DataComm/
  http://www.librosite.net/20/20a.asp?i=63

**REMARKS**
**SUBJECT**

| 27318 - Automation and Control | ECTS Credits: 6 |

**DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT**

Control systems are very present in our daily life. Examples of its applications can be found at home (temperature control, anti-theft system or mobile phone apps), in transportation systems (such as ABS or traction control of a car, or cruise control of planes), in industry (pharmaceutical, machine tool or process industry) or in the control of the traffic over the Internet. Areas such as economics, biology or medicine have also a wide range of applications that require the use of control systems.

A synthesized automatic control system has a clear goal: to achieve a system (machine, process or device) to behave in a certain way with minimal human intervention. If the control system has "feedback", then it is able to measure the behaviour of the controlled system and correct it if it deviates from the desired one. Feedback is a feature of life, as every organism share the ability to measure their own state, and make the required changes if necessary. Feedback determines how we grow, how we respond to stress or how we regulate body temperature, blood pressure or cholesterol level. Hence, control does not only make our life easier, but it is critical to our own existence.

Automatic control systems are inherently multidisciplinary. It is typically formed by sensors (to measure), actuators (in order to make changes on the system), computers and software (to calculate and make decisions).

The analysis and design of control systems requires the following knowledge:
- Knowledge of the domain of the process to be controlled (in this case, Engineering areas)
- Knowledge of control techniques
- Knowledge of the actuator and sensor technologies
- Knowledge of Real-Time systems
- Knowledge of actuator and sensor networks

This subject focuses on how to use knowledge of processes from different disciplines (physics, chemistry, mechanical, electrical, ... ) acquired in other subjects previously studied and the use of previously studied mathematical tools (differential equations and Laplace transform) in the analysis and design of control systems.

This aim is achieved by the following contents:

**THEORETICAL contents** to address modelling examples of real systems, their mathematical representation and their model-based dynamic behaviour analysis.

**METHODOLOGY contents** to address the different phases of a feedback control system design which ensures that the behaviour of a system lies always within some bounds.

**EXPERIMENTAL contents** to show the effect of controller design in real systems (scale models of simple industrial systems).

This subject is related with the following ones in the Bachelor studies: the controller design techniques for computer implementation are studied in the pre-intensification subject "Computer-based Control", while the more technological subject "Industrial Automation" is focused on the logic control and sequential control of Industrial Processes".

The Real-Time programming concepts, networks, robotics and advanced control techniques are studied in several subjects in the Master.

**COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT**

As the verified report of "Bachelor’s Degree in Industrial Technology Engineering" states, the skills and learning outcomes to be developed in this subject are:

- **M02R6** Knowledge of the basics of automatic systems and control methods.

- **LO** Automatic and control Systems design for machines and industrial facilities.

This Learning Outcome can be divided in the following partial ones:

- **LO1** Determination of the design goal, by identifying the main variables of the control system.

- **LO2** Formulating the linear mathematical model of simple systems, and their external representation based on the main variables analysis.
-LO3 Analysing the dynamic behaviour of the systems in the time domain.
-LO4 Analysing the effect of feedback on the dynamic behaviour of the system.
-LO5 Determination of the most adequate type of controller for each case, and its design in order to fulfil specific response specifications.
-LO6 Analysing the dynamic behaviour of the systems in the frequency domain.

THEORETICAL/PRACTICAL CONTENT

LECTURES:
Lesson 2 Dynamic System Modelling. System Mathematical Modelling (mechanic, hydraulic, electric, …) . Linearization.
Lesson 4 Time Domain Analysis. Test signals. Time response of first order, second order and great order systems. Experimental system identification.

LABORATORY SESSIONS:
The laboratory sessions are essential to acquire the knowledge on control systems and emphasize the basic concepts of Automatics and Control subject. Two kind of sessions have been considered:

A) Simulation sessions using Labview. The laboratory sessions are focused in analysing the modelling, analysis and simulation of feedback systems.
P2: Linealized systems. First order systems.
P3: Second order systems and pole dominance.
P4: Feedback systems. Stability and errors. PID Controller.

B) Real system control using scale models. Scale models are used to provide the student with the opportunity of analysing the effect of real control problems.
P1: Experimental identification and model validation.
P5: Design and validation of control systems.

METHODS
The aim of the subject is to provide the student with the necessary tools to design a control system, applying the basic control concepts to each step of the design process: modelling, analysis and design.
The lectures are used to explain the theoretical concepts while emphasizing their importance and their application context.
The seminars are used to strengthen the theoretical concepts by means of the resolution of practical exercises. In some sessions, concepts related with the laboratory sessions will be analysed, so that the preparation work required for the Laboratory Sessions is reinforced. Moreover, students are encouraged to work in teams to discuss their design results.
The laboratory sessions are focused on the different stages of a control system design and validation. Some of these sessions are focused on using real scale processes in which students work in teams, while others are based on the use of simulation software that will be handled individually.
In order to get the most of the seminars and the laboratory sessions, a proper preparation work is mandatory. The Seminar and Laboratory Notebook is the required tool to achieve this goal.
This way, students will fill the exercises and questions proposed in this notebook prior and during these sessions. This Notebook could be required by the lecturers at any time to analyse the progression of the students and provide with feedback.
All the information related with the subject (theory, simulation software) is available in the virtual platform eGELA: https://egela.ehu.es/. Hence, students should access regularly to the web page, as it will, in addition, be used to notify students with all matters related to the subject.

SOFTWARE USED:

- Labview based tool: Analysis, simulation and control tool for real scale models
- Virtual Platform (eGELA): Communication platform in which students will find the information related with the subject.
- Virtual Platform (GOODLE): Web-based evaluation platform

### TYPES OF TEACHING

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### ASSESSMENT SYSTEMS

- Continuous assessment system
- Final assessment system

### TOOLS USED & GRADING PERCENTAGES

- Extended written exam 70%
- Multiple choice test 20%
- Practical work (exercises, case studies & problems set) 10%

### ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The evaluation system used in this subject is of mixed type (being a subtype of the continuous evaluation), combining continuous evaluation and final exams, as detailed in Normativa de gestión para las enseñanzas de grado y de primer y segundo ciclo.

The evaluation tools to be used are:

- Partial written exam. Test type questions, open answer questions or problems can be found. 20%. Learning outcome: LO1-4
- Doctus and eGELA platforms for self-assessment and deliveries. 10%. Learning outcome: LO1-5
- Final written exam. Test type questions, open answer questions or problems can be found. 70%. Learning outcome: LO1-6

In order to pass the subject, it is required to obtain at least 50% of the mark using the aforementioned tools. Moreover, it is mandatory to pass the written final exam, this is obtaining at least the 50% of the mark associated to this part. If 50% of the mark is not achieved in this part, the final mark of the subject will be the one of the final written exam (considering a 10 points basis).

As it is detailed in the Normativa de gestión para las enseñanzas de grado y de primer y segundo ciclo, students can resign to the continuous evaluation in the Ordinary Call. This resignation must be formalised by presenting the corresponding document (provided by the lecturer) signed by the student in the Department of Automatics and System Engineering secretary’s office. This document must be formalised in the first 9 weeks of the course (according to the official course calendar) to be valid.

A complementary exam will be carried out for the students that have resigned to the continuous evaluation to evaluate the 30% of the mark associated to this part. This complementary exam will be carried out the day of the final written exam, and will be written and/or in the laboratory, evaluating the concepts equivalent to those covered in Seminar and Laboratory sessions. This is, the mark of these students will be obtained by the mark of a final written exam (70%) and the complementary exam (30%).

The unattendance to the official final exam, will automatically imply a resignation to the call. The resignation to the ordinary or extraordinary call will imply a "No-Show" mark.
EXTRAORDINARY EXAM CALL: GUIDELINES &DECLINING TO SIT

The final mark in the extraordinary call will be calculated by several exams that will evaluate all theoretical and practical concepts covered by the subject. The structure of the exams will be similar to those of the ordinary call, this is, a final written exam (70%), and a complementary exam (30%).

Students that have not resigned to the continuous evaluation will have the right to maintain the mark associated to this concept (%30), being exempt of the complementary exam. The final mark will be calculated by combining the final written exam (70%), and the continuous evaluation mark (30%).

Students that have not resigned to the continuous evaluation can choose not to maintain the mark associated to this concept (%30). This resignation to the maintenance of the continuous evaluation mark must be formalised by presenting the corresponding document (provided by the lecturer) signed by the student in the Department of Automatics and System Engineering secretary’s office. This must be formalised at least a month before the official extraordinary call exam date. The final mark will be calculated for this students by combining the final written exam (70%), and the complementary exam (30%).

For those students that have already resigned to the continuous evaluation in the ordinary call, the final mark will be calculated by combining the final written exam (70%), and the complementary exam (30%).

In order to pass the subject, it is required to obtain at least 50% of the mark using the aforementioned tools. Moreover, it is mandatory to pass the written final exam, this is obtaining at least the 50% of the mark associated to this part. If 50% of the mark is not achieved in this part, the final mark of the subject will be the one of the final written exam (considering a 10 points basis).

The unattendance to the official final exam, will automatically imply a resignation to the call. The resignation to the ordinary or extraordinary call will imply a “No-Show” mark.

COMPULSORY MATERIALS

Laboratory and Seminar Notebook. Faculty publication.

Labview-based software tool for simulation and control of real time systems.

eGELA virtual platform for subject notes, information and general issues.

Doctus virtual platform for web-based evaluation of practical sessions.

BIBLIOGRAPHY

Basic bibliography

In-depth bibliography

Journals

Useful websites
Comité Español de Automática. http://www.cea-ifac.es/
COURSE GUIDE 2019/20

Faculty 345 - Faculty of Engineering - Bilbao  Cycle Not Applicable
Degree GITECI30 - Bachelor’s Degree in Industrial Technology Engineering  Year Fourth year

COURSE

27325 - Structural Materials: Behaviour in Service and Mechanics of Fracture  Credits, ECTS: 6

COURSE DESCRIPTION

Based on the fundamental knowledge of Materials Science acquired in the second year, this course contributes to the
development of knowledge of the properties and behavior of structural materials in relation to the mechanical elements,
mechanical structures and manufacturing machines that use materials like constructive elements. This course will be of
general interest for some engineering specialty and to carry out final degree projects on Industrial Engineering.
This course explores the nature, properties and processing of structural, metallic, polymeric, composite and ceramic
materials with special emphasis on the microstructure and mechanical properties. The study of fracture, fatigue and
corrosion behavior in service is also analyzed.
The mechanisms that ensure horizontal coordination within the course are based on the coordination of programs of this
subject with others that introduce and employ similar concepts and principles, such as machine elements, machinery
calculations and structures theory.
Vertical coordination is associated with the structure of the study programme, so that the subjects necessary for the proper
tracking of the present subject are already given in previous courses of degree.

Los mecanismos que garanticen la coordinación horizontal, dentro del curso, se basan en la coordinación de los
programas de esta asignatura con otras que introducen y emplean conceptos y principios similares, como son Estática-
Mecánica y Termodinámica.
Los mecanismos que garanticen la coordinación vertical están asociados a la estructuración del propio Plan de Estudios
completo, de modo que las asignaturas precisas para el seguimiento de la presente estén ya impartidas (Física y
Química), y las asignaturas que precisan de ésta para su impartición estén en cursos posteriores, como efectivamente lo
están.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Capacity to address developments, projects and advanced studies in the field of materials engineering with a high degree
of autonomy.
Find and select information, written and oral communication skills, writing report and projects, documentation
management.

COURSE CONTENTS, THEORETICAL & APPLIED

Lesson 1. Presentation and Introduction. Types of materials against mechanical behavior. Crystal structure. Elastic
deformation and theoretical resistance. Non-crystalline structure. No elastic deformation.
Lesson 2. Structural Materials. Introduction to Physical Metallurgy. Hardening mechanisms metal alloys. Alloying and
shaping materials.
polymers.
CTOD. J integral. HRRFields.
Corrosion resistant materials.

TEACHING METHODS

In the theoretical classes, teachers give extensive explanations with the help of presentations. The book with all
presentations will be available to students in the reprographic service of the university.
In the seminars, teaching will focus on specific topics that require additional exercises to encourage teamwork and
participation of students with possible occasional debates. Thus, the theoretical knowledge of the subject is deepened in a
more practical and applied manner.
In practical laboratory experimental work will be developed to acquire knowledge and skills of the experimental techniques.
used in materials science. Students must carry a laboratory notebook (available in reprographic service center). The notebook includes the description of the practice and some short questions for self-assessment

**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>
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<tr>
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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
- GCL: Applied clinical-based groups
- TA: Workshop
- TI: Industrial workshop
- GCA: Applied fieldwork groups

**Evaluation methods**

- End-of-course evaluation

**Evaluation tools and percentages of final mark**

- Written test, open questions 55%
- Exercises, cases or problem sets 10%
- Teamwork assignments (problem solving, Project design) 35%

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

- Written exam of the theory and exercises: 55% of the final mark.
- Degree of use of the lessons practical exercises develop during lectures. Evaluation of the students autonomy ability.
- Preparation, written report and oral defense: 35% of the final mark
- Evaluation of comprehensive ability to use theoretical and practical knowledge for solving open problems on materials.
- Evaluation of the ability to work in teams making proposals, analyzing contributions of others, discussing ideas and implementing appropriate action. Interpersonal skills.
- Laboratory practice report: 10% of the final mark
- Evaluation of knowledge communication skills both by written and oral. Evaluation of the laboratory practices use.

If the student is not presented to the exam, by default it will be consider that the student express its resignation.

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

- Written exam of the theory and exercises: 55% of the final mark.
- Degree of use of the lessons practical exercises develop during lectures. Evaluation of the students autonomy ability.
- Preparation, written report and oral defense: 35% of the final mark
- Evaluation of comprehensive ability to use theoretical and practical knowledge for solving open problems on materials.
- Evaluation of the ability to work in teams making proposals, analyzing contributions of others, discussing ideas and implementing appropriate action. Interpersonal skills.
- Laboratory practice report: 10% of the final mark
- Evaluation of knowledge communication skills both by written and oral. Evaluation of the laboratory practices use.

If the student is not presented to the exam, by default it will be consider that the student express its resignation.

**MANDATORY MATERIALS**

- Power point of the lessons.
- Problem and exercises book.

**BIBLIOGRAPHY**

Basic bibliography

- Crawford R.J., Plastics Engineering, (third edition 1999)
Detailed bibliography


Journals

- International Journal of Plasticity
- Scripta Materialia
- Materials and Design

Web sites of interest

http://products.asminternational.org/hbk/index.jsp
http://www.sciencedirect.com/
In this course the particularities of the wireless mobile environment regarding the provision of telecommunications services are identified and the necessary adjustments at different levels compared to the non-mobile environment are analysed. Different technological solutions to provide mobility are studied and compared, analysing the specific problems solved by each of them, their application environment, network architecture, protocols, types of services they can offer...

The course seeks a specialization in the telematics aspects of mobile networks and services, fostering the acquisition of the skills to apply the techniques required by both telephony and data networks to the ever-growing mobile environments. The course is based on the general networking concepts presented in the course "Architecture of Telecommunication Networks and Services" which are particularized in this course for mobile networks. In addition, "Mobile Networks and Services" forms a block with two other courses: "Access Networks" and "Transport Networks". In the first one, the different technologies that allow the users to access the data networks are covered. Wireless and mobile networks are a subset of these technologies that in "Mobile Networks and Services" is studied in depth. In the second backhaul and interconnection networks are analysed.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

BASIC COMPETENCIES
- Students have demonstrated knowledge and understanding in a field of study that has its foundations on the general secondary education, and it is typically at a level which, although it is based on advanced textbooks, includes some aspects that involve knowledge of the forefront of their field of study.
- Students can apply their knowledge to their work or vocation in a professional manner and have skills typically demonstrated through devising and defending arguments and solving problems within their field of study.
- Students have the ability to gather and analyse relevant data (usually within their field of study) to make judgments that include reflection on relevant social, scientific or ethical aspects.
- Students can communicate information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students have developed those skills needed to undertake further studies with a high degree of autonomy.

COMPETENCIES OF THE GRADE
- Knowledge of basic subjects and technologies that enable the student to learn new methods and technologies and that will give him or her the versatility to adapt to new situations.
- Ability to solve problems with initiative, decision making, creativity, and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the activity of a Technical Telecommunications Engineer.
- Ability to work in a multidisciplinary group and in a multilingual environment and communicate, both in writing and orally, knowledge, procedures, results and ideas related to telecommunications and electronics.

SPECIALTY COMPETENCIES OF THE TELEMATICS MODULE
- Ability to apply the fundamental techniques of the networks, services and data communication applications, such as management systems, signaling and switching, routing, security (cryptographic protocols, tunneling, firewall, tariffication mechanisms, authentication and contents protection), traffic engineering (graph theory, queuing theory and teletraffic) pricing and reliability and quality of service, either in fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.

LEARNING RESULTS.
- The students will be able to describe the problems and the particular needs that arise in the provision of telecommunication services due to the wireless mobile environment, and will also be able to analyse comprehensively and compare alternative solutions to address these problems.
- The students will be able to search and analyse information on a mobile technology, working in a team. They will be able to analyse and understand in depth and, in most cases, experimentally test this technology as a prerequisite to achieve the following learning outcomes.
- The students will be able to prepare an oral presentation on the technology that has been analysed, present it to the class and satisfactorily answer questions about it.
- The students will be able to discuss the characteristics, advantages and disadvantages of mobile technologies, and compare them reasonably.

COURSE CONTENTS, THEORETICAL & APPLIED

1. Mobile networks and services: Introduction and context.
2. Technological requirements of the mobile environment.

**TEACHING METHODS**

Regarding the teaching methodology, the course is divided into two parts. In the first 6 weeks of the course lectures are used to present the first two units. In the second part of the course (9 weeks) the class is organised in work groups to analyse different mobile technologies and present them to the class. Seminar classes and classroom practices are used in this stage to accomplish these tasks.

**TYPES OF TEACHING**

<table>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>17.5</td>
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<td>12.5</td>
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<tr>
<td>Hours of student work outside the classroom</td>
<td>26.25</td>
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</table>

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

**Evaluation methods**

- End-of-course evaluation

**Evaluation tools and percentages of final mark**

- Written test, open questions  60%
- Teamwork assignments (problem solving, Project design)  30%
- Oral presentation of assigned tasks, Reading  10%

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

In the ordinary exam call, the mark will be the sum of 3 parts:

A. Partial examination: 10% of the mark
B. Analysis of technologies: 40% of the mark
C. Final examination: 50% of the mark

In order to pass the course, the students must meet the following conditions (all of them):

- Have participated actively in one of the working groups on technology,
- In the weighted sum (A + B * 0.1 * 0.4 * 0.5 + C), get at least 5 points (out of 10).
- In the weighted sum (A + C * 0.1 * 0.5), obtain at least 4 points (out of 10).

To decline to sit in the ordinary call of the course will be enough not to attend the final written test of the ordinary call.

If a student wants to decline the ongoing assessment, he/she must proceed according to the procedure and deadlines established in the Article 8.3 of the Student Assessment Rules of the UPV/EHU.

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

In the extraordinary exam call, the qualification will be determined by a final written test that will comprise the 100% of the subject.

To decline to sit in this call it will be enough not to attend the final written examination.

**MANDATORY MATERIALS**

Documentation available in the virtual classroom of the course in eGela.

**BIBLIOGRAPHY**

Basic bibliography


Detailed bibliography

Web sites of interest

- http://www.3gpp.org
- http://www.ieee802.org/11/
- http://standards.ieee.org/about/get/802/802.11.html
- http://www.wi-fi.org/
- http://www.ieee802.org/15/
- http://www.coit.es/foro/?op=cronologia&idcategoria=317 (Cronología de España)

Journals

- Apuntes de la asignatura "Conmutación I" de la UPM.

http://fundacion.vodafone.es/static/fichero/pre_ucm_mgmt_002620.pdf
Competencies / learning outcomes of the subject

Competencies of the subject:
- Knowledge and skills for the calculation, design and testing of machines.
- Ability to undertake developments, projects and advanced studies in the field of mechanical engineering, with a high level of autonomy.

Learning outcomes:
- Resistant design through the Finite Elements Method.
- Design against fatigue failure.
- Search for and select information, communicate it orally or in writing, draft reports.

Methodology

The subject consists of lectures, classroom practical work and practical computer sessions.

1.- Lectures

The basic part of the teaching of the subject, with the professors explaining the lessons in the classroom and interacting with the students. To make the most of these classes, students will receive the basic information on the lesson to be taught in advance. The sessions are mainly based on content explained on the board plus computer presentations.

2.- Practical work in class

Problem-solving and the study of practical cases to learn to select the most method for each case and apply the calculation methods and procedures presented in the lectures and computer sessions.

3.- Individual and group tutorials

The tutorials will be used to clarify aspects of the subject that the student may wish to discuss after having attended class and done the prior study work. The subject professors will be available at the times assigned for tutorials, published in the GAUR program of the UPV/EHU. The tutorials will take place in each professor’s study in the Department of Mechanical Engineering of the ETSI in Bilbao.

4.- Virtual teaching platform

The e-Gela-EHU platform is available to students with a range of information to facilitate following the course. Specifically, the following are published: the Student's Guide, the content of the computer sessions, and a collection with exam examples. Forums will also be created to foster participations by students and facilitate cooperative learning.

Ordinary exam call: guidance and withdrawal

In class, voluntary work can be proposed, relating to the preparation of reports and practical cases to be done individually by the students. Each student can carry out a project in the subject that can be worth 1 extra point to be added to his/her grade for the subject. Work of poor quality that does not score a minimum of 0.5 points will not be taken into account.
Likewise, in the practical computer sessions the students may be given short questionnaires to respond to immediately using the MOODLE platform. These questionnaires automatically give the correct answer once it has been entered, so the student can make a self-assessment and the professor have up-to-date information on the progress of the practical work group. These questionnaires can be evaluated to add 1 extra point to the student's grade.

In November an exam will be held during the teaching timetable, with a possible 1 point added. There will be a maximum of 2 extra points, so that if the total exceeds that figure it will not be added to the student's final grade. The final grade is the sum of the final exam plus the extra points scored. The overall total must be higher than 5 to pass the subject, on condition of getting at least 3.5 in the final exam.
SUBJECT
27384 - Analysis of Circuits
ECTS Credits: 6

DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

"Circuit analysis" is one of the basic subjects of the first year of the degree in Telecommunications Technology Engineering. It is placed in the module called Basic Training. The students will acquire basic knowledge on circuit theory, and will be able to solve simple circuits, reduce circuit complexity, and analyze circuit behaviour. Special attention will be placed on aspects related to telecommunication circuits. The subject is practice oriented, and comprises laboratory sessions to demonstrate applications and work with practical signals and systems related to telecommunications engineering.

Since the subject is both basic and practice oriented, it helps understanding other subjects like basic electronics, electronic devices and circuits, and circuit electronics. The subject is closely related to signal processing, a subject in which some of the tools and concepts introduced in circuit analysis are mathematically formulated.

To successfully complete Circuit Analysis, it is convenient to master basic complex-number algebra, linear algebra, and the basic concepts of electromagnetism. All these topics are covered in the mathematics and physics courses of the second high school year.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

This subject's competences are framed within the following competences of the Basic Training of the study plan:
CM4: Understanding and mastery of the basic concepts of linear systems and of the related functions and transforms, theory of electric circuits, electronic circuits, physical principle of semiconductors and logic families, electronic and photonic devices, technology of materials and its application to solve engineering problems of engineering.
CM2: Basic knowledge of computer programming and computer use, operating systems, data bases, and computer programs employed for engineering.

The subject specific competences are:
CE1: Know the mathematical tools and the basic concepts of the theory of circuits.
CE2: Know how to approach problems of electric circuits from proposed problem formulations. Apply the appropriate resolution method, and identify the correct solution.
CE3: Be able to analyse signals and circuits in the frequency domain.
CE4: Know how to use computer tools to simulate electric circuits, and be able to relate the results to the concepts of the theory of circuits.

The transversal competences of the degree developed in this subject are:
CT1: Ability to solve problems resourcefully, to take decisions, to be creative, to communicate and transmit knowledge, skills, and abilities, to understand the ethical and professional responsibility of Telecommunications Technical Engineers while developing their activity.
CT2: Ability to work in multidisciplinary teams and multilingual environments and to communicate knowledge both in writing and orally.

THEORETICAL/PRACTICAL CONTENT

1 Circuit Elements and Basic Laws
   1.1 Introduction
   1.2 Electric Circuit
   1.3 Circuit Elements
   1.4 Circuit Topology
   1.5 Kirchhoff's Laws
   1.6 Tellegen's Theorem
   1.7 DC Power and Energy
   1.8 Linearity

2 Simplification of Circuits
   2.1 Introduction
   2.2 Association of Resistances in Series and in Parallel
   2.3 Association of Ideal Sources
   2.4 Association of Passive Elements
   2.5 Real Generators Sources Circuit Topology
2.6 Association of Real Generators Sources
2.7 Thevenin and Norton Equivalents
2.8 Simplification and Elimination of Branches

3 Dynamic Circuits
  3.1 Introduction
  3.2 Transient Response
  3.3 DC Steady State
  3.4 Sinusoidal Steady State
  3.5 Power and Energy in Sinusoidal Steady State

4 Power Transmission
  4.1 Maximum Transfer of Power
  4.2 Everitt's Theorem
  4.3 Design of a Matching Network
  4.4 Insertion and Transmission Losses

5 Analysis of Circuits in the Frequency Domain
  5.1 Frequency Response
  5.2 Filters: Types and Characteristics
  5.3 Signal Filtering

METHODS

The contents of this subject are, essentially, worked on individually. The methodology for each mode of learning activity is described in this section, both for face-to-face teaching and for private study.

FACE-TO-FACE TEACHING (60h):
Master lectures (MAG): oral explanations of the fundamentals and theoretical concepts. These explanations are based on a set of slides for each topic, which can also be employed as documentation by students. (15h)

Classroom practices (PA): the teacher resolves ten problems per topic on the blackboard. Students know what problems will be done in advance, so that they can work on them prior to the face-to-face session. (15h)

Laboratory classes (LAB): simulation of circuits employing informatic computer tools (OrCAD/PSPICE). Some concepts worked in MAG or PA sessions are interrelated. At the same time, new theoretical concepts are learned. In addition, the fifth topic of the subject is entirely developed at the end of the course in laboratory classes. Sessions are based on exercise scripts/guides, in such a way that students know beforehand what they should prepare at home for the next session, which consists in a deliverable short task (pre-lab). (18h)

Seminars (SEM): question-solving sessions about things that have not been fully understood during the private study and resolution of problems. (12h)

PRIVATE STUDY (90h):

Magisterial classes/ster lectures: home assignments should be done every week, and some effort is also dedicated to the preparation for individual basic knowledge exams of basic knowledge (CB).

Classroom practices: students have to do 15 problems per topic individually. Questions that arise are solved in the seminars.

Laboratory classes: a deliverable short task (pre-lab) per session has to be done, and some effort is also dedicated to the preparation for questionnaires and for the final exam.

Seminars: there are individual assessments that should be prepared.

TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Type of teaching</th>
<th>M</th>
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<th>GA</th>
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<td>Classroom hours</td>
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<tr>
<td>Hours of study outside the classroom</td>
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<td>22,5</td>
<td>27</td>
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Legend:

ASSESSMENT SYSTEMS

- Final assessment system

TOOLS USED & GRADING PERCENTAGES
This subject has continuous evaluation composed of:

1. Continuous evaluation: 61% of the final grade. It is composed of:
   - Theory and exercises
     1.1 Basic knowledge topics 1 and 2: 13% of the final grade.
     1.2 Basic knowledge topics 3 and 4: 13% of the final grade.
   - Laboratory
     1.3 Pre-lab exercises presented before lab sessions start: 3.5% of the final grade.
     1.4 Questionnaires (3) during lab sessions: 10.5% of the final grade.
     1.5 Laboratory written exam, a practical exercise using PSPICE: 21% of the final grade.

2. Final individual exam: 39% of the final grade.
   2.1. Written exam with long exercises on concepts covered in topics 3 and 4: 39% of the final grade.

The final grade will be obtained doing the weighted mean of all grades, but a minimum grade is required in the following items:

Theory and exercises:
- 2.1 minimum grade 4/10.
- Weighted mean of 1.1, 1.2, 2.1, minimum grade 5/10 (final grade for the theory part).

Laboratory
- 1.5 minimum grade 5/10.
- Weighted mean of 1.3, 1.4, 1.5, minimum grade 5/10 (final grade for the lab part).

Each part (theory/lab) is passed independently, and once passed the grade will be kept for the coming calls.

Impossibility to follow the continuous evaluation.
Students unable to follow the continuous evaluation will have the opportunity to demonstrate they have acquired the learning results through a final evaluation consisting of:
- Final theory exam with long exercises and basic knowledge exercises: 65% of the final grade.
- Final lab exam with a PSPICE exercise (evaluation item 1.5): 35% of the final grade.

Ordinary call resignation
Students not showing up to evaluation items 1.5 and 2.1 (both of them) will be regarded as having renounced to the ordinary call.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The extraordinary call is composed of two parts:
1. Written individual theory exam with long exercises and basic knowledge exercises: 65% of the final grade.
2. Written individual lab exam, a practical exercise using PSPICE: 35% of the final grade.

Both exams have to be passed with a minimum grade of 5/10.

The students who do not present a written justification for their renounce to the continuous evaluation will have to demonstrate the adequate completion of the lab session practices.

COMPULSORY MATERIALS

In eGela (http://egela.ehu.eus/), students will be provided with the following learning materials necessary for the subject:

1. Overhead transparencies with the theoretical contents of the subject, topics T1-T4.
2. A collection of 10 problems to be solved in the classroom practices (PA) and 15 more problems aimed for offsite private work, topics T1-T4.
3. A collection of 15 problems per topic on basic concepts, topics T1-T4.
4. OrCAD/PSPICE user manual and installation guide.
5. Exercise scripts for the laboratory.
6. Videos.
BIBLIOGRAPHY

Basic bibliography
- R. E. Thomas, A. J. Rosa
  The analysis and design of linear circuits
  Wiley, 2011 (7th edition)
- R. L. Boylestad
  Introductory Circuit Analysis
  Pearson Education 2015 (13th edition)
- F. López Ferreras
  Análisis de Circuitos lineales (volúmenes I y II)
  Editorial Ciencia 3. 1994
- W. H. Hayt and H. Kemerly
  Engineering Circuit Analysis
- M. E. Van Valkenburg
  Network analysis
  Prentice Hall 1991 (3rd edition)

In-depth bibliography

Journals

Useful websites

REMARKS
The engineer dedicated to the design of structures and mechanical elements must own an important theoretical and practical knowledge. In particular, he should be able to explain the relationship between a particular structural member with the stresses to which it may be subjected, either in the form of applied forces, temperature variations, support displacements, etc., and the stresses and strains originated in the structure, all of which constitute the primary object of the "Elasticity and Strength of Materials". Among the different types of structures that could be considered, the course focuses on the analysis of structures formed by prismatic bars.

The content of the course is divided into two distinct blocks. After a first subject in which the student is introduced into the behavior of deformable solids and the concept of structure, in the following four topics the basics of the Theory of Elasticity are presented: stresses, strains, constitutive laws and elastic problem resolution, with particular attention to the problems of two-dimensional elasticity and a brief presentation of the most relevant experimental methods to obtain stresses and strains. This first block is concluded with a theme, theories of failure, which serves as a transition between the field of Elasticity and the following topics belonging more specifically to the Strength of Materials.

In the first topic of the second block, after describing the different types of structures formed by prismatic bars, the analysis of section forces and moments is addressed in these elements. A theme is dedicated to the analysis of simple lattices subjected to axial forces. In the last two themes the stresses and strains caused in pure bending and simple bending are studied, and this knowledge is applied to the resolution of isostatic structures.

This course is part of the curricular line of Mechanical Engineering and, therefore, is based on the subjects of 2nd course "Mechanics" and "Applied Mechanics" whose knowledge and mastery are essential to understand the behavior of structures and other mechanical parts considered as deformable solids. Obviously, the student should also have a good grasp of the fundamental concepts of "Algebra" and "Calculus" studied in the first year. Another link can also be found with another subject taught in the third year, "Theory of Mechanisms and Mechanical Vibrations", a discipline that helps determine the forces undergone by the elements of a mechanism, and from which stresses and strains can be obtained by means of the "Elasticity and Strength of Materials". In this way a proper design ensuring system integrity can be obtained.

The knowledge acquired in this subject also form the basis of other mechanical-type subjects of the fourth year such as "Theory of Structures and Construction", where new methods are shown in the calculation of structures formed by prismatic bars. It is also evident the relationship with the subjects "Theory of Machines" and "Machine Elements", where it is essential to obtain stresses and strains and to apply the corresponding theories of failure. Finally, the "Elasticity and Strength of Materials" is also basic for some subjects included in several Master courses: in the "Master in Mechanical Engineering" (a continuation of the Degree in Mechanical Engineering) and in the "Master in Industrial Engineering" (a continuation of the Degree in Industrial Technology Engineering).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The competence of the subject, for the common module of the Industrial Branch, and reflected in the memory of the degree is:

- Knowledge and use of the principles of strength of materials.

As a result of learning it is expected that the students are able to:

- Acquire the basic knowledge governing the Theory of Elasticity, fundamental for analyzing the behavior of deformable solids and therefore for the analysis of Strength of Materials.
- Establish the basic equations in the analysis of solids with linear elastic behavior and the range of application of the linear-elastic theory.
- Know the criteria for the selection and use of different failure theories in the calculation of structures.
- Become familiar with some of the experimental techniques used in the calculation of stresses and strains in structures.
- Be able to calculate the stresses and strains in lattices, both isostatic and statically indeterminate. For these latter structures special emphasis is placed on the use of the force method.
- Be able to determine the stresses and strains in isostatic structures subjected to bending.

COURSE CONTENTS, THEORETICAL & APPLIED

THEORETICAL CONTENTS

1. INTRODUCTION
2. CONCEPT OF STRESS
3. GENERAL THEORY OF STRAIN
4. THE ELASTIC SOLID
5. THE ELASTIC PROBLEM
6. THEORIES OF FAILURE
TEACHING METHODS

The contents of the subject “Elasticity and Strength of Materials” are taught through lectures, practical classes, seminars and laboratory practice.

In the lectures the contents and theoretical concepts of each topic are presented with the aid of some specific publications available to the student and by the resolution of practical exercises.

In the practical classes problems based on structures and mechanical systems are solved in order to consolidate the concepts presented in the lectures.

Throughout the semester three seminars are held, in which larger problems as well as exams of previous editions are solved. The arrangement in small seminar groups propitiates an interactive resolution of problems between the professor and the students.

Along the course two laboratory practices are performed, the first corresponding to the tension test and the second dedicated to the experimental measurement method of extensometry. The practices are carried out in the “Laboratory of Strength of Materials and Structures” of the Department of Mechanical Engineering. Previously, and depending on each practice, students individually or divided into groups initially attend a theoretical presentation and solve analytically some exercise related to the practice. During the session, students are divided into smaller groups so as to carry out experimental measurements and validate their calculations. At the end of each practice, students must submit a report with the results and final conclusions.

On the virtual platform eGela, the following material is available to the students: the Student Guide, a collection of review exercises, some problems to be solved in the seminars and other problems from the examination sessions, together with the results and exam grades. All subject groups have at their disposal the same material simultaneously.

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>
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- GCA: Applied fieldwork groups

Evaluation methods
- End-of-course evaluation

Evaluation tools and percentages of final mark
- Written test, open questions 95%
- Exercises, cases or problem sets 5%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In this subject a partial exam is proposed that allows reducing contents in the final exam. It will be assumed that by not doing or not obtaining the required grade in this partial exam the student is giving up the continuous assessment system.

The requirements for passing the course are:
1. Attend all laboratory practices.
2. Get an average rating greater than or equal to 5.0.

The laboratory practices account for 5% and the written tests for 95% of the final grade. The written tests consist of individual resolution of problems and theoretical questions. The first written test enables to pass definitively the first part of the course (for this it is necessary to obtain a rating equal to or greater than 4.0). In the second part of the course, a score equal to or greater than 3.5 should be obtained in order to be able to get a pass average. The final grade is the average of the two partial tests. Students may also make a full examination even after having passed the first of the written tests. The theoretical part of the exam is in any case one third of the mark for each exam.

According to the current regulations of the University of the Basque Country - EHU, it is sufficient for the student not to present himself to give up the corresponding call.
**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

In the extraordinary examination a written exam including the full course will be performed. This will consist of individual resolution of problems and theoretical questions. The theoretical part accounts for one third of the exam. The final grade will be obtained by taking the laboratory practices into account.

As in the ordinary call, to give up this call it will be sufficient for the student not to present himself.

**MANDATORY MATERIALS**


**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**


**Journals**

- Int. J. of Mechanical Sciences, Elsevier.
- Int. J. of Solids and Structures, Elsevier.
- Computers & Structures, Elsevier.

**Web sites of interest**

- https://egela.ehu.es/
- es.scribd.com/doc/305851/Resistencia-de-materiales-Problemas-resueltos
- es.wikipedia.org/wiki/Resistencia_de_materiales

**OBSERVATIONS**
### COURSE GUIDE

**Faculty**: 345 - Faculty of Engineering - Bilbao  
**Cycle**: Not Applicable  
**Degree**: GTELEC30 - Bachelor's Degree in Telecommunications Engineering  
**Year**: Fourth year

<table>
<thead>
<tr>
<th>COURSE</th>
<th>27389 - Microprocessor-based Designs</th>
<th>Credits, ECTS:</th>
<th>4.5</th>
</tr>
</thead>
</table>

### COURSE DESCRIPTION

The objective of this subject is to initiate the student in the analysis of the characteristics of different microprocessors to select the most suitable one, for the design that must be done.  
There are some design requirements that must be fulfilled. Focusing on the microprocessor and adding the necessary elements, the design of a product (hardware and software) will be completed.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Capacity to design analog and digital electronics devices, analog-digital and digital-analogue conversion, radio frequency, power and conversion of electrical power for telecommunication and computer applications.

Capacity to carry out the specification, implementation, documentation and set-up of electronic, instrumentation and control devices and systems, considering both the technical requirements and the corresponding standard regulations.

Therefore, the student acquires the ability to select advanced microprocessors, electronic components and integrate them into a digital system based on a microprocessor, in order to create a product, that fulfill the specification. They also acquire the ability to configure and program the microprocessor for the required functionality.  
It uses the concepts of analogue and digital electronics of other subjects of the degree.

Modern microprocessors compete designing complex systems, with FPGA and DSP. So it is necessary to analyze points as computational speed and performance, use of memory, processor, coprocessors and peripherals performance, bus organization and compiler efficiency.

Much of the effort is dedicated to the design of the program: computer tools for editing, compiling, debugging, simulating, linking and loading in memory, configuration of peripherals, C-programming, auxiliary libraries, real time execution.

Objective: To give the students the capacity to design and develop digital circuits based on microprocessors of great computing capacity.

### COURSE CONTENTS, THEORETICAL & APPLIED

1. Introduction to systems based on advanced microprocessor  
2. Detailed Knowledge of microprocessors: kernel, memories, interrupts, timers, I/O ports, Peripheral.  
3. Design of a product based on a microprocessor.  
5. C Programming oriented to microprocessor.  
6. Complete development of a microprocessor program to load into it.  
7. The microprocessor's electronic card: physical and electrical aspects.

**Practices**
- Analysis and comparison of microprocessors.  
- Product Design with microprocessors.  
- Study of a micro of the family Kinetis.  
- Knowledge of the development environment.  
- Study of the evaluation card.  
- Development of a program on the evaluation card:  
  - Debugging.  
  - Loading and executing on the card.  
  - Management of the main parts of the  
- Free Work with the microprocessor.

### TEACHING METHODS
TYPES OF TEACHING

<table>
<thead>
<tr>
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Evaluation methods
- Continuous evaluation  
- End-of-course evaluation

Evaluation tools and percentages of final mark
- Exercises, cases or problem sets  15%  
- Teamwork assignments (problem solving, Project design)  65%  
- Oral presentation of assigned tasks, Reading  20%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Continuous Evaluation: All parts must be approved separately.  
The waiver of the continuous evaluation shall be carried out as set out in the corresponding evaluation regulation.  
The Final examination will count 100%, and include a theoretical and practical part in the laboratory.  
The procedure for waiving a call will be the one included in the corresponding legislation.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

It will be done by final test that and includes a theoretical and practical part in the laboratory.  
The same criteria as in the ordinary call Will Be followed

MANDATORY MATERIALS

Kinetis KwikStik evaluation board

BIBLIOGRAPHY

Basic bibliography
- Kinetics user’s and instructions manual  
- Codewarrior manual

Detailed bibliography

Journals

Web sites of interest
- www.freescale.com/Kinetis  
- www.freescale.com/codewarrior

OBSERVATIONS

The teaching material is available on the eGELA platform.
### SUBJECT

27383 - Laboratory of Digital Systems

ECTS Credits: 4,5

### DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

The subject Digital Systems Laboratory is a compulsory subject of the Electronic Systems specialty in the fourth year of the Degree in Engineering in Telecommunication Technology.

The objective of this subject is to equip students with the ability to design and develop digital systems with hardware and software processing units integrated in an FPGA. These tailor-made mixed circuits offer a high degree of flexibility and high throughput. The incorporation of this type of devices in the products of the companies of the industrial sector is very interesting and the demand of professionals with capacity to work with this type of technologies is high.

In this subject, from a practical approach, students deal with high speed hardware design oriented to reconfigurable devices, the detailed study of a simple soft processor embedded in the reconfigurable device and the design methodology necessary to face the complete development of a mixed system.

The subjects Digital Electronics and Digital Systems converge in this subject. The concepts and capacities acquired in them must be applied intensively, extensively and in combination. In this way, the bases are established to be able to face the design of complex systems based on platforms.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

In this subject the competences M05SE4 and M05SE5 of the module M05 Electronic Systems are worked:

- **M05SE4**: Ability to apply electronics as support technology in other fields and activities, and not only in the field of Information Technology and Communications.
- **M05SE5**: Ability to design circuits of analog and digital electronics, analog-digital and digital-analog conversion, radiofrequency, power and electric power conversion for telecommunication and computer applications.

The following are the most important learning outcomes that students should acquire through this subject:

- Identify the internal architecture of the FPGAS.
- Properly describe the fundamental circuits for the synchronous digital design at high speed.
- To know the process of synthesis and implementation of complex designs based on FPGAs.
- Describe mixed circuits composed of a small processor to which custom circuits are added and the program that runs on it.
- Perform the co-simulation of mixed circuits and the test using embedded logic analysis.
- Document complex designs realized in FPGAs using a specification document and a reference design.

### THEORETICAL/PRACTICAL CONTENT

**Topic 1: Advanced electronic design with FPGAS**  
VHDL design optimized for FPGA architecture  
Synchronous design  
Advanced management techniques of global clocks  
Management of design constraints

**Topic 2: Design with soft mini-processors**  
Mixed-core architecture  
8-bit soft microprocessor  
Code generation

**Topic 3: Hardware-software integration in an FPGA**  
Integration of software in FPGA design flow  
Cosimulation

### METHODS

The subject is taught in a clearly practical orientation.

In the laboratory students work individually and also in groups. Several projects are developed, some highly guided and others with a free part for students to use their imagination and autonomous work. It stimulates the planning and organization of work, study inside and outside the classroom, positive attitude towards peers, oral and written expression, discussion of answers, bibliographic search and use of English.
The master classes explain the fundamental concepts. The students must deepen these concepts through the study of theoretical contents and the realization of practical exercises.

### TYPES OF TEACHING

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<thead>
<tr>
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### ASSESSMENT SYSTEMS

- Final assessment system

### TOOLS USED & GRADING PERCENTAGES

- Individual work  20%  
- Team work (problem solving, project design)  80%

### ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The evaluation of the subject is done through the continuous assessment system. The weight of the different activities in the final note is as follows:

1. Individual basic practices (20%)
2. Final practice in team (80%)

The students interested in relinquishing the continuous evaluation must submit a writing to the responsible teacher showing their resignation before the end of the 10th week of the period in which the subject is taught. Students who resign to the continuous evaluation must carry out a practical examination in the laboratory on the day of the examination of the official announcement. The grade obtained in this practical exam replaces the continuous evaluation note in the case of submitting the written resignation.

The student who does not carry out the continuous evaluation or who, having resigned it, does not attend the final exam, will have a grade of Not Presented.

### EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The evaluation in the extraordinary call will consist of a practical examination in the laboratory on the day of the examination of the official call.

The student who does not attend the final exam will have a grade of Not Presented.

### COMPULSORY MATERIALS

Documents in the egela platform of this subject.

### BIBLIOGRAPHY

**Basic bibliography**
- Floyd, T.L., Fundamentos de sistemas digitales, 7a edición, Prentice Hall, 2001
- Uyemura, J. P., Diseño de sistemas digitales. Un enfoque integrado; Thomson Learning, 2000
- Xilinx Inc, Xilinx ISE In-Depth Tutorial (UG695), http://www.xilinx.com

**In-depth bibliography**
- Ashenden, Peter J, “The designer's guide to VHDL”.

**Journals**
- Xcell online, https://www.xilinx.com/about/xcell-publications/xcell-journal.html

**Useful websites**
- http://www.xilinx.com
- http://www.opencores.org
Optical communications are taking on a more important role in the field of telecommunications engineering. Optical communications are subject to continuous development and efforts are directed towards increasing data transmission capability and quality. Such an effort requires the continuous review and updating of knowledge.

Students will acquire:
- Practical knowledge about optical communications and optical transmission networks, paying special attention to the operation and correct handling of optical devices and other pieces of equipment that are usually employed in optical fiber telecommunications.
- Sufficient skills to be able to set up fiber optic systems.

Students work individually or in groups. On one hand, students work individually in the lectures; on the other, they work in groups of three or four in the seminars. The methodology is explained in more detail below:
- Theoretical basics and concepts are explained using PowerPoint presentations.
- Problem-solving activities are carried out; these problems are related to the theory explained in the lectures.
- Experimental measurements in the laboratory are processed and recorded in standard reports.

The total mark of the subject is divided into two sections:
- 35% of the total mark: assessment of the lectures.
- 65% of the total mark: assessment of the seminars.

To pass the subject it is required:
- To get at least a 50% pass mark on the lectures.

Assessment of the lectures:
* Questionnaires in the e-Gela platform (7% of the total grade).
* Set of problems and/or questions in a final written exam in the official examination date of the final assessment test.
* Students have the right to be graded by final assessment: they must present a written request to do this, with a deadline of 9 weeks prior to the final assessment, starting from the beginning of the four-month period.
* Students who achieved at least a 50% pass mark in the assessment of the lectures of a previous call:
  * It is possible to keep the mark of the assessment of the lectures of the previous call without having to take the written exam again.
* Students not fulfilling the previous condition:
  * They will have to take the written exam.

Seminars:
* Standard reports of the measurements obtained.
* Students work in groups and each report must be submitted after each session.
* Practical exam after the written exam.
* Individual.

Withdrawal from a call:
- Students may withdraw from the ordinary exam call one month before the end of the teaching period. To do this, they must present a written request to this end.
- Non-attendance at the exam call will result in a withdrawal (NOT PRESENTED will be applied).

Lecture materials and notes are available in the e-Gela virtual platform:
- PowerPoint slides used in the lectures.
- Questions from the exercises worked on in the lectures.
- Manuals and standard reports of the seminars.

Information about the use of materials, media and resources:
- During teaching activities:
  * No telephone systems, devices or any other type of help are permitted, except as provided for below.
  * Students are permitted to use books or course notes as well as electronic or computer systems or devices. Should these systems or devices have access to the Internet, any search for other than instructional materials will be prohibited.
- In the final assessment test:
  * Neither books or course notes nor telephone, electronic or computer systems or devices nor any other type of help are permitted, except as provided for below.
  * Students are only permitted to use calculators.

This teaching guide conforms to the "Normativa" (Regulations).
## TEACHING GUIDE 2018/19

<table>
<thead>
<tr>
<th>Centre</th>
<th>345 - Faculty of Engineering - Bilbao</th>
<th>Cycle</th>
<th>Indiferente</th>
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<tr>
<td>Plan</td>
<td>GTELEC30 - Bachelor's Degree in Telecommunications Engineering</td>
<td>Year</td>
<td>Third year</td>
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### SUBJECT

| 26850 - High-frequency Systems | ECTS Credits: 6 |

### DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

High-frequency systems subject is one of the basic subjects of the 3rd year of Telecommunications Engineering Degree. It is located within the module called Telecommunication systems and it follows the Electromagnetic Fields subject.

In this course, the main concepts and basic techniques of microwave engineering are studied, learning and analysing the behaviour of the circuits and the subsystem used with high frequency signals.

This course allows getting a knowledge of the technology of the microwave components which are part of a communication system that works with high frequency signals.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

- Ability to built, use and manage the networks, services, processes and applications of telecommunications, when they are understood as an acquisition systems, transportation, representation, processing, storage, management and presentation of multimedia information, from the point of view of the transmission systems.
- Ability to apply the techniques in which the networks, services and applications of telecommunications are based, in both fixed and mobile scenarios, personal, local or long distance, with different bandwidths, including telephony, broadcast, television and data, from the point of view of the transmission systems.
- Ability to analyze the components and their specifications for guided and no-guided communication systems.
- Ability to select circuits, subsystems and systems of radiofrequency, microwave, broadcast, radio-link and radiodetermination.
- Ability to select antennas, equipments and transmission systems, guided and no guided waves propagation by electromagnetic, radiofrequency or optical ways and the corresponding management of the radio electric space and the frequency allocation.
- Ability to analyze, encode, process and transmit multimedia information using analog and digital signal process techniques.

### THEORETICAL/PRACTICAL CONTENT

**High Frequency Technology:**
- Smith chart
- Lines: Microstrip, stripline
- Impedance Matthing

High frequency network characterization
- S parameters
- High frequency circuits analysis

**Passive devices:**
- Resonators
- Power dividers and directional couplers
- Microwave filters

**Active devices:**
- Detectors and mixers
- Control circuits bases on PIN diodes
- Amplifiers
- Oscillators

**LABORATORY PRACTICE:** waveguide measurements, network analyser, passive devices measurements, active devices measurements.
METHODS
In the lectures of this course the required knowledge will be explained in order to solve problems. The most of the class time will be devoted to solving problems.

In laboratory practice knowledge and skills will be acquired which complement the knowledge acquired in class.

TYPES OF TEACHING

<table>
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ASSESSMENT SYSTEMS
- Continuous assessment system
- Final assessment system

TOOLS USED & GRADING PERCENTAGES
- Extended written exam  60%
- Practical work (exercises, case studies & problems set)  40%

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
The evaluation has 2 sections:

Section 1) Evaluation by a final written exam of the lectures and classrooms practices

Section 2) Evaluation of the Laboratory practices (attendance compulsory)
- Continuous assessment:
  * Proposed practices reports
  * Final written exam
  + Students have the right to be assessed by final assessment: they must report a written statement for such a claim, with a deadline of 9 weeks, starting from the beginning of the teaching period.
- Final assessment:
  * Lab exam after the written exam (in the official examination date).
  * Final written exam
- Final mark of the subject: the course is passed with a global score equal to or greater than 5 points out of 10, being necessary to obtain a minimum mark of 5 of 10 in sections 1 and 2.

When the two sections are passed, the final mark will be calculated by the following formula:
0,6*(Section 1) + 0,4*(Section 2)

When one of the sections is failed, its mark is taken as the final mark.

The laboratory practice section mark, regarding Continuous assessment, is only available for the ordinary and extraordinary calls, it will not be saved for following calls.

Declining to sit: not attending the final exam call will be considered equivalent to a withdrawal (no examination attempt is used).

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
The students who have passed one section in the ordinary call are not required to do that section exam in the extraordinary call, although they have the option to do it.

In case of the student who does the pass section exam in the extraordinary call, the mark obtained in that section exam of
the extraordinary call will be taken to calculate the final mark, even if it is lower than the obtained in the ordinary call.

Declining to sit: not attending the final exam call will be considered equivalent to a withdrawal (no examination attempt is used).

### COMPULSORY MATERIALS

Pozar D.M. "Microwave Engineering" Addison-Wesley

Scott A. W. "Understanding microwaves", John Wiley & Sons, Inc, 1993

Collin R.E. "Foundations for Microwave Engineering". McGraw-Hill

### BIBLIOGRAPHY

#### Basic bibliography


#### In-depth bibliography


Bahl I. "Microwave Solid State Circuit Design"- John Wiley & Sons

Combes P.F. "Microwave Components, Devices and Active Circuits". John Wiley & Sons

Rizzi P.A. "Microwave Engineering: Passive Circuits". Prentice Hall

Chang K. "Microwave Solid State Circuits and Applications". John Wiley

#### Journals

Microwave and Wireless Components Letters, IEEE

Microwave Magazine, IEEE

Microwave Theory and Techniques, IEEE Transactions on

Microwaves, Antennas & Propagation, IET

Microwaves, Optics and Acoustics, IEE Journal on

#### Useful websites

Microwaves & RF http://mwrf.com

Minicircuits http://www.minicircuits.com/homepage/homepage.html

AMTI Microwave Circuits http://www.diplexers.com

Agilent Technologies http://www.home.agilent.com

http://www.engr.uky.edu/~gedney/courses/ee523/

### REMARKS
DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

The course aims at applying the network architecture and interconnection principles in the telematics modules in order the students to be able to deploy a whole end-to-end system including all nodes and services required. They will therefore design and configure in a lab environment the addressing/routing mechanisms and internetworking protocols from link up to application layer to support the information exchange among all the elements in the telecommunication service supply chain (that would include both describing, programming and validating routing and signalling elements throughout the architecture).

On the other hand the infrastructure designed should be able to deliver required QoS levels and guarantee proper performance of deployed services. Optimization mechanisms and enhancements will be also considered in order to face possible degradation situations.

In the scope of the telematics module the course aims at combining the views from "Access Networks" and "Transport Networks" courses in a holistic/e2e manner.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The course aims at applying the network architecture and interconnection principles in the telematics modules in order the students to be able to deploy a whole end-to-end system including all nodes and services required.

* Design and configure in a lab environment the addressing/routing mechanisms and internetworking protocols from link up to application layer to support the information exchange among all the elements in the telecommunication service supply chain (Competence TE2 -routing, signaling- and TE4 -description and validation of protocols and interfaces- from the Telematics Module)

* Design a  infrastructure as to deliver required QoS levels and guarantee proper performance of deployed services (TE5 -enhancements of networks and services via technological- and TE6 -designing of architecture-)

* Empirically evaluate the obtained performance and propose possible enhancements/optimization mechanisms to face degradation conditions (TE3 -ability to compose services by using planning and analysis tools-).

THEORETICAL/PRACTICAL CONTENT

It is basically a lab course so that most lab tasks will be group-tasks following this structure::
1. Introduction to the simulated company networking and services requirements/problems.
2. HW and SW installation and maintenance.
3. Basic services and link level.
4. Isolated company network.
5. Interconnection.
7. Advanced services and enhancement.

METHODS

After setting 2-3 people group the problem of designing and deploying network and services for the simulated company will be addressed following a "problem based learning" approach. That would include not only pure technical aspects but also cost and suitability for the company.

Every group will be in fact responsible for defining its objetives and ambition.

As a pre-requisite all student will follow a personal basic network/services administration initial instruction.

In both cases autonomous online learning will be heavily promoted, keeping any master class to a minimum.

In order to ensure the feedbacking process the simulated company definition process will be comprehensively supported by the teacher and will also involve two oral defences.

TYPES OF TEACHING

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<tr>
<th>Type of teaching</th>
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<tr>
<td>Classroom hours</td>
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Legend:  
M: Lecture  
S: Seminario  
GA: Pract.Class.Work  
GL: Pract.Lab work  
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GCL: Clinical Practice  
TA: Workshop  
TI: Ind. workshop  
GCA: Field workshop
### ASSESSMENT SYSTEMS
- Final assessment system

### TOOLS USED & GRADING PERCENTAGES
- Oral defence 23%
- Team work (problem solving, project design) 69%
- Exposition of work, readings, etc. 8%

### ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
This is a 100% lab course, Project based. Therefore, the initial server admin task will be individually evaluated but all the rest will be presented a group tasks (including task reports, public defenses, etc.). Final mark will be the weighted sum of the partial ones following the distribution in this guide. According to the official University of the Basque Country the students are entitled to dismiss the continuous evaluation and apply for a single final probe by sending a written request to their teacher due 9 weeks from the start the teaching period. In that case the final evaluation would be equivalent to that in the extraordinary evaluation.

### EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
Considering that all the practical skills must be evaluated the student will present his working company project in an oral defence and show it actually working according to the specification.

### COMPULSORY MATERIALS
Provided it is a project based course students' capability to face on their own the problems is particularly encouraged. Therefore, at the beginning of each lab some initial guidance will be provided but the groups will later search for information online.

### BIBLIOGRAPHY

#### Basic bibliography
Basic bibliography is associated with every single tool/software to be used for the deployment of the simulated company’s network. In fact, the course itself demands students to be responsible for the research phases either via online browsing of by using manufacturers’ handbooks/tutorials (even those available in previous courses).

#### In-depth bibliography
- LIFS (various authors, available online www.tldp.org)
- The Linux System Administrator's Guide (various authors available online www.tldp.org)
- Linux Advanced Routing & Traffic Control (various authors, available online http://www.lartc.org/)

#### Journals
Being a practical engineering lab no research journal is foreseen as useful.

#### Useful websites
- Manuals
  - http://www.tldp.org/
  - http://www.lartc.org
  - http://www.cisco.com
- Software
  - https://sourceforge.net/
  - https://github.com/
  - https://www.kernel.org
- Stackoverflow.com/
- News
  - www.reddit.com
  - www.slashdot.org
  - www.barrapunto.com

### REMARKS
This subject is the framework where the knowledge acquired in electronics in the previous courses is developed through practical implementations. It complements the subject of Circuits of Telecommunication of the same specialty. It focuses, but not exclusively, on those circuits, systems and measurement instruments used in communications electronics systems and circuits.

Subjects require to acquire module competences:

COURSE 1st: Basic Electronics, Devices and Electronic Circuits
Electronic Instrumentation. Electronic power systems.
COURSE 4: Telecommunication Circuits, Electronic Systems Technology.

Competencies/learning results for the subject

Goals:
- Analyze and deepen the operation of electronic systems for the transmission of signals generated by telecommunication systems.
- Assess, determine and specify the reliability and accuracy of electronic telecommunication systems.
- Design and solve electronic systems of telecommunication systems through individual and cooperative work.
- Detect, assess and solve problems affecting telecommunications systems due to different types of sources of disturbance.

Competencies:

Professional or specific
- Identification and resolution of communication engineering problems using electronic systems.
- Design capability oriented to the electronic product.

Transversal or general
- General reasoning, applied and critical.
- Autonomous Learning.
- Search for information.

Specific competences of the MO5 module - Electronic Systems:
-M05SE1: Ability to build, exploit and manage systems of capture, transport, representation, processing, storage, management and presentation of multimedia information, from the point of view of electronic systems.
-M05SE3: Ability to perform the specification, implementation, documentation and set-up of equipment and systems, electronic, instrumentation and control, considering both the technical aspects and the corresponding regulatory regulations.
-M05SE5: Ability to design circuits of analog and digital electronics, analog-digital and digital-analog conversion, radiofrequency, power and electric power conversion for telecommunication and computer applications.
-M05SE6: Ability to understand and use feedback theory and electronic control systems.
-M05SS8: Ability to specify and use electronic instrumentation and measurement systems.
-M05SS9: Ability to analyze and solve problems of interference and electromagnetic compatibility.

Theoretical/practical content

Design and assembly of basic electronic subsystems in telecommunications systems
- Electronic components and selection criteria
- Oscillators
- Modulators and Demodulators
- Small Signal Amplifiers
- Power Stages
Instrumentation and measurement techniques
- Synthesized signal and function generator
- Spectrum analyzer
- Network Analyzer
METHODS

Methodology of teaching based on laboratory work, which consists of designing and constructing, through a series of guided practices, electronic subsystems for the implementation of basic functions in telecommunications.
The student must design, assemble, measure, improve the designs until they meet the required starting specifications, and finally characterize the built circuits.
The subject will be managed through a virtual platform that will allow the immediate sharing of messages and information, access to documentation and electronic specification sheets, consultations, discussion groups, etc.
The non-presence part will be dedicated to the search of information, reading of documentation, specification sheets and application notes, and the preparation of designs and even electronic assembly of prototypes, as well as electronic simulation of subsystems which may be relevant. It will also be dedicated to the completion of the final reports of the practices carried out.
To prepare the laboratory practices there will be brief lectures and a previous job of searching information on the web. In laboratory practices, the proposed electronic systems should be designed, simulated and physically realized. Finally, the electronic system should be characterized with a report.

TYPES OF TEACHING

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<tr>
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</tbody>
</table>

Legend:
- M: Lecture
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ASSESSMENT SYSTEMS

- Final assessment system

TOOLS USED & GRADING PERCENTAGES

- Oral defence 20%
- Practical work (exercises, case studies & problems set) 40%
- Team work (problem solving, project design) 40%

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The scores will be based on the evaluation of the work performed in class, the prototypes to be designed and assembled, and the final report of the prototype assemble and, which should include the design process and the characterization of the implemented circuits.
Evaluation instruments:
- Attendance control sheet through ICTs and presence.
- Written report of the theoretical realization by means of simulation of the proposed practices.
- Resolution in the laboratory of the proposed practices.
- Written report of laboratory practices.
The resignation procedure is the one included in the corresponding regulations. The evaluation of those students that accept the resignation is done by a test for the 100% of the subject.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The evaluation in second call consists of a test, for the 100% of the subject, to be carried out in the laboratory.

COMPULSORY MATERIALS

- Orcad, PSpice, LTspice, Agilent ADS or equivalent CAD/CAE tool.

BIBLIOGRAPHY

Basic bibliography
Steve C. Cripps. RF Power Amplifiers for wireless Communications. Artech House 1999

In-depth bibliography
Pieter L.D. Abrie. Design of RF and Microwave Amplifiers and Oscillators. Artech House, Inc. 1999
David M. Pozar. Microwave Engineering. Addison-Wesley
Chris Bowick. RF Circuit Design. SAMS

Journals
- RF Design
- Microwaves & RF
- Microwave Engineering
- Microwave Journal

Useful websites
- http://www.radioelectronicsschool.net/
- http://www.mwjournal.com
- http://www.mwee.com/
- http://www.mwrf.com/
- http://rfdesign.com/

REMARKS
The subject has a MOODLE server (eGela).
SUBJECT
27365 - Theory of Communication
ECTS Credits: 7,5

DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT
This subject is integrated into the common module of telecommunication (Module 02), and as such, it studies the basic principles of telecommunications. The subject describes, both from a formal and a mathematical point of view, the basic mechanisms that allow the transmission of information in modern telecommunication systems (radio and digital television, data transmission, telephone communications etc.). To this end, both the digital information to be transmitted (with stochastic characteristics), and the limitations of the channel through which the transmission is performed, are modeled considering two main cases: the transmission through bandwidth-limited channels and AWGN channels. Both, base-band and pass-band systems are studied. The mathematical models learned in the lectures are reinforced by means of laboratory sessions.

The subject is taught during the second semester of the second year of the degree. Thus, it uses the background acquired in the subjects 'Circuit Analysis' and 'Signal Processing' (first course) related to the tools used for signal analysis and signal processing (convolution and Fourier transform). It is also assumed that the students have the skills and abilities related to the basic techniques of statistical analysis (subject of 'Statistics', first course) and other basic tools of algebra and calculus ('Algebra', 'Calculus I and II' and 'Advanced Mathematics'), such as graphical representation of functions, basic integrals, operations with complex numbers, trigonometric functions, vector representation and basic operations with vectors. In addition, it is important for the students to understand the concepts of energy and power, acquired in the subject 'Extension of Physics'.

On the other hand, as a subject of basic fundamentals of communications, it prepares the students for future subjects in the field of communications (subjects of Module 03), such as 'Telecommunication Systems', 'Radiocommunication Systems' and 'Mobile Communications', where the concepts studied in Communication Theory are used as a background for a more elaborate description of the techniques used for the transmission of information in communication systems. Coordination is ensured through the general mechanisms of coordination: course, module and degree.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT
Upon successful completion of this course students will be able to:
- List and describe the basic components of a communication system and interpret its fundamental parameters.
- Operate formally with the usual stochastic processes in communication systems and analyze their spectral characteristics.
- Describe formally the basic techniques to modulate information in digital form.
- Identify the basic types of digital and analog modulations and be able to interpret the associated graphical representations (power spectral density, IQ constellation, eye diagram).
- Design an optimal receiver for basic digital modulation techniques based on elementary specifications.
- Program with computer tools oriented to the analysis, design and implementation of the modulation and demodulation subsystems from the point of view of the detection and generation of the signals.
- Manage instrumentation for the generation and detection of digital and analog modulated signals.

THEORETICAL/PRACTICAL CONTENT
Classroom teaching:
Lesson 1 Introduction to communication systems
Lesson 2 Signals and random processes
Lesson 3 Transmission of signals with noise
Lesson 4 Bandpass signals and systems
Lesson 5 Baseband digital communications
Lesson 6 Digital modulations
Lesson 7 Noise in digital communications

Seminars
Resolution of complex problems in group

Laboratories
Practice 1 Analog Modulations. AM.
Practice 2 Analog modulations. FM.
Practice 3 Digital modulations

**METHODS**

**PRESENTIAL TEACHING:**
- Classroom lectures:
  * exposition of fundamentals and theory
  * problem resolution.

It will be necessary for the students to perform the required personal work (non-contact teaching) to follow the classes.

- Laboratory practices: simulation of analog and digital communication systems in the Matlab / Octave environment and analysis of digital communication systems using real equipment.
- Seminars: discussion, resolution and oral presentation, both individually and as a group of complex problems.

**NON-PRESENTIAL TEACHING:**
- Classroom lectures:
  * Study of the theory proposed for the week. Preparation of lists of questions for discussion in the classes face-to-face
  * Resolution of proposed problems and preparation of exercises.
- Laboratory practices: preparation of the proposed practices and relate results to the theory.
- Seminars: Individual and team preparation of the proposed problems.

**TYPES OF TEACHING**

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**ASSESSMENT SYSTEMS**

- Continuous assessment system
- Final assessment system

**TOOLS USED & GRADING PERCENTAGES**

- Extended written exam  65%
- Multiple choice test  25%
- Exposition of work, readings, etc.  10%

**ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT**

Two assessment systems are considered in ordinary call: on the one hand, the continuous evaluation system, which requires regular attendance at the classes and a regular follow-up of the subject, surpassing the partial ones that are carried out; on the other hand, the final evaluation system, basically consisting of a single final exam of the subject. Both systems are exclusive, so the student must expressly waive the continuous evaluation to be able to take the final evaluation test.

A) CONTINUOUS EVALUATION SYSTEM

A continuous evaluation will be carried out throughout the course through three individual partial evaluation tests (PEP) along with the evaluation of work done in the Seminars. In each of the PEP they will evaluate the competences acquired in solving problems (lectures, classroom practices and seminars) and in laboratories (laboratory classes):

- PEP1 (Week 6):
  * Lessons 1 and 2 (PEP1-M)
  * Laboratory Practice 1 (PEP1-L)
- PEP2 (Week 10):
  * Lessons 3 and 4 (PEP2-M)
  * Laboratory practice 2 (PEP2-L)
- PEP3 (ordinary call):
  * Lessons 5, 6 and 7 (PEP3-M)
  * Laboratory Practice 3 (PEP3-L)

- Seminars: Teamwork evaluation: oral and written presentation of complex problems during the seminar sessions.

**CALCULATION OF THE FINAL NOTE**
The final grade of the subject will be calculated with the following formula:

$$NF = 0.65 \times (N(PEP1-M) \times 0.3 + N(PEP2-M) \times 0.3 + N(PEP3-M) \times 0.4) + 0.25 \times (N(PEP1-L) \times 0.33 + N(PEP2-L) \times 0.33 + N(PEP3-L) \times 0.34) + 0.1 \times N(Seminars)$$

To pass the subject it will be necessary to fulfill the following conditions:
- Obtain an NF equal to or greater than 5 points out of 10 (5/10).
- Having obtained an average score in the part of Classroom (M) higher than 3 points out of 10, an average score in the part of Laboratories higher than 3 points out of 10, and an average score in the part of Seminars greater than 3 points out of 10. That is to say:
  * $N(PEP1-M) \times 0.3 + N(PEP2-M) \times 0.3 + N(PEP3-M) \times 0.4$ must be equal or greater than 3 out of 10
  * $N(PEP1-L) \times 0.33 + N(PEP2-L) \times 0.33 + N(PEP3-L) \times 0.34$ must be equal or greater than 3 out of 10
  * $N(Seminars)$ must be equal or greater than 3 out of 10
- Have a minimum attendance of 75% to face-to-face classes

In case you have not obtained a minimum of 3 points out of 10 in any of the sections and the final grade obtained through the formula was greater than 4.5 the final grade that will be reflected in the minutes will be 4.5 / 10.

ASSISTANCE TO THE PRESENTIAL TEACHING

To be able to follow the continuous evaluation system, a minimum attendance of 75% is required for face-to-face classes in each of its modalities.

This criterion will be applied throughout the course, so that in order to be evaluated in the partial evaluation tests (PEPs), this requirement must be met on the date of completion of each test.

The rejection of the continuous evaluation may be done through written communication to the professor of the subject until April 30, 2019. The rejection of the continuous evaluation supposes the loss of the results of the evaluations previously made.

B) FINAL EVALUATION SYSTEM

It will consist in the realization of an exam on the day of the ordinary call. The exam will have two parts, one written test consisting of problem solving of the subject and a test of laboratory practices.

The Final Note will be calculated by applying the following formula:

$$NF = 0.75 \times (N(M+PA)) + 0.25 \times (N(Lab))$$

It will be necessary to obtain a minimum score of 3 out of 10 in each of the sections. That is to say:
- $N(M+PA)$ must be equal to or greater than 3 points out of 10
- $N(Lab)$ must be equal to or greater than 3 points out of 10

In case you have not obtained a minimum of 3 points out of 10 in any of the sections and the final grade obtained by the formula was higher than 4.5 the final grade that will be reflected in the minutes will be 4.5 / 10.

The rejection of the continuous evaluation must be made through written communication to the teacher of the subject until April 30. The rejection of the continuous evaluation supposes the loss of the results of the evaluations previously carried out. The rejection of the continuous evaluation can be done separately for the laboratories, on the one hand, and for the set of classroom lectures -seminars, on the other. If the continuous assessment of the part of classroom lectures is waived, the seminars will automatically be renounced and the part of classroom lectures will have a weight of 75% of the grade.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

The evaluation in the extraordinary call will be made with respect to the same contents taught during the course (classroom lessons (M+PA), Laboratory practices (Lab) and Seminars).

It will consist of an examination on the day of the extraordinary call. The exam will have two parts, one written test consisting of problem solving on the subject and a test of laboratory practices.

The Final Note will be calculated by applying the following formula:

$$NF = 0.75 \times (N(M+PA)) + 0.25 \times (N(Lab))$$

It will be necessary to obtain a minimum score of 5 out of 10. Additionally, it will be necessary to obtain a minimum score of 3 out of 10 (3/10) in each of the sections. That is to say:
- $N(M+PA)$ must be equal to or greater than 3 points out of 10 (3/10)
- $N(Lab)$ must be equal to or greater than 3 points out of 10 (3/10)

In case you have not obtained a minimum of 3 points out of 10 in any of the sections and the final grade obtained by the formula was higher than 4.5 the final grade that will be reflected in the minutes will be 4.5 / 10.

If a grade equal to or greater than 5/10 has been obtained in the ordinary call at the Classroom lectures modalities (M+PA), it will be possible to keep this note for the extraordinary call. The same applies to the Laboratory Practices modality.

No grade obtained during the course in the different sections is maintained for later courses.
**COMPULSORY MATERIALS**

Teaching support tool egela.ehu.eus
Notes and collection of problems of the subject (available in egela)

**BIBLIOGRAPHY**

**Basic bibliography**

A. Bruce Carlson
*Communications Systems: An Introduction to Signals and Noise in Electrical Communications*
McGraw-Hill, 2010 (5ª Edición)

Ferrel G. Stremler
*Introduction to Communications Systems*
Addison-Wesley 3ª Ed. 1990

Symon Haykin
*Communication Systems*
John Wiley & Sons, 2ª Ed. 1994

Jesus López, Eduardo Martos
Señales aleatorias. Teoría y ejercicios resueltos.
Ed. Marcombo

**In-depth bibliography**

Antonio Artés, Fernando Pérez González y otros
*Comunicaciones digitales*
Also available in pdf: http://www.tsc.uc3m.es/~antonio/libro_comunicaciones/El_libro.html

John G. Proakis; Masoud Salehi
*Communications Systems Engineering*
Prentice-Hall International, 1994

Stocastic Processes: Procesos estocásticos:
A. Papoulis
*Probability, random variables, and stochastic processes*

**Journals**

**Useful websites**


Diferent Tutorials in digital communications :
http://www.complextoreal.com/tutorial.htm
The "Access Networks" course is one of the subjects of the Telematics specialization in the third year of the degree in Engineering in Telecommunication Technology. It belongs to the area of "Networks" of this specialty together with "Transport Networks" and "Mobile Service Networks" within this branch.

This subject presents and explains the main characteristics of the access network, which is the part of the network that connects the end user of the service to the first node in the network that supports this service. This course, together with Mobile Networks and Services and Transport Networks make up a set to have a complete vision of the current networks. Mobile Networks and Services deals with aspects of access networks that include mobility. Transport Networks completes the study of communications networks to describe the functioning of the different service nodes, their interconnection and techniques that allow the services to be provided.

The subject is divided into two main parts. In the first part, the features and technologies of Public Access Networks, which are those available to the general public, are presented. In the second part, Corporate Access Networks are analysed. These help provide access to a particular closed group of users. The architecture and operation of both types of networks are very different and that is the reason for this division.

For the study of Public Access Networks technologies, they will be classified and described according to the transmission medium used: wired (ADSL, HFC, FFTX...) or wireless (WiMAX...). In the case of Corporate Access Networks technologies, different technologies are analyzed and some complex scenarios are also introduced, such as logical segmentation of a LAN, remote access to a private network and loop resolution in LANs.

One of the main aims of this subject is that the student should develop the ability to manage specifications, regulations and mandatory standards as well as analyze and evaluate the social and environmental impact of technical solutions. To meet these goals, legislation or the main regulations related to the access network infrastructure (CTI and structured cabling systems) necessary for the design and installation of these networks in a timely manner are also introduced.

Prerequisite to take this course is, at least, having acquired the basic concepts related to communications networks introduced in the Telecommunication Networks and Services Architecture course, which is compulsory one-year course in the second year of the degree.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

This subject contributes to the following telematics competency related to the design and deployment of networks:

- Ability to apply the fundamental techniques of networks, services and data communication applications such as signalling, switching and management systems, routing, security (cryptographic protocols, tunnelling, firewall, charging mechanisms, authentication and content protection), traffic engineering (graph theory, queuing theory and teletraffic) charging and reliability and quality of service, either in fixed, mobile, personal, local or long distance environments, with different bandwidths, including telephony and data.

### COURSE CONTENTS, THEORETICAL & APPLIED

#### THEORETICAL CONTENT

1. Introduction
2. Public Network Access Technologies
3. Corporate Network Access Technologies

#### PRACTICAL CONTENT

1. Seminar 1: Getting knowledge about my access network
2. Seminar 2: QoS and network neutrality
3. Practice 1: Access network performance
4. Practice 2: Structured cabling and CTIs
5. Practice 3: VLAN

### TEACHING METHODS

As regards the methodology, the course is divided into two parts: 1) the theoretical knowledge is taught in lectures and in...
classroom practice (30 hours) and 2) the subject has a practical component based on laboratory practice (27 hours) and two seminars (3 hours).

In lectures, the teacher’s explanation will be supported by material that will be available in eGela. Debate with students will be encouraged, together with activities that may help the understanding of the topics discussed in the context of the classroom.

In laboratory practical work, both autonomous (based on individual questionnaires) and group work will be required. The practices and reports will be developed in pairs and groups.

Finally, in seminars debate and oral presentation of current issues related to access networks will be encouraged.

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.

### TYPES OF TEACHING

<table>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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<td>27</td>
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<td>Hours of student work outside the classroom</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
- GCL: Applied clinical-based groups
- TA: Workshop
- TI: Industrial workshop
- GCA: Applied fieldwork groups

### Evaluation methods
- Continuous evaluation
- End-of-course evaluation

### Evaluation tools and percentages of final mark
- Written test, open questions 50%
- Exercises, cases or problem sets 25%
- Individual assignments 5%
- Teamwork assignments (problem solving, Project design) 15%
- Oral presentation of assigned tasks, Reading 5%

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the ordinary examination modality, the mark will be the sum of 2 parts:
A. Final exam: 50% of the mark
B. Continuous Evaluation: 50% of the mark, of which
   - 25% - reports of practical work and explanation of it
   - 5% - handing in of individual questionnaires
   - 15% - attitude and progress shown in class (all kinds of class)
   - 5% - presentation of work done (seminars)

In order to pass the course, the students must fulfil ALL the following conditions:
- To have attended all the compulsory attendance classes (laboratory classes and seminars).
- To pass both parts of the subject, A and B. In that case, the final grade will be the sum of the two parts. In case of failure to pass any of the two parts, the final grade will be that of the failed part.

If a student wants to opt out of continuous evaluation or of ordinary evaluation, he/she must proceed according to the procedure and deadlines established in the Student Evaluation Rules, in articles 8 and 12 respectively.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the extraordinary exam call, the note will be the result of a final exam that will comprise the 100% of the subject.

To decline to sit in the extraordinary call of the course, it will be enough not to attend the final written test of the extraordinary call.

### MANDATORY MATERIALS

Documentation available in the official virtual classroom of the course (egela): https://egela.ehu.es/
BIBLIOGRAPHY

Basic bibliography

Detailed bibliography
* "Local access network technologies". Paul France. IEE telecommunications series 47.

Journals

Web sites of interest
http://oa.upm.es/2697/ Libro "Tecnologías de Banda Ancha y convergencia de redes" Álvarez-Campana et al
http://www.bandaancha.es/Informacion/Tecnologias/Paginas/Tecnologias.aspx Information about WideBand technologies by the Spanish Ministry of Energy, Tourism and Digital Agenda
http://www.itu.int/pub/T-REC ITU-T Recommendations

OBSERVATIONS
DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

Short description
This course provides essential knowledge about telecommunication transport networks. The most significant technologies for data transport over long distances will be analyzed as well as the information transport techniques for every technology, regardless of the nature of them (data, PSTN, mobile services), and with reliability and quality of service guarantee. In addition the most significant signaling techniques and systems for the management, operation and maintenance of these networks will be described. And different mechanisms and protocols for the routing information will also be analyzed. To sum up, the main goal of this course is to develop in students the ability to understand the global operation of transport networks, their main components and the functionality and role of each of them.

Contextualisation
This subject fits in the part of the Telecommunication degree related to Telecommunication Networks and Services. The aim of this subject is to study in detail the most relevant transport networks technologies, such as those related to transmission, switching, routing and signaling. In this context some of the concepts introduced in the subjects "Architecture of Telecommunication Networks and Services" (2nd year of the degree) and Telecommunication Systems (5th semester of the degree) are used. In addition, this subject is complementary with the subject "Access Networks", taught in the same four-month period, and whose contents are closely related. "Transport Network" is also related to other courses given in subsequent four-month periods of the Telecommunication degree such as "Network and Services Deployment and Management" "Mobile Networks and Services" and "Multimedia Services".

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

From the point of view of competencies, this subject contributes to the telematics competencies related to the design and deployment of networks and services. The competencies of the correspondent module and transverse competencies this subject contributes to are detailed next.

Competencies of the telematics speciality.
Ability to build, operate and manage telecom networks, services, processes and applications, considering all of these concepts as systems for acquisition, transportation, representation, processing, storage, management and presentation of multimedia information, from the point of view of telematics services.
Ability to apply learnt techniques in networks, services and telematics applications, such as management systems, signaling and switching, routing, security (cryptographic protocols, tunneling, firewall, billing mechanisms, content authentication and protection strategies), traffic engineering (graph theory, queuing theory and teletraffic) billing, reliability and quality of service, both in fixed, mobile, personal, local or long distance environments and with different bandwidths, including telephony and data.

Transverse competency
Communicate and transmit knowledge, skills and abilities. Communicate in writing knowledge, procedures, results and ideas related to telecommunications and electronics, in a multilingual environment.

THEORETICAL/PRACTICAL CONTENT

0. INTRODUCTION
0.1. Introduction to this subject
0.2. Introduction to main concepts related to transport networks: routing, transmission, switching and signalling.

1. ROUTING
1.2 Routing in data networks
1.2.1 Static routing (ARP-IP, RIBs and FIBs)
1.2.2 Dynamic routing: RIP, OSPF, BGP
[Some of the routing concepts are studied and worked by means of laboratory practices]

2. TRANSMISSION
2.1 Introduction
2.1.1 Introduction to transmission networks
2.1.2 Contextualization, evolution and operation
2.2 Transmission in multiservice networks
2.2.1 Introduction to optical transport networks
2.2.2 Digital Multiplexing Hierarchies TDM
2.2.2.1 PDH (just introduction: obsolete in RT)
2.2.2.2 SDH / SONET
2.2.3 Optical Multiplexing Hierarchies (emerging networks)
2.2.3.1 OTN / WDM
2.2.3.2 MPLS-TP

2.3 Transmission in data networks

3. SWITCHING
3.1 Switching
3.1.1 Introduction
3.1.2 Types of switching: circuit, packet, connectionless and connection oriented
3.2 Circuit Switches
3.2.1 Spatial / Temporal / Two-dimensional switching
3.2.2 Single-stage / multi-stage switches
3.2.3 Packet Switches
3.3.1 Elements: input interface, output interface, switching framework, processor.
3.3.2 Queue management, sending planning, discard criteria
3.3.3 Switching frameworks in routers: 3 generations
3.3.4 Evolution of connection-oriented networks: X.25, FR, ATM

3.4 Integrated Switching
3.4.1 Hybrid Switching
3.4.2 Based on circuit switching
3.4.3 Based on packet switching

4. SIGNALLING
4.1 Signaling
4.1.1 What is it? Functions (in circuits and packets based networks)
4.1.2 Classification (in circuits and packets based networks)
4.2 SS7 Signalling
4.2.1.1 Common channel network signaling
4.2.1.2. Architecture of SS7 signaling network
4.2.1.3 SS7 protocols
4.2.2 ISUP
4.2.2.1 Supported services by ISUP. ISUP vs ISDN
4.2.2.2 ISUP Messages Formats
4.2.2.3 Call control procedures and messages
4.2.3 MTP
4.2.3.1 MTP3
4.2.3.2 MTP2
4.2.3.3 MTP1

METHODS

The subject consists of lectures (M), Seminars (S), and Laboratory Sessions (PL).
It will be necessary to deliver a practice report for every practical exercise proposed by the teacher. The exercises in the lab and their corresponding reports can be made in pairs. Students must submit reports one week after the final session of every exercise.

TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Type of teaching</th>
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Legend:  
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GCA: Field workshop

ASSESSMENT SYSTEMS

- Final assessment system

TOOLS USED & GRADING PERCENTAGES

- Extended written exam 70%
- Practical work (exercises, case studies & problems set)  30%

**ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT**

A. Written exam (70 % of the total score)
   This exam consists of two parts:
   b. First part exam.
      - When: The 8th week of the semester.
      - Score: 20% of the total score.
      - Content: First lesson of the subject (routing).
   c. Second part exam.
      - When: Public date of the ordinary exam call
      - Score: 50% of the total score.
      - Content: Second, third, and fourth lessons of the subject (transmission, switching and signalling).

B. Seminars continuous assessment: 10% of the total score.

C. Labs continuous assessment: 20% of the total score.
   Reports, attendance and active participation at lab session.
   20% of this score is assigned to the quality of the written reports.

To pass the subject it is required:
- To get a score equal to or greater than 3,5 points out of 7 on the written exams.
- To get a score equal to or greater than 1,5 points out of 3 on the laboratory plus seminars section.

Attendance at all seminars and lab sessions is required for continuous assessment.
Withdrawal from examination: not attending the second written exam will be considered equivalent to a withdrawal.

**EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT**

- Final assessment system: 100% of the total score.
To pass the subject it is required:
- To get a score equal to or greater than 5 points out of 10 on the final written exam.

**COMPULSORY MATERIALS**

Web page of the subject in egela site:
http://egela1617.ehu.eus

**BIBLIOGRAPHY**

Basic bibliography
- "Conmutación I" UPM &#8211; Volume I
- Van Bosse, J.G. "Signalling in Telecommunication Networks", J. Wiley & Sons
- Peter tomsu, Christian schmutzer, "Next Generation Optical Networks", ed. Prentice hall, 2002

In-depth bibliography

Journals

Useful websites
**Descripción y contextualización de la asignatura (Inglés)**

The subject “Sistemas de Radiocomunicación” is the last mandatory subject of Radiocommunications area for all the students. It is a continuation of Electromagnetic Fields (Campos Electromagnéticos, 2nd year) and Telecommunication Systems (Sistemas de Telecomunicación, 3rd year, 1st trimester). Therefore, good knowledge of concepts and techniques taught in these subjects is recommendable to study “Sistemas de Radiocomunicación” subject.

In this subject, basic and general concepts applicable to every radiocommunication systems are studied. Later, the main four types of systems are analyzed: radio links, broadcasting, satellite communications and mobile communications. In the laboratory, students use equipment and software for the analysis and simulation of radiocommunication systems.

The concepts and capabilities acquired by the students will allow them to get into the job market under favorable conditions in the radiocommunication area.

**Competencias / resultados de aprendizaje de la asignatura (Inglés)**

- Ability to construct, operate and manage networks, services, processes and telecom applications, understood these as systems of acquisition, transportation, representation, processing, storage, management and presentation of multimedia information, from the point of view of transmission systems.
- Ability to apply the techniques in networks, services and telecommunications applications in both fixed and mobile environments, personal, local or long distance, with different bandwidths, including telephony, radio, television and data, from the standpoint of transmission systems.
- Capacity for the selection of antennas, transmission equipment and systems, propagation of guided and unguided waves by electromagnetic means, RF or optical and related management and allocation of radio frequency space.

**Metodología (Inglés)**

In the master classes, the lecturer will give lectures using audiovisual means and materials previously available for the students.

Questions and problems will be solved in the class in a participatory way. Most problems and exercises will be provided together with the solutions. Hence, students could go in depth in the theoretical knowledge and real applications of the subject and the addressed concepts.

In the laboratory experimental works will be carried out in order to acquire knowledge and skills on the experimental techniques used in radiocommunications.

**Convocatoria ordinaria: orientaciones y renuncia (Inglés)**

The subject is evaluated following the ongoing assessment (“evaluación continua”) typology that is composed of two parts: a theoretical part (composed of a mid-term exam and a final exam) and a laboratory part.
Final mark:
- 80% of the mark from the theoretical part plus 20% from the mark of the laboratory part
- Minimum: 4 points out of 10 in each part.

1) The mark of the theoretical part (written exam corresponding to master and practical classes) is calculated as follows:

- Mid-term exam: 50% of the mark. Chapter 1, 2 and 3.
- Final exam: 2 parts, each one is 50% of the mark
  - 1st part. Chapters 4, 5, 6 and 7
  - 2nd part. Chapters 1, 2 and 3. If the student does this exam, the new mark will replace the mark of the mid-term exam.

2) The mark of the laboratory part corresponds to an individual theoretical-practical exam in the laboratory. The exam will take place in the last laboratory session.

Attending to the laboratory is mandatory to be evaluated following the “evaluacion continua” system.

The students refusing the ongoing assessment system, following the procedure and the deadlines stated in Normativa de Evaluación del Alumnado, will have a final evaluation in the form of a written exam consisting of a part corresponding to lectures (80%) and a part corresponding to the laboratory (20%).

Waiving the ordinary call: students not sitting for any of the two parts of the final exam – neither lab exam, neither written exam - will be considered as students waiving the ordinary call.

**CONVOCATORIA EXTRAORDINARIA: ORIENTACIONES (INGLÉS)**

Written exam consisting of a part corresponding to lectures (80%) and a part corresponding to the laboratory (20%).

If a student requests to maintain the mark of the laboratory part from the ongoing assessment, the student will have only a written exam corresponding to lectures. The final mark will be calculated from the laboratory part (20%) and from the written exam (80%).
**MATERIALES DE USO OBLIGATORIO (INGLÉS)**
- Lecture slides
- Practical cases and problems
- Guides for laboratory

**BIBLIOGRAFÍA (INGLÉS)**

**Bibliografía Básica (INGLÉS)**
- Pablo Angueira, Juan Antonio Romo “Microwave Line of Sight Link Engineering” ISBN: 978-1-118-07273-8; 2012

**Bibliografía de profundización (INGLÉS)**

**Revistas (INGLÉS)**
- IEEE Antennas and Wireless Propagation Letters
- IEEE Transactions on Antennas and Propagation
- IEEE Transactions on Communications
- IEEE Transactions on Vehicular Technology

**Direcciones de Internet de interés (INGLÉS)**
- ITU-R: https://www.itu.int/en/Pages/default.aspx
- IEEE: http://ieeexplore.ieee.org/Xplore/home.jsp
### SUBJECT
27385 - Electromagnetic Fields

### DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT
In order to be able to work on applications related to communications, antennas, radars and microwaves, it is necessary to understand how electromagnetic waves are created, transmitted and received. To become familiar with integrated circuits of smaller size working on higher frequencies, the engineers have to take into account the effects of wave propagation on those chips and circuit wafers. Due to the latest discoveries in material sciences, there is no doubt that a revolution is already taking place in the control and manipulation of light. Among these discoveries, it is worth mentioning the structures based on photonic band-gaps, omnidirectional dielectric mirrors, plasmonic surfaces, birefringent multilayer plates, metamaterials of negative refractive index, and the control of slow and fast light. For a full understanding of those discoveries, it is essential to master the basics of electromagnetic waves that will be covered in this subject.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT
The aim of this subject is to make students be able to:
- Define and understand terms related to electromagnetic waves, as well as acquire knowledge of new technologies on their own for the development of telecommunications systems. (Competence R1 of the telecommunications module, competence G003 of the degree.)
- Use skills, tools, and applications to solve and develop solutions applied to telecommunications, handling specifications, regulations, and compulsory rules, and understanding the ethical and professional responsibility of a technical telecommunications engineer. (Competence R2 of the telecommunications module, competences G004 and G006 of the degree.)
- Handle, analyse, and specify the basic parameters of electromagnetic waves for its application in communication systems, performing measurements, calculations, and reports, and understanding the propagation mechanisms, the transmission of waves on different media, and the devices used to transmit and receive those waves (Competences R4 and R8 of the telecommunications module, competences G003 and G005 of the degree.)
- Analyse the normal and oblique incidence of plane waves on plane surfaces, and evaluate the advantages and drawbacks of guided and non-guided propagation systems, being able to explain clearly the procedures, results, and ideas related to telecommunications. (Competence R5 of the telecommunications module, competence G009 of the degree.)

### THEORETICAL/PRACTICAL CONTENT
- **LESSON 0. INTRODUCTION**
- **LESSON 1. PLANE WAVES**
  1. Introduction. General description. Maxwell's laws on the frequency domain
  2. Propagation of plane waves on different media: lossless media, media without magnetic loss, good insulators, good conductors
  3. Polarization of plane waves
  4. Power flow
  5. Phase velocity and group velocity
- **LESSON 2. NORMAL AND OBLIQUE INCIDENCE ON FLAT SURFACES OF DISCONTINUITY**
  1. Normal incidence on flat surfaces of discontinuity
    1.1. Normal incidence in 2 media. Reflection and transmission coefficients. Superposition of two waves
    1.2. Normal incidence in 3 media. Normal incidence in media with N flat surfaces of discontinuity. How to suppress reflections on the first medium
  2. Oblique incidence on flat surfaces of discontinuity
    2.1. Snell's laws. Refractive index. Total reflection
    2.2. Separating the components of the incident electric field on the plane of incidence. Parallel polarization and perpendicular polarization. Analysis of the reflection coefficients. Polarization angle
- **LESSON 3. ELECTROMAGNETIC RADIATION**
  1. Radiation mechanism
  2. Basic parameters of antennas: radiation pattern, directivity, and gain
  3. Typical/basic antennas. Reciprocity theorem
  3.1. Linear antennas
  3.2. Aperture antennas
  3.3. Reciprocity theorem
  4. Friis formula
- **LESSON 4. GUIDED WAVES**
  1. Waveguides
    1.1. Statement of the problem and generalization
    1.2. Modes and propagation parameters
2. Transmission lines
   2.1. Transmission lines. Study of TEM modes
   2.2. Circuitual equivalence of a line
   2.3. Equations and solutions of the transmission line
   2.4. Impedance transformers
   2.5. Reflections on transmission lines

Practical laboratory work:
- P1: Measurement of RF signals with the spectrum analyzer
- P2: Measurement of the frequency on waveguides
- P3: Measurement of coaxial cables with the network analyzer
- P4: Measurement of the standing wave ratio on waveguides
- P5: Measurement of antennas

METHODS
The theory of each lesson is explained using slides in the lectures. There is also available a book of the subject for further reading. These lectures will be complemented by problem-solving activities. The experience gained during the lectures will be applied to the practical laboratory work.

TYPES OF TEACHING

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Legend:
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ASSESSMENT SYSTEMS
- Continuous assessment system
- Final assessment system

TOOLS USED & GRADING PERCENTAGES
- Extended written exam 88%
- Team work (problem solving, project design) 12%

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
The total score of the subject is divided into two sections:
- 88 % of the total score: assessment of the written exam.
- 12 % of the total score: assessment of the practical laboratory work.

To pass the subject it is required:
- To get a score equal to or greater than 5 points out of 10 on the written exam and
- to get a score equal to or greater than 5 points out of 10 on the practical laboratory work.

Assessment of the written exam:
- Only final assessment.
  * Written exam in the official examination hour: set of problems and/or questions.

Assessment of the practical laboratory work:
- Continuous assessment:
  * Reports of the obtained measurements.
  * Team work; it is mandatory to submit each report after each session.
  * Students have the right to be assessed by final assessment: they must report a written statement for such a claim, with a deadline of 9 weeks, starting from the beginning of the four-month period.
- Final assessment:
  * Practical exam after the written exam (in the official examination date).

Declining to sit: not attending the final exam call will be considered equivalent to a withdrawal (no examination attempt is used).

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
The total score of the subject is divided into two sections:
- 88 % of the total score: assessment of the written exam.
- 12 % of the total score: assessment of the practical laboratory work.

To pass the subject it is required:
- To get a score equal to or greater than 5 points out of 10 on the written exam
  and
- to get a score equal to or greater than 5 points out of 10 on the practical laboratory work.

Assessment of the written exam:
- Students that got a score equal to or greater than 5 points out of 10 on the written exam of the previous call:
  * It is possible to keep the score of the written exam of the previous call without having to take the written exam again.
- Students not fulfilling the previous condition:
  * Written exam in the official examination hour: set of problems and/or questions.

Assessment of the practical laboratory work:
- Students that got a score equal to or greater than 5 points out of 10 on the practical laboratory work of the previous call:
  * It is possible to keep the score of the practical laboratory work of the previous call without having to take the practical exam.
- Students not fulfilling the previous condition:
  * Practical exam after the written exam (in the official examination date).

Declining to sit: not attending the final exam call will be considered equivalent to a withdrawal (no examination attempt is used).

### COMPULSORY MATERIALS


### BIBLIOGRAPHY

#### Basic bibliography


#### In-depth bibliography


#### Journals

Revista Española de Física: http://www.revistadefisica.es/index.php/ref/index

#### Useful websites

http://www.amanogawa.com/waves.html
http://webpages.ursinus.edu/riley/courses/p212/lectures/lectures.html
http://hyperphysics.phy-astr.gsu.edu/HBASE/hph.html
http://www.falstad.com/mathphysics.html
http://www.colorado.edu/physics/2000/index.pl
http://www-personal.umich.edu/~jbourj/em.htm
REMARKS

This teaching guide conforms to the "Normativa reguladora de la Evaluación del alumnado en las titulaciones oficiales de Grado" (BOPV nº 50 de 13-01-2017).
**TEACHING GUIDE 2018/19**

**Centre**: 345 - Faculty of Engineering - Bilbao  
**Cycle**: Indiferente  
**Plan**: GTELEC30 - Bachelor's Degree in Telecommunications Engineering  
**Year**: Fourth year

**SUBJECT**

27388 - Radar & Satellite Navigation Systems  
**ECTS Credits**: 4,5

**DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT**

The subject 'Radar y Sistemas de Navegación por Satélite' is in 4th course, within the intensification on 'Telecommunication systems'. It is focused on the technologies that obtain positioning and additional information from objects, by means of the electromagnetic properties of the radio signals: Radar systems and Global Navigation Satellite Systems (GNSS).

In the syllabus, concepts from previous subjects related to radiocommunication systems, antennas and propagation are applied. The students must have basic knowledge of these topics.

The approach of the subject is quite practical. Theoretical concepts are applied to operational situations and specifications of real radars are used in the examples.

It is possible to make the exam in English. Basic materials are also available in English.

**COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT**

The student will learn different technologies used in the radar and GNSS systems. They will apply, in a practical way, concepts learnt in previous subjects about propagation, antennas and signal processing.

The student will work with these concepts in practical situations and representative examples.

**THEORETICAL/PRACTICAL CONTENT**

The basic contents of the subject are:
- Analysis of the radar signal in time and frequency domains.
- Understanding of the functionalities ans specifications of the subsystems that compose a generic radar system (antenna, transmission, reception, signal processing, anti-clutter techniques, ...)
- Main data processing techniques used in radar and GNSS
- Architecture of the GNSS
- Signals, data processing and services in GPS and Galileo

**METHODS**

The core of the subject is described in the theoretical lecturers, where the main concepts and the approach of the practical exercises are described.

Additionally, practical problems describing representative situations will be faced by the students, by applying the concepts of the syllabus and technical specifications of real radars. The practical problems will be presented by the professor, both in theoretical lecturers and seminars, and solved by the students in working groups.

The lab practise will be focused in radar simulations related to selected concepts from the syllabus, with a software tool developed for that purpose. The students will write a short report for each individual practise, including the results and the analysis of the problem resolution.

Field practise will provide a close approach to real radar systems or to simulators of applications based on radar systems.

**TYPES OF TEACHING**

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**ASSESSMENT SYSTEMS**

- Continuous assessment system  
- Final assessment system

**TOOLS USED & GRADING PERCENTAGES**

- Extended written exam  60%
The evaluation of the subject will be as follows:

- An individual written exam about theoretical concepts and short practical questions, after the first weeks of the triannual (15%)
- Reports of the lab practise and a final practical exam with questions related to the simulations developed in the lab practise (25%). Periodical reports of the lab practise must be handed over on time.
- A final written exam with theoretical questions and practical problems (60%). It is required to pass this final exam.

The evaluation criteria are the following:

- Proper knowledge and comprehension of the main contents and concepts of the subject.
- Adequate relation of theoretical concepts, technological requirements and technological solutions
- Adequate application of the previous items to specific representative situations
- Accuracy of the quantitative results of practical examples

Students that choose not to participate in partial exams must notice this fact to the professor at least one week before the first partial trial. Otherwise, they will be evaluated in the partial exams, even if they are not present in the trial.

Students that choose not to participate in partial exams will be evaluated in a final exam composed by:

- A written exam containing the most relevant theoretical concepts, practical questions and problems (75%)
- The development of a lab practise, similar to those developed during the course. Reports already developed by the student might be considered in the evaluation (25%)

The evaluation will consist of a final exam composed by:

- A written exam containing the most relevant theoretical concepts, practical questions and problems (75%)
- The development of a lab practise, similar to those developed during the course. Reports already developed by the student might be considered in the evaluation (25%)

The resources for the students are:

- Syllabus of the subject
- Exercises, practical problems and representative examples
- Practical cases, technical specifications of radars
- User manual of the software tool for lab simulations
- Additional bibliography

These resources will be available at virtual room for the students E-Gela.

Basic bibliography
- GNSS tutorials

In-depth bibliography
- Monopulse principles and techniques, S. M. Sherman, Artech House, 1984
- Principles of Modern Radar, J.L. Eaves et al.
- Radar Principles, N. Levanon.
- Radar System Design and Analysis, S.A. Hovanesssian, Artech House Inc., USA, 1984
- Guía práctica del GPS, P. Correia, Marcombo.
- Documentación sobre el sistema GPS publicada por el DoD de EEUU (disponible en E-gela)
- Documentación sobre el sistema Galileo publicado por la Agencia Espacial Europea (disponible en E-gela)

Useful websites
http://www.navipedia.net/
http://www.gps.gov/
http://www.esa.int/galileo
http://www.esa.int/Our_Activities/Navigation/The_present_-_EGNOS/What_is_EGNOS
"Signal Processing" is one of the basic subjects from the first year in the Bachelors degree on Telecommunications Technology Engineering. It is part of the block named Basic Training. In this subject the student will learn the mathematical tools for the analysis of signals and systems continuous and discrete both in the time and frequency domain. This is an applied subject that shows in the laboratory sessions where the student will work with practical signals and systems found in telecommunications engineering.

This subject extends and formalizes some of the tools introduced in the subject circuit analysis, and serves as foundation for more advanced subjects like Communications Theory, Communication Systems or Multimedia Signal Processing.

To succesfully complete "Signal Processing" it is convenient to master computations with complex numbers and to have a basic mastery of calculus of a single variable, which are both covered in the subject Calculus I.

This subject works the following transversal competences:
Capacity to solve problems with drive, decision making and to communicate and transmit knowledge, habilities and dexterities understanding the ethic and professional responsibilty of the Technical Engineer in Telecommunications Engineering.

Capacity to work in multidisciplinary teams in a multilingual environment and to communicaty, both in oral and written form, knowledge, procedures, results and ideas related to telecommunications and electronics.

And the following competence from the basic module:
Understand and master the fundamental concepts of linear systems and their corresponding functions and transforms.

This main competences would yield the following learning results:
Use the formal time-domain representations of continuous and discrete time signals and systems, and understand the dynamics of linear systems in the time domain.

Represent signals and understand the dynamics of linear systems in the frequency domain.

Use the A/D and D/A conversion.

Individually solve and explain the proposed problems/homework.

Solve practical telecommunications engineering applications with real-live signals in cooperative laboratory sessions.

1st topic. Continuous and discrete signals in the time-domain
2nd topic. Continuous and discrete systems in the time-domain
3rd topic. Continuous signals and systems in the frequency-domain
4th topic. Discrete signals and systems in the frequency-domain
5th topic. Sampling

And the following lab sessions (weekly)
Session 1 Handling signals in matlab
Session 2 Plotting continuous and discrete signal
Session 3 Audio signals and wav files
Session 4 Frequency domain continuous and discrete
Session 5 The voice signal
Session 6 ECG and the waveform generator
Session 7 Linear filtering
Session 8 Applications of linear filtering
Session 9 Waveform distortion in linear filtering
Session 10 Spectral analysis
Session 11 Sampling and aliasing
METHODS
In the lectures the teacher presents the necessary theoretical background for topics 1-4, and solves problems in the classroom. The teacher facilitates the autonomous learning of the student by presenting short questions and additional problems to be solved by the student.

During the lab sessions the teacher and students will solve practical problems using the Matlab environment, and the students will work in groups. The teacher encourages group work, and the capacity for analysis and synthesis through additional work related to each of the lab sessions.

The seminars will consist of two evaluation sessions for the lab sessions as well as for the completion of the theoretical aspects of topic 5.

TYPES OF TEACHING

<table>
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<tr>
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<tr>
<td>Classroom hours</td>
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<tr>
<td>Hours of study outside the classroom</td>
<td>33.75</td>
<td>15</td>
<td>11.25</td>
<td>30</td>
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ASSESSMENT SYSTEMS
- Final assessment system

TOOLS USED & GRADING PERCENTAGES
- Extended written exam  65%
- Practical work (exercises, case studies & problems set)  35%

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
The evaluation of the theoretical part (65%) and of the laboratory (35%) of the subject are independent the student must obtain a minimum grade of 5 in both parts to pass the subject.

* Evaluation of the theoretical part
  a) Once each of topics 1, 2, 3 and 4 is finished a short 15 minute evaluation to solve a short question of the topic.
  b) Part 1: once topics 1 and 2 are finished, a partial exam with problems and short questions. The grade from the exam (75%) will be averaged with the short questions of topics 1 and 2 mentioned in a) (25%). The minimum grade to pass part 1 is 5.
  c) In the ordinary evaluation there will be two exams:
     * Part 2: exam on topics 3, 4 and 5 with problems and questions. The grade from this exam (75%) will be averaged with the short questions on topics 3 and 4 (25%) from a) to compute the grade on part 2.
     * Exam on topics 1 and 2 for the students who have not passed part 1.

To pass the theoretical part the minimum grade is 5 (60% part 2 and 40% part 1) and a minimum grade of 4 in both parts is mandatory.

* Evaluation of the lab
  - Evaluation exam of lab sessions 1-6: 40% of the lab grade.
  - Evaluation exam of lab sessions 7-10: 7-10: 60% of the lab grade.

The evaluation exams will be done in lab sessions. To pass the lab the minimum grade is 5, with a minimum grade of 4 in each of the three parts.

Impossibility to do the mixt evaluation
The particular cases mentioned in "normativa de gestión para las enseñanzas de grado" must communicate their particular situation to the teaching staff at the start of the course. Both parts will search the best way to evaluate, tailored to the specificity of the student.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
In the extraordinary evaluation only the theoretical part will be evaluated. The exam will have problems and questions from topics 1-5. To pass the theoretical part the minimum grade in the exam is 5.
The necessary materials to complete the subject will be available in eGela and comprise:
Lecture notes (topics 1-5).
Problem book (topics 1-5).
Short questions booklet.
Lab session guides (sessions 1-11) and a template for each of the lab session reports.

BIBLIOGRAPHY

Basic bibliography
Notes and problem book created by the teaching staff and available in eGela.

In-depth bibliography
Oppenheim AV. Discrete-time signal processing (3rd edition).
Burrus CS. Computer based exercises for signal processing using Matlab 5.

Journals

Useful websites

REMARKS
Methodology

To teach this subject, as has been done progressively in previous years, lectures are combined with other resources such as practical classroom work, seminars, laboratory practical work (computer and workshop) and individual tutorials.

Lectures: The theoretical content and concepts of each topic are explained in the lectures. Material on the subject is used and made available to students: PowerPoint presentations, demonstration videos, etc. The explanations will be accompanied by short illustrative exercises based on real mechanical systems.

Practical classroom work: In each session problems based on real machines will be examined and solved, with the aim of consolidating the concepts presented in the theoretical classes (lectures).

Seminar: During the year a seminar will be held on the design and selection of elements in a complex machine. The small-group structure of the seminars will allow problem-solving and the study of theoretical-practical questions both individually and in groups, with the professor teaching the seminar always in attendance and providing guidance.

Practical laboratory work: During the course a practical computer session will be held on the design and calculation of cam-follower systems.

Practical workshop: In this session the workshop will be visited to observe the cutting of bevel gears and the operation of a series of gear trains.

Individual and group tutorials: During the specific tutorials, (see section 1.5 of this document) the subject professors are available to discuss questions with students, either individually or in groups. These doubts will be related to the content of the lectures, practical sessions, seminars, practical laboratory work or the preparation of exams to be taken during the course.

Virtual teaching platform: The platform https://egela.ehu.es/ is available to students with material for each subject. Specifically, the current Student's Guide, the content of the practical computer work and workshops, and a collection of exam material, as well as some of the PowerPoint presentations. The programs specifically created for practical computer work in this subject are also available to students.

Ordinary exam call: guidelines and withdrawal

A mid-course exam will be taken with the content of Thematic Unit A. If a student passes this exam, he/she does not have to take this unit if he/she wishes, and will only have to take the part of the exam that deals with Thematic Unit B.

In any event, the student may decide to take the entire final exam and request that the entire subject be graded according to his/her performance in this exam.

To withdraw from the call, it is sufficient for the student not to show up for the exam, in which case he/she will be considered NOT PRESENTED.

Extraordinary exam call: guidelines

To withdraw from the call, it is sufficient for the student not to show up for the exam, in which case he/she will be considered NOT PRESENTED.
The content of this course assumes and complements the knowledge previously acquired in the subject "Elasticity and Strength of Materials". During the development of this course it is intended that students acquire skills in solving problems of structural design and mechanical elements formed from the union of prismatic bars as well as analysis techniques to deal with deformable solids. In addition, it helps to introduce mechanical design concepts useful in the design of structures of diverse functionality.

The first topic is devoted to complete the analysis of bending, particularly unsymmetrical bending and combined bending with axial force. In the next topic, the concept of hyperstaticity in bending and its application to solving simple statically indeterminate structures by classical methods are exposed, with special emphasis on the method of forces. In the third issue the torsion theory and its application to pieces of circular cross-section is addressed. Next, two issues of considerable interest are presented: the buckling instability and the energy theorems. The program is completed with a brief exposition of the elementary theory of impact problems. With this course the student will have the basic knowledge to successfully address problems of calculation and design of solids formed by prismatic bars.

As mentioned before, this course is a continuation of the course "Elasticity and Strength of Materials" and is part of the curricular line of Mechanical Engineering. So, like that, the subject "Solid Elastic Calculation" is based on the subjects of second course "Mechanics" and "Applied Mechanics" whose knowledge and mastery are essential to understand the behavior of structures and other mechanical parts considered as deformable solids. Obviously, the student should also have a good grasp of the fundamental concepts of "Algebra" and "Calculus" studied in the first year. Another link can also be found with another subject taught in the third year, "Theory of Mechanisms and Mechanical Vibrations", a discipline that helps determine the forces undergone by the elements of a mechanism, and from which stresses and strains can be obtained by means of the "Solid Elastic Calculation". In this way a proper design ensuring system integrity can be obtained.

The knowledge acquired in this subject also form the basis of other mechanical-type subjects of the fourth year such as "Theory of Structures and Construction", where new methods are shown in the calculation of structures formed by prismatic bars. It is also evident the relationship with the subjects "Theory of Machines" and "Machine Elements", where it is essential to obtain stresses and strains and to apply the corresponding theories of failure. Finally, the "Solid Elastic Calculation" is also basic for some subjects included in several Master courses: in the "Master in Mechanical Engineering" (a continuation of the Degree in Mechanical Engineering) and in the "Master in Industrial Engineering" (a continuation of the Degree in Industrial Technology Engineering).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The competence of the subject corresponding to the module Specific Technologies, and reflected in the memory of the degree is:
- Knowledge and ability to apply the fundamentals of elasticity and strength of materials to the behavior of real solids.

As a result of learning it is expected that the students are able to:
- Understand the fundamentals of calculation of statically indeterminate structures with particular emphasis on the method of forces and master the resolution of simple structures composed of prismatic bars.
- Complete calculation of stresses and strains in structures subjected to different types of forces including torsion effects in circular prismatic bars.
- Acquire the skills to carry out the advanced analysis of bars under biaxial or unsymmetrical bending.
- Know the procedures for calculating heterogeneous sections subjected to pure bending and be able to apply the transformed section method and the static method.
- Master the analysis of elements subjected to eccentric compression, both in materials with similar behavior in tension and compression, and those that do not support tensile stresses.
- Acquire theoretical analysis methods for calculating supports against buckling under compression and become familiar with the standards-based calculation (Technical Standards for Building).
- Be able to use as an alternative energy methods to calculate both isostatic and statically indeterminate structures, understanding the meaning of the fundamental energy theorems.
- Know the method of the equivalent static load to solve impact loads on structures with both linear and nonlinear behavior.

COURSE CONTENTS, THEORETICAL & APPLIED

THEORETICAL CONTENTS
ITEM 1. UNSYMMETRICAL BENDING. COMBINED BENDING AND AXIAL FORCE. HETEROGENOUS SECTIONS
ITEM 2. ANALYSIS OF BENDING IN HYPERSTATIC STRUCTURES
ITEM 3. THEORY OF TORSION
ITEM 4. INSTABILITY: BUCKLING THEORY
ITEM 5. ENERGY THEOREMS
ITEM 6. IMPACT ELEMENTAL THEORY

LABORATORY PRACTICES
PRACTICE SESSION 1. PHOTOELASTICITY
PRACTICE SESSION 2. BENDING OF BEAMS

TEACHING METHODS

The contents of the subject "Solid Elastic Calculation" are taught through lectures, practical classes, seminars and laboratory practice. In the lectures the contents and theoretical concepts of each topic are presented with the aid of some specific publications available to the student and by the resolution of practical exercises. In the practical classes problems based on structures and mechanical systems are solved in order to consolidate the concepts presented in the lectures. Throughout the semester three seminars are held, in which larger problems as well as exams of previous editions are solved. The arrangement in small seminar groups propitiates an interactive resolution of problems between the professor and the students. Along the course two laboratory practices are performed, the first corresponding to a photoelasticity test and the second consisting of the measurement of reactions and deformations in beams subjected to bending. The practices are carried out in the "Laboratory of Strength of Materials and Structures" of the Department of Mechanical Engineering. Previously, and depending on each practice, students individually or divided into groups initially attend a theoretical presentation and solve analytically some exercise related to the practice prior year. During the session, students are divided into smaller groups so as to carry out experimental measurements and validate their calculations. At the end of each practice, students must submit a report with the results and final conclusions. On the virtual platform eGela, the following material is available to the students: the Student Guide, a collection of review exercises, some problems to be solved in the seminars and other problems from the examination sessions, together with the results and exam grades. All subject groups have at their disposal the same material simultaneously.

TYPES OF TEACHING

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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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<td>Hours of student work outside the classroom</td>
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Evaluation methods

- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 95%
- Exercises, cases or problem sets 5%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In this subject a partial exam is proposed that allows reducing contents in the final exam. It will be assumed that by not doing or not obtaining the required grade in this partial exam the student is giving up the continuous assessment system. The requirements for passing the course are:
1. Attend all laboratory practices.
2. Get an average rating greater than or equal to 5.0.

The laboratory practices account for 5% and the written tests for 95% of the final grade. The written tests consist of individual resolution of problems and theoretical questions. The first written test enables to pass definitively the first part of the course (for this it is necessary to obtain a rating equal to or greater than 4.0). In the second part of the course, a score equal to or greater than 3.5 should be obtained in order to be able to get a pass average. The final grade is the average of the two partial tests. Students may also make a full examination even after having passed the first of the written tests. The theoretical part of the exam is in any case one third of the mark for each exam.

According to the current regulations of the University of the Basque Country - EHU, it is sufficient for the student not to present himself to give up the corresponding call.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the extraordinary examination a written exam including the full course will be performed. This will consist of individual
resolution of problems and theoretical questions. The theoretical part accounts for one third of the exam. The final grade will be obtained by taking the laboratory practices into account. As in the ordinary call, to give up this call it will be sufficient for the student not to present himself.

MANDATORY MATERIALS


BIBLIOGRAPHY

Basic bibliography

Detailed bibliography

Journals
- Int. J. of Mechanical Sciences, Elsevier.
- Int. J. of Solids and Structures, Elsevier.
- Computers & Structures, Elsevier.

Web sites of interest
- https://egela.ehu.es/
- es.scribd.com/doc/305851/Resistencia-de-materiales-Problemas-resueltos
- es.wikipedia.org/wiki/Resistencia_de_materiales

OBSERVATIONS
ADVANCED TELEMATIC SERVICES

DESCRIPTION AND CONTEXTUALIZATION OF THE SUBJECT

The main objective of this subject is that the student achieves the ability to develop advanced remote services and applications. Java EE is used as the base technology, although other alternatives are presented. The student will also deploy the services in his/her own server, so basic server administration is also covered.

This subject depends on the Java programming capability developed in the Programming in Distributed Environments subject, and the concepts of database design of the Basic Programming subject.

COMPETENCIES / LEARNING OUTCOMES OF THE SUBJECT

...

THEORETICAL-PRACTICAL CONTENT

METHODOLOGY

All classes will be given in the form of lectures, and most of them also in classroom exercises and computer practices. As part of the lectures, small assessment tests will be prepared to help the student gauge his/her progress in the subject; this will also be part of the continuous assessment. Computer practical work is done individually and focuses on the application of the concepts developed in the lectures, so they will not be a repetition of these. During the classroom exercises the students will present their development of the corresponding computer practices, which will also lead to a discussion with the rest of the students and will be part of the continuous assessment.

ORDINARY CALL: GUIDELINES AND WITHDRAWAL

A continuous assessment system is followed consisting of:

- Examinations during the course (30%): attendance at lectures will be monitored by tests carried out in class, according to teaching needs. Computer practical work will be evaluated by public presentation and discussion in class, and by participation in computer and classroom practical work. If the oral presentation is not made or if attendance at any of the lecture tests, computer or classroom practical work sessions is below 80%, then the total mark for the examinations during the course will be 0. Not preparing practical computer work in advance will count as an attendance fault.
- Final examination on the official exam date (70%): this will consist of the development of a computer program.

In order to pass it is necessary to achieve at least 4.0 in the final examination and an average 5.0 in this and the rest of the examinations.

In order to withdraw from this ordinary call it is sufficient not to attend the final exam.

In order to renounce to the continuous assessment Article 8 of the Regulations on Assessments of Students is applicable. In this case, the assessment will be carried out following the same system as the one followed in the extraordinary call.

EXTRAORDINARY CALL: GUIDELINES

The assessment consists of a final exam constituting 100% of the grade. This exam contains a
written part and another practical one carried out in the computer. Both parts must be passed in order to pass the subject.

Those students with a grade of at least 6.0 over 10 in the lecture tests (continuous assessment) under the ordinary call can keep that grade for the written part of the extraordinary call in the same academic year.

**MATERIALS OF COMPULSORY USE**

This subject makes use of a virtual classroom in the e-Gela platform where the student can access the following compulsory material for each type of class:

* Lectures: outlines to help in following the lectures that must be filled in by the student.
* Practical work: protocols for the different computer work, which must be read in advance to help with the preparation of sessions.
COURSE GUIDE 2020/21

Faculty 345 - Faculty of Engineering - Bilbao
Degree GIAMBI30 - Bachelor's Degree in Environmental Engineering
Cycle Not Applicable
Year Fourth year

COURSE

27440 - Environmental Management in Industry
Credits, ECTS: 4.5

COURSE DESCRIPTION

The main aim of the course is to provide knowledge of the design, implementation and evaluation of environmental management systems in industry, as well as other environmental management tools useful to reduce the impact of industrial activities and to report on their commitment to do so.

This course is taught during the last semester of the Degree. It requires previous knowledge acquired in basic and specific courses, in particular in "Environmental Science and Technology". "Environmental Management in Industry" is an optional course, but compulsory in the "Environmental Management" specialization. However, this course is useful for students of any variation of the Degree in Environmental Engineering, as well as Chemical Engineering, Civil Engineering and Industrial Engineering, among others.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The competences acquired in the course will allow students to:
- Describe and argue the benefits of implementing an environmental management system in organizations, in particular in the industrial sector.
- Detail the main features and applications of existing environmental tools in order to implement an environmental management system.
- Identify the main steps in order to plan, design, implement, assess, and improve an environmental management system.
- Describe the fundamentals and applications of other useful environmental management tools such as life cycle assessment, eco-design, environmental footprint, ecolabelling and others.

COURSE CONTENTS, THEORETICAL & APPLIED

The main contents of the course comprise four topics:

TEACHING METHODS

The course will be delivered by means of:
- Lectures (MC), which will be used to explain core contents in order to develop students' knowledge and understanding of the aforementioned concepts.
- Seminars (S), which will be used for practical activities, discussions in groups, reviews, etc.
- Computer labs (CL), which will be used to solve practical cases and to prepare an individual report that will be presented to the group at the end of the semester.

TYPES OF TEACHING

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<tr>
<td>Hours of face-to-face teaching</td>
<td>22.5</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 methods
- Continuous evaluation
- End-of-course evaluation
Continuous assessment is used in both ordinary and extraordinary assessment sessions. The completion of activities, computer lab reports and the exposition are included in the assessment criteria (60%). Students are also required to take a final written exam in May/June (40%). It is essential to pass this final exam (minimum grade: 5.0/10.0) to average it with the grades obtained during the semester (activities, computer lab reports and oral defence):

Any student wishing to waive continuous evaluation and wishing to be marked by final assessment instead of by continuous assessment in the ordinary session should request this in a written document from the lecturer responsible for the course before the ninth week after the course starts. In this case, the student must do the following in May/June:

- Written exam: multiple choice test (40% of final grade)
- Resolution of a practical case (50% of the final grade)
- Computer lab test (10% of the final grade)

El estudiante que quiera renunciar a la evaluación continua, y quiera ser evaluado mediante evaluación final, deberá presentar un escrito al profesorado responsable de la asignatura indicando su renuncia antes de la novena semana después del comienzo de la asignatura. En este caso el alumno deberá realizar:

- Prueba escrita tipo test (40% de la nota final).
- Resolución de un caso práctico (50% de la nota final).
- Prueba de práctica de ordenador (10% de la nota final).

Students who do not pass the subject in the ordinary call are required to take a written exam similar to that in the ordinary session (40% of the final mark). The remaining 60% of the mark will correspond to the activities carried out throughout the semester (practical activities, computer lab reports and oral presentation).

Any student who requested to be qualified by final assessment in the ordinary session will be marked according to the same criteria as in the ordinary session.

Materials required to follow the sessions will be shared with the students through eGela virtual platform (https://egela.ehu.eus/):

- Lecture materials and documents,
- Instructions for practical activities and computer lab guides,
- Links to useful websites and useful reports.

Basic bibliography

- AENOR, Prevención y control integrados de la contaminación. AENOR ediciones (2003).
- AENOR, Gestión Ambiental. AENOR ediciones (2011).
- Sociedad Pública de Gestión Ambiental-IHOBE. Etiquetado ambiental de producto. La declaración ambiental de...

Detailed bibliography
- Carrillo, J., Del Río, P. y Könnölä, T. Eco-Innovación: Claves para la Competitividad Sostenible y la Sostenibilidad Competitiva. Editorial Netbiblo (2011)

Journals

Web sites of interest
US Environmental Protection Agency (EPA) http://www.epa.gov
International Standards Organization (ISO) http://www.iso.org
European Environment Agency (EEA) http://www.eea.eu.int
Diario Oficial de las Comunidades Europeas (DOCE) http://europa.eu.int/eur-lex/
Ministerio para la Transición Ecológica https://www.miteco.gob.es/es/
Asociación Española de Normalización y Certificación(AENOR) http://www.aenor.es
Sociedad Pública de Gestión Ambiental del Gobierno Vasco- IHOBÉ http://www.ihobe.es

OBSERVATIONS
The main objective of this subject is the study of statics, kinematics and dynamics of rigid bodies, essential background for subjects related to the theory of machines and mechanisms, elasticity and resistance of materials. This subject is based on fundamental principles of physics and mathematics, and will enlarge the practical vision of the students, providing them with the resources needed to analyze different mechanical problems.

Moreover, in this subject the students will get an opportunity to realize how useful the knowledge they already have is, and the application it has in the engineering field. The concepts developed in this subject will be based on vector calculus and matrix algebra, and these will be used on mechanical systems.

The skills developed in this subject are the base of other third year subjects of the Mechanical Engineering Bachelor's Degree: Elasticity and Resistance of Materials, Kinematics and Dynamics of Machines, Design of Machines, Structures and Industrial Constructions and Mechanical Technology. These skills are also the base of Mechanical Engineering that any engineer of the branch of Industrial Engineering (Bachelor's Degree in Electricity and Bachelor's Degree in Industrial Electronics and Automation included) should master.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Specific skills:
- Get to know, understand, and apply the concepts and basic principles of resistance of materials and of mechanisms and machines. These concepts and principles will be essential in the study of advanced methods and theories of mechanical engineering.
- Apply the strategies of the scientific methodology: analyze any problematic situation in a qualitative and quantitative way and set up a hypothesis and solution by applying the methods used in applied mechanics.
- Express correctly the theoretical knowledge, solution methods, and the results obtained for problems dealing with the equilibrium and movement analysis of mechanical systems, using the specific terminology and vocabulary.

Transversal skills:
- Ability to work efficiently in team, proposing and debating different ideas and taking decisions along with the other team members.
- Have a responsible attitude, be organized in the work and willingness for the learning process.

Learning results:
After studying this subject, the students must have acquired the following abilities related to the mechanical analysis and calculus:
- To model a mechanical system composed of rigid elements and simple mechanical elements.
- To evaluate how the different loads are transmitted to the supports in simple isostatic structures.
- To analyze the kinematics of simple mechanical systems, obtaining the velocities and accelerations of points and elements, expressed in fixed and mobile reference systems.
- To obtain the gravity centers and inertia properties of rigid bodies and planar surfaces.
- To analyze the dynamics of simple planar and spatial mechanical systems.
- To evaluate the variation of internal forces in simple beams under point or distributed forces.
- To evaluate the stress in simple elements.
- To transmit all the previous results in a clear and comprehensive way to a specialized audience.

COURSE CONTENTS, THEORETICAL & APPLIED

- Lesson 1: Force systems
  Basic knowledge of calculus with vectors. Definitions and properties of the momentum generated by a force acting about an axis and a point. Concept and properties of a pair of forces. Equivalence and reduction of force systems.

- Lesson 2: Static equilibrium
Study of structural systems, fundamental axiom of the static equilibrium of a rigid body. Concepts of links and mechanical action. Calculus of the forces and reactions that appear in the different elements of a mechanical system. Analysis of isostatic structures and methods solve lattices.

- Lesson 3: Friction
Study of the simplified hypothesis of Coulomb to analyse the friction in a sliding movement, friction coefficient and friction angle. Industrial applications of the friction.

- Lesson 4: Funicular bodies
Equilibrium study of funicular bodies, cables working under the effect of point and distributed forces. Study of catenaries.

- Lesson 5: Kinematics of the rigid body
Velocity and acceleration concepts applied to a particle. Analysis of the simple movements of translation and rotation of a solid body. Meaning of the angular velocity vector and angular acceleration vector. Law of vector derivatives in mobile frames. Velocity and acceleration fields. Study of the relative movement of a point with respect a mobile system. Study of the relative movement of a solid body with respect a mobile system.

- Lesson 6: Kinematics of planar movement

- Lesson 7: Mass geometry
Concept and properties of gravity centre and static moment. Theorems of Pappus-Guldin. Inertia moments with respect to axis, planes and points. Inertia products. Steiner theorems. Inertia tensor and the main inertia direction of a body.

- Lesson 8: Dynamics of the rigid body

- Lesson 9: Dynamics of bodies with a fixed axis
Study of bodies with a rotation movement about a fixed axis. Calculus of the reaction forces in the links. Equilibrium of rotors.

- Lesson 10: Dynamics of planar movement
Study of the magnitudes and equations of dynamics for a planar case. Analysis of the different possible cases and how to solve them. Application to mechanical systems that are part of machines and mechanisms.

- Lesson 11: Inertia momentums of a surface
Description of the moments and products of inertia for planar surfaces. Main moments of inertia and main directions of inertia, obtained by applying the circle of Mohr.

- Lesson 12: Internal forces
Concept of internal force in a section of a body. Axial force, shear force and bending moment. Representation of the corresponding diagrams.

- Lesson 13: Normal tensions
Concept of normal tension and unitary deformation in the axis of a body. Relation between the tension and the deformation, Hooke law. Relation between the tensions and the internal forces in a section.

TEACHING METHODS
The main theory lectures will be complemented with exercises solving lectures and computer practise.

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
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<th>GCL</th>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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<td>Hours of student work outside the classroom</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
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups
**Evaluation methods**
- End-of-course evaluation

**Evaluation tools and percentages of final mark**
- Written test, open questions 80%
- Teamwork assignments (problem solving, Project design) 20%

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**
* Written exam: 80% of the final mark

+ Exams period in the first semester:
  - First partial exam: from lesson 1 to lesson 7. To pass the exam, students must earn a minimum mark of 5/10. Students who pass the exam will not be tested again on this material in the second partial exam.

+ Exams period in the second semester. There are two possible cases:
  - Second partial: from lesson 8 to lesson 13. To be eligible for this option, students must have passed the first partial. The final mark of the subject will be the GEOMETRIC mean of the marks obtained in the two partials.
  - Final exam: all syllabus. Students who did not pass or appear for the first partial must take this exam.

Additional information:
- In all exams, partial and final, the theory part will account for 40% of the mark of the exam, and the exercises will account for 60%.
- Students who do not attend the second partial or the final exam will get a final mark of No presentado (did not attend).

* Tasks: 20% of the final mark
  - During the scholar year, students will be asked to develop different tasks (10 approximately).
  - Students who apply to the final evaluation will be evaluated with a single exam, the results of which will constitute the 100% of the final mark of the subject. Students who want to be evaluated with the final evaluation system must apply for it within the deadline established in the Norma reguladora de Evaluación del alumnado en las titulaciones de Grado de la UPV/EHU before the 4th week of the second semester.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**
- Students who have not passed the ordinary evaluation will get the chance of writing a final exam of the whole subject.
  - By default, the marks of the tasks will be also taken into account in this evaluation (20% of the final mark), so the mark obtained in final exam will be the 80% of the total mark in the subject.
  - If in any case the mark obtained in the final exam is higher than the one obtained after considering the tasks, the final mark in the subject will be the higher mark.
  - The evaluation for students who do not attend the exam will be "Not presented".

**MANDATORY MATERIALS**

**BIBLIOGRAPHY**

**Basic bibliography**
Journals

Web sites of interest

**OBSERVATIONS**

In case of a State of Emergency or similar situation when in-person activities are not allowed, classes, evaluations and any other activity will be carried out online. Students will be informed through official channels (eGela and university official e-mail).
DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

As an interdisciplinary subject, it is important to provide the students with suitable knowledge for the assimilation and going into detail on other subjects in the course. This will help to avoid unnecessary overlaps and gaps in content.

ORDINARY EXAM CALL: GUIDELINES & WITHDRAWAL

Unless otherwise specified, the ‘mixed’ assessment will apply to you. This assessment will be scored as follows:

A) Personal work. A score of 10% of the final grade will be given from a test to be carried out over 12 or 13 weeks during the course. The test will be performed using the e-Gela application (virtual platform). Each test will score 0.083 or 0.077 (depending on the weeks). It is enough to answer correctly. Sessions will start on Friday afternoons and end on Monday afternoons. Answering the questions is a serious matter, so a minimum of 9 sessions will be required to be assessed at the end of the course. That is, if the number of tests you take up to the end of the course is < 9, this section does not score in any final grade.

B) Laboratory. 25%. Of this percentage, 15% corresponds to an individual final examination. This exam will consist of a previously completed practical work, part of it, or a proposed exercise different from those previously completed.

The remaining 10% corresponds to the continuous assessment of the laboratory sessions. This continuous assessment includes the reading, understanding and preparation of the practical work and its performance, session by session.

C) Final written test. 50%. Within it, MINIMUM TEST, 10%. The MINIMUM TEST is a test in which basic concepts necessary for the understanding of the subject are assessed. This minimum test is a qualifying test, a necessary condition for passing the course. If this test is not passed, the remaining 40% is not taken into account and the subject is not passed. The remaining 40% assesses knowledge of theory and exercises.

D) Monographic work. 15%. Group work, which will consist of the development and presentation of a problem proposed in class.

MINIMUMS

All the grades specified above will be added together in the January call, provided that the minimum test has been passed and that the minimum of 30% in the laboratory and a minimum of 30% in the monographic work has been passed.

NOT PRESENTED:

Having taken the mixed evaluation, not passing the course means missing a call (the one in January). If a student does not take the written exam or does not pass the minimum
test, he/she will be given the grade of FAIL with a grade equal to the sum of the laboratory + the monographic work (at most 4).

Those students who have not taken the mixed assessment but do not take the exam will have a grade of NOT PRESENTED.

**TO PASS:**
To pass the course, apart from fulfilling the requirements specified above, the sum of all the sections must be greater than or equal to 5.

Exam aimed at the rest of the students (those who have not been evaluated under the criteria of mixed assessment).

The student who copies in either the mixed or the final assessment will FAIL the subject. When the student requests it (always through the SECRETARIAT OF THE SCHOOL and in a formal document that will be analyzed by the ACADEMIC ORGANIZATION of the school), the student has the right to take a theoretical and practical exam, through which he/she can be assessed for 100% of the course.
SUBJECT
27711 - Data Mining

ECTS Credits: 6

DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

Good programming skills are required as well as basic statistics.

Related topics:
- computation
- statistics and operative research
- machine learning
- artificial intelligence
- business intelligence
- decision support systems

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

By the end of the course the student will be able to:
- describe information extraction fundamentals and its potential scope on information systems.
- apply data mining approaches to particular tasks related to knowledge discovery, business intelligence and decision support systems.

THEORETICAL/PRACTICAL CONTENT


Clustering: Signal compression. Approaches: k-means, hierarchical, agglomerative. Applications (e.g. homes, species, customer trends).

Predictive models: Inference algorithms: neural networks, bayesian networks, random forest, logistic regression etc. Evaluation metrics (e.g. confusion matrix, precision, recall, f-score, AUC). Ensemble models. Multi-class mono-label vs. multi-class multi-label prediction models. Real tasks and international research challenges. Applications: clinical diagnoses.


METHODS

The approach is mainly practical, the classes are taken in the lab. Programming labs are carried out and presented in groups. By the end of the course a research-style poster is presented covering a related article or a self-implemented application.

Assessment parts and weighting: over 10.0 pts
40% (~ 4.0 pts): Labs and works carried out throughout the course
60% (~ 6.0 pts): Exam

Two requirements must be satisfied:
1. Achieve, at least, 40% on both parts i.e. minimum 1.6 points at labs and 2.4 points at the exam.
2. Summing up both parts together, achieve, at least, 5.0 points out of 10.0.

TYPES OF TEACHING

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<tr>
<th>Type of teaching</th>
<th>M</th>
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<tr>
<td>Classroom hours</td>
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<td>Hours of study outside the classroom</td>
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TOOLS USED & GRADING PERCENTAGES
- Final assessment system
  - Extended written exam  60%
  - Practical work (exercises, case studies & problems set)  40%

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
Assessment parts and weighting: over 10.0 pts
40% (~ 4.0 pts): Labs and works carried out throughout the course
60% (~ 6.0 pts): Exam

Two requirements must be satisfied:
1. Achieve, at least, 40% on both parts i.e. minimum 1.6 points at labs and 2.4 points at the exam.
2. Summing up both parts together, achieve, at least, 5.0 points out of 10.0.

In order to evaluate the labs: in the ordinary call continuous assessment is carried out. In the remaining calls (either extraordinary call or calls taken in advance) a lab-exam is taken in replacement of the continuous assessment.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT
Assessment parts and weighting: over 10.0 pts
40% (~ 4.0 pts): Labs and works carried out throughout the course
60% (~ 6.0 pts): Exam

Two requirements must be satisfied:
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In order to evaluate the labs: in the ordinary call continuous assessment is carried out. In the remaining calls (either extraordinary call or calls taken in advance) a lab-exam is taken in replacement of the continuous assessment.

COMPULSORY MATERIALS
  eGela

BIBLIOGRAPHY
Basic bibliography


In-depth bibliography


Journals
  ACM Transactions on KDD
  IEEE Transactions on Knowledge and Data Engineering
  Data Mining and Knowledge Discovery (DMKD)
  ACM SIGKDD Explorations
  Data & Knowledge Engineering (DKE)

Useful websites
  http://www.cs.waikato.ac.nz/ml/weka/
  http://kaggle.com/
http://www.kdd.org/
http://www.kdnuggets.com/

**REMARKS**

English Friendly Course (EFC):

The lecturers are willing to tutor, conduct examinations and/or accept papers in English, although classes are given in Spanish.

They are purposed for international students with a medium level of Spanish, but they manage better in English.
SUMMARY

The subject of *Extension in technical drawing* is taught in the third year in the mechanical technology degree. The subject is related to a large number of aspects; all of them deal with aspects of design or project development.

The subject of *Extension in technical drawing* complements the knowledge of the basic subject of *technical drawing in Engineering*, getting deeper in the industrial standardization and the management of essential graphic communication tools in our industrial context.

Therefore, it is highly recommended that students who enroll have previously approved the subject of *technical drawing in Engineering* taught in the first year.

COMPETENCES / RESULTS OF LEARNING THE SUBJECT

According to the ANECA Report for the Degree in Mechanical Engineering, this subject will try to train students in the specific competence of the Mechanical Technology Module considered TEM-1, which is related to the competences of the C3, C5 degree, C10 and C13. Teachers will also try to contribute to their training in competences C1 and C14.

SPECIFIC COMPETENCES OF THE MECHANICAL TECHNOLOGY DEGREE, WHICH ARE DEVELOPED IN THIS SUBJECT:

TEM-1 Knowledge and skills to apply graphic engineering techniques.

SPECIFIC COMPETENCES OF THE DEGREE, THAT ARE DEVELOPED IN THIS SUBJECT:

C1. Ability to write, sign and develop projects in the field of industrial engineering, specific mechanical technology, which have as their object, in accordance with the knowledge acquired as established in section 5 of Ministerial Order CIN / 351/2009, the construction, renovation, repair, conservation, demolition, manufacturing, installation, assembly or exploitation of: structures, mechanical equipment, energy installations, electrical and electronic installations, industrial plants, and manufacturing and automation processes.

C3 Knowledge in basics, which enables them to learn new methods and theories, and gives them versatility for certain new situations.

C5 Knowledge for the realization of measurements, calculations, valuations, rates, examinations, studies, reports, work plans and other similar works.

C10 Ability to work in a multilingual and multidisciplinary environment.

TRANSVERSAL COMPETENCES OF THE DEGREE, THAT ARE DEVELOPED IN THIS SUBJECT:

C13. Apply the own strategies of the scientific methodology: analyze the problematic situation qualitatively and quantitatively, propose hypotheses and solutions, use the own models of industrial engineering to solve them in MECHANICAL SPECIALTY.
C14 Work effectively in a group, integrating skills and knowledge, to make decisions in the field of industrial engineering, MECHANICAL SPECIALTY.

RESULTS OF LEARNING THIS SUBJECT (collected in the memory of ANECA):

RA1. Know, understand and apply the technological and graphic concepts, adapted to new situations, for professional development.
RA2. Develop strategies and procedures to solve graphic problems, as a channel to address engineering projects.
RA3. Use the graphic communication between technicians, interpreting the standard drawings of Technical Drawing in Industrial Engineering, involving new technologies.
RA4. Work as a team, solve problems with a critical and responsible technical / cultural exchange.
RA5. Plan and manage projects in the field of industrial engineering, according to the current legislation.

THEORETICAL-PRACTICAL CONTENTS
1. FUNDAMENTALS AND METHODOLOGICAL BASES OF INDUSTRIAL DESIGN
   - Areas of development and application of Industrial Design in Engineering.
2. STANDARD DEVELOPMENT OF INDUSTRIAL ELEMENTS AND MECHANISMS
   - Industrial elements

TEACHING

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<th>Type</th>
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<td>68</td>
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ORDINARY CALL: GUIDANCE AND DISCLAIMER
A mixed evaluation will be carried out, combining the exam grade with the continuous evaluation of the student's work and the skills developed (individual and in group, face-to-face and non-face-to-face):

1. PERFORMANCE OF PRACTICES (Exercises, Cases, Problems ...) 20%
2. TEAM WORK (Problem solving, Project design ...) 20%
3. WRITTEN TEST 60% (Excluding condition: students must pass this exam, to pass the subject).

All proposed deliverables, both individual and team, are mandatory for continuous evaluation. To be qualified it is necessary to have delivered them, in the form and on the dates proposed by the teacher. Students who have not delivered the deliverables at the time, will not be able to deliver them later.

According to Article 8.3 of the regulations governing the evaluation of students in official degree degrees, the student who submits in writing to the faculty responsible for the subject renounces the continuous evaluation, within a period of 9 weeks from the
beginning of the Four-month period, you will have the right to be evaluated through the final evaluation system, regardless of whether or not you have participated in the continuous evaluation system.

FINAL EXAM

If a student chooses a final evaluation option, his grade will consist of:

- Written test (80%)
- Laboratory Practice Test (20%).

To pass the subject it is necessary to obtain a grade higher than 50% in each of them, each of which may include content or exercises related to the entire program developed in class during the course.

However, according to Article 12.2 of the Regulations for the Evaluation of students in official Degree degrees: “In the case of continuous evaluation, if the weight of the final test is greater than 40% (in the case of this subject) of the qualification of the subject, it will be enough not to submit to said final test so that the final qualification of the subject is not presented or not presented. Otherwise, if the weight of the final test is equal to or less than 40% of the grade of the subject, the student may resign the call within a period that, at least, will be up to one month before the end date of the teaching period of the corresponding subject. This waiver must be submitted in writing to the faculty responsible for the subject. In the case of a final evaluation, the non-submission to the test set on the official exam date will mean the automatic withdrawal of the call.”

In all written tests, students must identify themselves through their academic card, ID or driving license and can only use basic drawing utensils, consisting of: ruler, square and bevel, compass, pens, markers and erasers. Not being allowed to have at your fingertips: backpacks, books, notes, phones, calculators, or any other type of electronic device. At the beginning of the tests they will be indicated where they should leave all the objects not allowed, being considered a serious fault the possession of them during the tests.

EXTRAORDINARY CALL: ORIENTATIONS

According to Article 9.2 of the regulations governing student evaluation in official degree degrees, the evaluation of the subject in the extraordinary call will be carried out exclusively through the final evaluation system. Your qualification will consist of a single:

- Final test (100%). Any type of content and exercises, both theoretical and practical, that the teachers consider appropriate to verify the knowledge and skills addressed in this subject which are included in the first sections of this guide.

According to Article 12.3 of the regulations governing the evaluation of students in the official degrees, not showing up in the official date of the extraordinary call will mean automatic waiver of the call.

In all written tests, students must identify themselves through their academic card, ID or driving license and can only use basic drawing utensils, consisting of: ruler, square and
bevel, compass, pens, markers and erasers. Not being allowed to have at your fingertips: backpacks, books, notes, phones, calculators, or any other type of electronic device. At the beginning of the tests they will be indicated where they should leave all the objects not allowed, being considered a serious fault the possession of them during the tests.

MATERIALS FOR MANDATORY USE

EGela platform of the UPV / EHU.

BIBLIOGRAPHY

Basic


Normas UNE e ISO.

ZORRILLA, E. y MUNIOZGUREN, J. - Dibujo Técnico. S. de Representación - Publicaciones EIB UPV/EHU.

ZORRILLA, E. y MUNIOZGUREN, J. - Dibujo de Ingeniería - Publicaciones EIB UPV/EHU.

ZORRILLA, E. y MUNIOZGUREN, J. - Normalización Básica. Dibujo Técnico - Publicaciones EIB UPV/EHU.

ZORRILLA, E. y MUNIOZGUREN, J. y otros - Ejercicios Prácticos de Gráficos de Ingeniería - Publicaciones EIB UPV/EHU.


GONZÁLEZ GARCÍA, V. y otros - Sist. de Representación. Sistema Diédrico (Tomo I) - Ed. TEXGRAF.

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LUZADDER, W.J. - Fundamentos de Dibujo en Ingeniería - PRENTICE-HALL.

JENSEN, C. et all - Dibujo y diseño en ingeniería - McGraw-Hill.


Deepening


LEIGHTON WELLMAN, B. - Geometría Descriptiva. - Editorial Reverté S.A.

HOHEMBERG, F. - Geometría Constructiva Aplicada a la Técnica. - Editorial Labor, S.A.

GRANT HIRAN, E - Geometría Descriptiva Práctica. - Ediciones del Castillo, S.A.

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IZQUIERDO ASENSI, F. - Ejercicios de geometría descriptiva II (acotado y axonométrico) – ORYMU.


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**Journals**

Técnica Industrial.

- [http://www.tecnicaindustrial.es/TIFrontal/home.aspx](http://www.tecnicaindustrial.es/TIFrontal/home.aspx)

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- [https://www.revistadyna.com/inicio-dyna](https://www.revistadyna.com/inicio-dyna)
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IMHE.
- https://www.izaro.com/revistas/IMHE/

Electronic Designs.
- https://www.electronicdesign.com/

Era Solar.
- https://www.energias-renovables.com/empresas/era-solar

**Web-sites**

https://www.aeipro.com/es/

https://4pm.com/

https://www.pmi.org/Pages/default.aspx

https://www.elsevier.com/es-es

http://www.directindustry.es/

http://planosconciri.blogspot.com/

http://dibujotecnico.edu.umh.es/

**OBSERVATIONS**

This guide gathers the basic guidelines for all the teachers of the subject. Subsequently, each teacher can provide their students a Group Subject Guide, with more detailed information.
SUBJECT

27722 – Elasticity and Strength of Materials.

DESCRIPTION AND CONTEXTUALIZATION OF THE SUBJECT

Elasticity and Strength of Materials is a specific subject of Mechanical Engineering, which deals with the behavior of real solid bodies (deformable) subjected to various types of load. This subject provides students with fundamental knowledge for the analysis and design mechanical and structural systems (such as machines, industrial constructions, mechanisms, etc.). The subject provides the necessary knowledge to analyze the stress and deformation states in resistant mechanical elements.

It is, therefore, an essential basis for the subjects "Machine Design" and "Industrial Structures and Constructions" that are taught in the 2nd semester in the curriculum of the Degree in Mechanical Engineering.

To face this subject without excessive difficulty, it is necessary to follow the sequence of subjects foreseen in the curriculum and therefore, it is considered essential to have passed the following subjects:

- Physical fundamentals of engineering
- Algebra
- Calculus
- Applied Mechanics, mastering:
  + Concepts related to static equilibrium,
  + Obtaining of the internal forces in a cross section (axial, shear and bending) and establishment of diagrams.

COMPETENCES / LEARNING RESULTS OF THE SUBJECT

Competences in Specific Technology, Mechanical Module:

Knowledge and skills to apply the fundamentals of the elasticity and strength of materials to the behavior of real solids.

Learning outcomes/results:

- Know, understand and apply the fundamentals of the elasticity and strength of materials to the behavior of real solids that enable the student for the subsequent application of advanced methods and theories in his/her professional development, in areas of mechanical engineering; and likewise, give him/her a great versatility to adapt to new situations.
- Apply adequately the strategies of the scientific methodology to the problems posed by the structural systems and deformable solid: analyze the situation qualitatively and quantitatively, raise hypotheses and solutions to solve problems typical of mechanical engineering.

- Express, using the appropriate means, the theoretical knowledge, methods of resolution, results and aspects inherent to the problems posed by the balance of the deformable solid and structural systems, using the specific vocabulary and terminology.

- Work effectively as a group integrating skills and knowledge to formulate ideas, discuss proposals and adopt decisions in the development of works typical of the elasticity and strength of materials.

- Carry out measurements, calculations, studies, reports and other analogous work related to problematic situations that may arise in the field of elasticity and strength of materials.

THEORETICAL-PRACTICAL CONTENTS

The contents to be developed will be established according to the following sections:

1. Introduction.

2. Concept of tension.

3. General theory of deformation.

4. The elastic problem.

5. The elastic solid.

6. Failure theories.

The prismatic piece. Internal forces and deformations; Navier’s hypothesis. Isostatic beams and hyper-static beams. Diagrams of efforts.

8. Simple axial effort.
Tensile or compression simple stress state. Deformations in tensile or simple compression. Hyper-static structures. Effect of temperature and deformations or previous stresses.


The elastic curve. Moment area method: Mohr’s theorems. Application of the superposition principle.

11. Hyper-static bending.


13. Instability: Buckling.
Critical load. Euler’s formulas. Anchorage conditions in columns. Field of application of Euler’s formula.

METHODOLOGY

The lectures will be expository and will develop the concepts and theoretical contents necessary to overcome successfully the subject. Model exercises will also be presented by the teacher.

The seminars are fundamental, given the applied nature of the subject; in them, students should work on problems of practical application. In these classes, group work and active participation of the students will be encouraged.

TYPES OF LECTURES

Types of lectures
Hours of On-Campus lectures
Non-face-to-face activity hours of the student

ASSESSMENT SYSTEMS

- Final evaluation

METHODS AND PERCENTAGES OF RATING

- Written test 70%
- Completion of practical assignments (exercises, cases or problems) 30%

**ORDINARY CALL: ORIENTATIONS AND RESIGNATION**
The evaluation of the competences will be done through two partial exams and/or a final exam, which will represent 70% of the final grade in the subject. The remaining 30% will comprise the note of the deliverables that will be developed throughout the semester. In total, exam and deliverables, it must be obtained an average grade higher than 5.0 in order to be considered the subject as approved.

Throughout the semester, there will be two partial exams, which will allow to free final exam, both in the ordinary and in the extraordinary call, the passed part. In these partial exams, it must be achieved at least 40% of the maximum grade, in order to maintain the qualification and make the average with the part evaluated in the final exam, which must also reach at least 40% of the maximum grade of the part evaluated.

During the semester, various deliverables will be evaluated, in which a minimum score of 40% must be achieved (in each of them) of the maximum grade to be considered as surpassed. There will be three opportunities to overcome these deliverables (during the semester, ordinary and extraordinary calls).

The student will be qualified in any the ordinary and the extraordinary calls if he / she attends any of the final exams in these calls.

**EXTRAORDINARY CALL: ORIENTATIONS AND RESIGNATION**
The final evaluation in this call will also be divided into a test that will represent 70% of the grade and in three deliverables with a percentage of 30% (in both parts a minimum qualification of 40% of the maximum note). In total, exam and deliverables, the students must obtain an average grade higher than 5.0 to be able to consider the subject as approved.

**MATERIALS OF COMPULSORY USE**
Available in: https://egela.ehu.es/

**BIBLIOGRAPHY**

**BASIC BIBLIOGRAPHY**

RESISTENCIA DE MATERIALES. Luís Ortiz Berrocal. Universidad Politécnica de Madrid. 1980
SPECIALTY BIBLIOGRAPHY


JOURNALS

INTERNET ADDRESSES OF INTEREST
TEACHING GUIDE 2020/2021

FACULTY: 363 – Faculty of Engineering in Bilbao

PLAN: GMECAN30 – Bachelor’s Degree in Mechanical Engineering

SUBJECT

26620 – Kinematics and Dynamics of Machines

CREDITS: 9

DESCRIPTION AND CONTEXT OF THE SUBJECT

Engineers who design machines and study mechanical problems should get a great theoretical and experimental education. More specifically, they should be able to explain the existing relation between the structural topology, the geometry, the forces and the movement in mechanisms and machines. All of this is the focus of the current subject – Kinematics and Dynamics of Machines.

The main goal of teaching this subject is that students acquire the skills to solve typical kinematics problems in mechanisms and analyse the dynamics of machines, considering them, as the problem may require, as rigid bodies or as deformable bodies. Besides, the students will learn the first concepts related to the synthesis of mechanisms. Once the basic techniques have been exposed, they will be applied to study certain machine elements, such as cams and gears. These elements which transmit forces and movement, are part of a complex system – the machine, object of study in this subject.

This subject is part of the curriculum of Mechanical Engineering and is based on the second year subject Applied Mechanics, which students must master to correctly follow the syllabus of this subject. At the same time, the skills developed in this subject are the base of other subjects of third year – Elasticity and Resistance of Materials, Design of Machines, Structures and Industrial Constructions and Mechanical Technology. Kinematics and Dynamics of Machines specifically develops the base of machine theory, and it is essential to study the subject Design of Machines.

COMPETENCES / LEARNING RESULTS OF THE SUBJECT

The main aim of this subject is that the students acquire the skills to solve typical kinematics problems in mechanisms and analyse the dynamics of machines considering them as either rigid bodies or as deformable bodies.

More precisely, the specific skills developed in this subject are:

- Understand the structure of mechanisms: elements and kinematic joints, degrees of freedom, concept of kinematic chain.
- Study the fundamental theorems of planar movement, as a base of the analysis and synthesis of mechanisms.
- Acquire the necessary skills to analyse the kinematic problem of mechanisms. Study of rotation ability, analysis of singular positions and obtention of quality parameters of mechanisms.
• Analyse the direct and inverse dynamic problems of planar mechanisms (considering rigid body) by applying the concepts learnt in Applied Mechanics and specific procedures for desmodromic mechanisms.
• Dynamic analysis of deformable body systems of one or several degrees of freedom.
• Analysis of planar cams. Knowledge about the different types of cams and their applications.
• Study the kinematics and dynamics of gears, specially the cylindric ones. Knowledge about the gear trains.

Apart from these specific skills of the subject, following transversal skills are also evaluated:
• Ability to work in a multi-lingual and multi-discipline atmosphere.
• Apply the strategies of the scientific methodology: analyse any problematic situation in a qualitative and quantitative way and set up a hypothesis and solutions by applying the methods used in industrial engineering, speciality of mechanical engineering.
• Work successfully in a team, applying the abilities and knowledge of each member of the team to take decisions in the field of industrial engineering, speciality of mechanical engineering.

Regarding the learning results, the student must be able to:
• Describe the main components of a machine.
• Classify the machines according to their properties and kinematic and dynamic characteristics.
• Develop the model of a mechanical system composed by rigid or deformable bodies and simple mechanical elements.
• Study exhaustively the kinematics of planar mechanisms.
• Deal with the different geometrical and analytical technics for the kinematic analysis.
• Analyse the kinematics of planar cams with followers using graphical and analytical methods.
• Analyse the kinematics of cylindrical gears.
• Analyse the interferences in the transmission in cylindrical gears.
• Raise the distribution of forces in the transmission with gears.
• Use the current standards to calculate and set the dimensions of gears.
• Analyse the dynamics of simple machines.
• Deal with the different geometrical and analytical techniques to solve the inverse and direct dynamic problem.
• Set the preliminary dimensions of a flywheel unit by applying analytical procedures.
• Design and analyse deformable mechanical systems using models of one or several degrees of freedom.

In relation to the transversal skill, the students must be able to:
• Transmit their results orally and writing in a coherent way, using technical language.
• Participate actively and assume individual responsibility when working in a team.
• Collaborate using the appropriate tools when working in team.
THEORETICAL-PRACTICAL CONTENTS

Unit A: Kinematics of mechanisms

- Lesson 1: Basic concepts of mechanisms and machines
- Lesson 2: Geometry of planar movement
- Lesson 3: Kinematic analysis of planar mechanisms
- Lesson 4: Kinematics of cams
- Lesson 5: Kinematics of gears

Unit B: Dynamics of machines

- Lesson 6: Inverse dynamic problem
- Lesson 7: Direct dynamic problem
- Lesson 8: Vibrations theory

METHODOLOGY

The main theory lectures will be complemented with exercises solving lectures and computer practise.

TYPES OF TEACHING

Final evaluation: only

<table>
<thead>
<tr>
<th>Teaching type</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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</thead>
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<td>On-site teaching hours</td>
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<td></td>
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<tr>
<td>Non on-site studying/learning hours</td>
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<td>45</td>
<td>22,5</td>
<td></td>
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</tr>
</tbody>
</table>

Where:

- M: main theory lectures
- S: seminar
- GA: solving exercises lectures
- GL: lab practise
- GO: computer practise
- GCL: clinical practise
- TA: workshop
- TI: industrial workshop
- GCP: field test

EVALUATION SYSTEMS

- Continuous evaluation
- Final evaluation

TOOLS AND CALIFICATION PERCENTAGES

- Written test: 80%
- Practical tasks (exercises, cases of study): 10%
- Group projects: 10%
ORDINARY EXAM: ORIENTATION AND RESIGNATION

Points breakdown:

- 10%: projects developed during the scholar year
- 10%: group project
- 80%: written exams

Minimum requirements to pass the subject following continuous evaluation:

- Minimum mark of 5/10 in each exam
- Minimum mark of 5/10 in the projects

Final evaluation: only students who apply to the final evaluation will be evaluated with a single exam, the results of which will constitute the 100% of the final mark of the subject. Students who want to be evaluated with the final evaluation system must apply for it within the deadline established in the Norma reguladora de Evaluación del alumnado en las titulaciones de Grado de la UPV/EHU.

EXTRAORDINARY EXAM: ORIENTATION AND RESIGNATION

Extraordinary evaluation: students will get the chance of writing a final exam in which all the concepts necessary to obtain the 100% of the mark will be evaluated.

BIBLIOGRAPHY

Kinematics, Dynamics and Design of Machinery; Waldron, K.J, Kinzel, G.L.

Mechanism Design. Analysis and Synthesis; Erdman, A. G.; Sandor, G. N.
Prentice-Hall, 1997

Theory of Machines and Mechanisms; Uicker, J.J. (Jr.); Pennock, G.R.; Shigley, J.E.

Mechanical Engineering Design; Shigley, JE

Machine Elements in Mechanical Design; Mott, RL

OBSERVATIONS

In case of a State of Emergency or similar situation when in-person activities are not allowed, classes, evaluations and any other activity will be carried out online. Students will be informed through official channels (eGela and university official e-mail).
TEACHING GUIDE

Description and contextualization of the subject

The subject of Machine Design is a compulsory subject of the third year of the Mechanical Engineering Degree. Its purpose is to provide the concepts, procedures and decision analysis techniques required for the mechanical design of various machine elements. In this sense, the mechanical engineer faces in his professional life many situations in which he must design, analyze, interpret failures, redesign, maintain or/and select different machine elements efficiently. This process requires considering throughput specifications or the performance of each element at the individual level, as well as the interfaces between these elements as part of a machine.

The understanding and practical application of the design theories and methodologies explained in this subject requires previous knowledge acquired in the subjects of Applied Mechanics and Elasticity and Strength of Materials. It is more than advisable (not to say practically mandatory) to have passed these subjects, since the subject of Machine Design takes as a starting point the concepts acquired in these subjects. In addition, although it is not essential, it is also advisable to have passed the subject of Machine Kinematics and Dynamics.

Skills/ Learning results

- To know, understand and apply the fundamentals of Machine Design, in such a way that they enable students to apply advanced methods and theories in their professional development in areas of Mechanical Engineering. This skill will also provide them with great versatility to adapt to new situations.
- To apply properly the strategies of the scientific methodology: analyze the problem situation qualitatively and quantitatively, propose hypotheses and solutions for solving typical problems of Machine Design, in the field of Mechanical Engineering, and, finally, to understand and interpret the results.
- To express correctly, using the appropriate means, the theoretical knowledge, resolution methods, results and inherent aspects of the propounded problems by the calculation, construction and testing of machines, within Mechanical Engineering, using the specific vocabulary and terminology of the subject.
- To work effectively in a team, integrating skills and knowledge to formulate ideas, discuss proposals and adopt decisions in the development of own works of Machine Design and within the field of Mechanical Engineering.
- To develop designs, projects and processes in the field of Machine Design, and within the field of Mechanical Engineering. As well as making measurements, calculations, studies, reports and other similar work, related to problematic situations to sort out in the field of the specialty.
- To know, understand, interpret and apply the legislation correctly, specifications, regulations and mandatory standards in Machine Design, within the field of Mechanical Engineering.

Theoretical-practical contents
The theoretical-practical contents taught in Machine Design classify into the following main sections:

Chapter I: an up to date and unified introduction to Machine Design.

Chapter II: the study of the behavior of materials under static stresses: stress concentrations, failure theories and fracture mechanics.

Chapter III: explains the classic methods of analysis of materials under variable loads of fatigue, both in the case of uniaxial and multiaxial stresses.

Chapter IV: given its current wide use in the field of mechanical design, a brief overview of the Finite Element Method in the mechanical computer design is given.

Chapter V: applying the knowledge acquired in the previous chapters, as well as in previous subjects of the Degree, this chapter addresses the design of the main elements of machines widely used in mechanical engineering, such as shaft, clutches, brakes, belts, bearings, screwed joints, etc.

**Methodology**

This subject has master classes and seminars.

In the master classes, the professor will explain the theoretical concepts of the different chapters of the subject. To follow the class, the student will have reference books (in English), a course book (in Spanish) and some PowerPoint presentations (pdf files) in Spanish. These PowerPoint presentations are a summary of the course book, prepared so that the student can follow the explanations of the professor and take notes. Occasionally there will be exercises/activities to strengthen the theoretical concepts, trying to encourage the participation of the student.

In the seminars, the professor will propose and solve the exercises corresponding to the content explained in the lectures. He/she will encourage each student to solve each exercise individually before the seminar, and that he/she discusses with the other students and the professor the proposed solution. In this way, the student will assimilate better the concepts of each exercise and will acquire skills related to oral communication, the ability to synthesize and teamwork.

On the other hand, in the seminars the teacher will propose each week an exercise/activity that the students (in groups of 2 to 4 students) will have to solve and deliver through the eGela platform. The objective of this weekly group work is to perform a continuous assessment of the student (the qualification of these group assignments will count towards the final grade of the subject), as well as to enhance their ability to work in groups.

**Evaluation system**

- Final Evaluation System
  - Qualification percentages:
    - Written exam (%): 70
Regular call: Orientations and renunciation

The evaluation of the subject in the ordinary call will be carried out as follows:

1. Throughout the course, students must perform individual and/or group work in which the knowledge acquired in the subject (hereinafter deliverable) is applied. Each deliverable will consist in the resolution of proposed exercises or complementary activities proposed weekly, and that the professor will guide in the seminars, tutorials ... Each individual / group will have to deliver each week the exercise / activity proposed the previous week, realizing in this way a continued monitoring of the course. The weight of the note of the deliverables on the final grade of the subject is 30%.

2. Once the first 8 lessons had been taught, a non-obligatory individual theoretical-practical partial examination will be carried out. Students who wish to, may take the partial exam to evaluate the content corresponding to the first 8 lessons. In order to assist the partial exam, it will be mandatory requirement to have submitted all the deliverables corresponding to the first 8 lessons. Students who pass this partial exam will have passed the first part of the subject and may take the final exam only with the subject corresponding to the last 7 lessons. The weight of the partial exam grade will be 35%.

3. At the end of the course, an obligatory final theoretical-practical individual exam will be held. The weight of the individual exam grade on the final grade of the subject is 70% (35% in the case of having passed the partial exam). Those students who have passed the first partial exam and want to take only the second partial, must have delivered the deliverables corresponding to the last 7 lessons.

Students who do not make the deliverables corresponding to the first 8 lessons or the last 7, will only opt for the evaluation through the final exam.

Therefore, to pass the subject in ordinary call it is necessary to independently pass both the individual exam (partial and final, or only final) and the deliverables.

Only 100% of the grade can be obtained by means of a single theoretical-practical written exam by the students who requested it within the deadlines set out in the Regulations governing the Evaluation of students of Official Degrees of the UPV / EHU (through an email to the teacher before the 9th week of the course).

Supplementary call: Orientations and renunciation

As explained in the previous section, to pass the subject in ordinary call it is necessary to independently pass both the exam and the deliverables. In case of passing one of the two parts (exam or deliverables) in the ordinary call, the note of said part will be kept until the extraordinary call.
In this extraordinary call, you must retake the failed part (exam and / or deliverables) in the ordinary call.

There will be the possibility of taking a final exam with the necessary sections to obtain 100% of the grade for all students.

**Mandatory materials to use**

- [https://ocw.ehu.eus/course/view.php?id=441](https://ocw.ehu.eus/course/view.php?id=441) (Spanish)
- Power Point presentations in pdf format (Spanish) to download from eGela.
- Exercises collection in pdf format (Spanish) to download from eGela.

**References**

SUBJECT
26015 - Computer Structure

ECTS Credits: 6

DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT
In this subject the different parts of a computer are analysed, its elements and their functionality, starting with the circuits that form part of the Arithmetic Logic Unit and going up in the level of abstraction. Knowledge gained in the first semester subjects Foundations of Computer Technology, Digital System Design Principles and Basic Programming. Some knowledge and skills of this subject are developed at another level in the next semester’s subject Computer Architecture.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

· To understand machine's inner language and programs in assembly language, including inner mechanisms for subroutine management.

· To analyse memory system's performance to evaluate its influence in a computer's performances.

· To program input/output applications for the surround sensing (hardware event-driven programming).

· To understand the working of a computer's standard peripherals.

· To analyse different bus protocols to determine their influence in the computer's data transfer performance.

· To understand computer's inner architecture and the role of each unit in the execution of instructions, with its implication in the execution time and memory occupation of the programs.

THEORETICAL/PRACTICAL CONTENT

0 - Basic concepts
A quick review of the concepts and competences that shall be known.

1 - von Neumann architecture
Introductory topic in which basic concepts of the von Neumann architecture are reviewed: computer's inner architecture and role of each unity in the instruction execution. Following this introduction, the subject will focus in the study of the different subsystems that make up the aforementioned architecture.

2 - Computer's instructions
This topic is centred in the analysis of the instruction set of a computer: instruction format, addressing modes, instruction types, etc. All of this taking into account actual machines' designs examples. The process of translation from high level instructions to machine language will also be addressed, through concrete examples in C programming language.

3 - Subroutines
In this topic, the CPU's support for the subroutine treatment will be studied, analysing the execution of a subroutine and the activation record's management. The basic needed instructions will be introduced, taking into how current architectures manage this subject.

4 - Memory subsystem
This topic treats the basic memory subsystem of a computer. First of all the memory hierarchy concept is introduced, to afterwards focus on the study of the main memory, studying the basic alternatives for memory module interconnection; all of this analysing the influence of the different alternatives in the overall performance of the computer. Finally, the different types of memories and their organization in a commercial PC type machine will be studied.

5 - Input/output subsystem
This subject is dedicated to the study of the input/output subsystem of a computer, like an interface between the machine and the user. The following concepts will be studied: peripheral driver, independent vs. mapped I/O, polling or interrupt driven I/O and DMA (Direct Access Memory). Finally, the standard peripherals in a commercial PC type computer will be presented.

6 - Connection between subsystems: buses
In this topic, the subsystem for interconnection of the different elements composing the von Neumann architecture will be studied: the buses. Starting with the bus hierarchy concept and the main bus characteristics: transmission and arbitration protocols. To end some commercial buses for a PC type machine will be analysed.
## METHODS

In the theory classes the concepts are explained with the aid of some examples. In the classroom practices, exercises are done with the aim to deepen the previously seen theory, besides some teamwork. In the laboratory sessions we will work on assembly language and hardware event-driven, linking it to the concepts seen in classroom, and so condensing in something practical and real the theoretically treated ideas.

## TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Type 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>Classroom hours</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td></td>
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<tr>
<td>Hours of study outside the classroom</td>
<td>40</td>
<td>30</td>
<td>20</td>
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</table>

Legend:
- **M**: Lecture
- **S**: Seminario
- **GA**: Pract.Class.Work
- **GL**: Pract.Lab work
- **GO**: Pract.computer wo
- **GCL**: Clinical Practice
- **TA**: Workshop
- **TI**: Ind. workshop
- **GCA**: Field workshop

## ASSESSMENT SYSTEMS

- Final assessment system

## TOOLS USED & GRADING PERCENTAGES

- The assessment will be made as specified below 100%

## ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

Mixed evaluation
- a. Written exam: 5 points (1p. minimal knowledge test + 4p. theory and exercises)
- b. Laboratory: assembly language (8085) 1 point
- c. Laboratory: event-driven programming (EDP) (Arduino) 1 point
- d. Weekly test: 1 point
- e. Teamwork 1: 1 point
- f. Teamwork 2: 1 point

Everybody, unless express notification at the beginning of the course, belong to the mixed evaluation system. Otherwise, the 100% of the grade can be obtained via a written exam (theory and practice) plus a laboratory exam.

### ABSENCE

Students under the mixed evaluation system that fail to appear to the ordinary exam will receive a failing grade (grade in the records will be that of laboratory + classroom practices).

Students not under the mixed evaluation system that fail to appear to the ordinary exam will receive a classification as "Absent".

Students who so wish can resign to the grade accumulated during the continuous assessment, by filling and handing an application form (available in eGela) at least one month prior to the exam date. In that case, the classification will be "Absent". It brings to lose the grade accumulated during the course also for the extraordinary call, in which it will be necessary to make apart from the written exam of 5 point two other tests of 2 points each: one related to the work done in the classroom practices and a laboratory exam.

### MINIMUM

- Minimal knowledge test (questions to evaluate basic concepts)
- 20% of the grade of EDP and assembly programming exam
- 20% of the grade of the teamwork 1 & 2

Students under the mixed evaluation system that fail to appear to the ordinary exam or fail to pass the minimum of each section will receive a failing grade (grade in the records will be that of laboratory + classroom practices).

### REQUIREMENTS TO PASS

- Surpass the minimum requirements in each section and obtain an overall grade equal or greater than 5.

## EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

RESIGN
Every student (under or not mixed evaluation system) that fails to appear to the ordinary call exam will obtain an "Absent" in the records.

EXAM TYPE

* 5 point written exam for those students following the mixed evaluation system that have not lost the grades obtained in the classroom practice and laboratory.
* 9 point exam (written + laboratory) for those students who have lost the grades obtained during the continuous assessment or resign to them for the previous call.

MINIMUM

* Minimal knowledge test (questions to evaluate basic concepts)
* 20% of the grade of EDP and assembly programming exam
* 20% of the grade of the teamwork 1 & 2

REQUIREMENTS TO PASS

* Surpass the minimum requirements in each section and obtain an overall grade equal or greater than 5.

COMPULSORY MATERIALS

The lecture notebook (power point presentation, wording of the practices and proposed exercises) for the class will be available at the photocopying service. These notes are not to be considered as a study book, but as the basis for each student's personal notes.

BIBLIOGRAPHY

Basic bibliography

- Estructura de computadores. N. Azkona [OCW EHU ISSN 2255-2316]
- Logic and computer design fundamentals M. Morris Mano et C. Kime. [Prentice Hall]
- The essentials of computer organization and architecture L. Null, J. Lobur [Jones and Bartlett]
- Computer organization and architecture W. Stalling [Prentice Hall]
- Fundamentos de los computadores P. de Miguel Anasagasti [Thomson]

In-depth bibliography

&amp;#8226; Estructura y diseño de computadores D. A. Patterson & J. L. Hennessy [I, II, III] [Reverté S.A.]
Computer organization and design D. A. Patterson & J. L. Hennessy [I, II, III] [Morgan Kauffman Publishers]

&amp;#8226; Organización de computadores V.C. Hamacher et al. [Mc. Graw Hill]
Computer organization V.C. Hamacher et al. [Mc. Graw Hill]

&amp;#8226; Organización de computadores: un enfoque estructurado A. S. Tanenbaum [Pearson Education]
Structured computer organization A. S. Tanenbaum [Pearson Education]

&amp;#8226; The indispensable PC hardware book H. P. Messmer [Addison-Wesley]

&amp;#8226; El PC: hardware y componentes J. E. Herrerías Rey [Anaya multimedia] (tema 6)
Sistemas digitales y tecnología de computadores J. García Zubia [Thomsn] (chapter 1)
Arquitectura del PC, M. Ujaldón. [Ciencia-3, 2003]

Journals

- Byte (https://archive.org/details/byte-magazine)
- Personal Computer & Internet
Useful websites
- http://williamstallings.com/COA/COA7e.html
- http://atc.ugr.es/intro_info_mcgraw.html
- http://atc.ugr.es/~acanas/arquitectura.html
- http://www.intel.com [and other manufacturers]

VIRTUAL INTERNET PLATFORM: eGela

REMARKS
SUBJECT

26621 – Industrial Structures and Constructions.

DESCRIPTION AND CONTEXTUALIZATION OF THE SUBJECT

Industrial Structures and Constructions is a specific subject of Mechanical Engineering. The studies will allow students to design, calculate and define structures (estimation of the loads to be applied, calculation schemes and dimensioning of elements), the essential basis for the realization of professional projects of industrial constructions.

To address this subject without excessive difficulty, it is essential to follow the sequence of subjects expected in the course of studies and therefore, it is considered essential:

- Having passed the subject of Applied Mechanics.
- Having attended the subject of Elasticity and Resistance of Materials (third year, first semester), mastering concepts related to hyperstaticity, static equilibrium, tensions and deformations, section forces and moments (bending, shear, axial and torsion), sizing and checking of sections and obtaining axial, shear and moment diagrams.

COMPETENCES / LEARNING RESULTS OF THE SUBJECT

Competences in Specific Technology, Mechanical Module:

Knowledge and capacity for the calculation and design of industrial structures and constructions.

Learning outcomes/results:

- Know, understand and apply the theoretical and technological concepts required to identify and establish structural systems and provide the student with the necessary training to meet the performance requirements set out in applicable standards and the functional requirements.
- Apply appropriate scientific methodology: analyze the qualitative problematic situation and quantitatively propose hypotheses and solutions to solve structural problems of varying complexity.
- Effectively communicate the knowledge, procedures, results, skills and aspects related to structural design, using specific vocabulary and terminology, and appropriate means.
- Work effectively in multidisciplinary and multilingual environments, integrating skills and knowledge to make decisions related to the design and management of structural projects in the industrial field.

- Develop designs and projects in the field of industrial constructions in accordance with the corresponding construction technology and making use of available techniques and tools to solve structural problems.

- Know, understand and apply the legislation, specifications, regulations and mandatory standards in the field of industrial constructions.

THEORETICAL-PRACTICAL CONTENTS

The following topics will be discussed:

1: Introduction to structural design.


2: Articulated knot structures.


3: Structures of rigid knots.

- Analysis of rigid knot structures. Rigidity, distribution and transmission of moments. Relationships between deformations and forces.

4: Loads on buildings.


5: Characterization of industrial buildings.


6: Introduction to reinforced concrete.

7: Bases of calculation of reinforced concrete sections.


8: Sizing of reinforced concrete sections.


9: Matrix calculation of structures.


METHODOLOGY

The lectures will have explanations of the theoretical part of the subject, basic and essential for the realization of the practical parts.

In the seminar exercises, reports (team work), oral presentations and other tasks of practical application will be assigned, requiring the students to apply their knowledge to practical cases.

In computer practices problems will be solved using different software.

TYPES OF LECTURES

Types of lectures
Hours of On-Campus lectures
Non-face-to-face activity hours of the student

Magistral: Lecture
Seminario: Seminar
Práctica de ordenador: Computer Exercise
Práctica de Laboratorio: Laboratory Exercise (Laboratory Sessions)
Práctica de Aula: Classroom Exercise

ASSESSMENT SYSTEMS
- Final evaluation

METHODS AND PERCENTAGES OF RATING
- Written test (essays and analyses) 50%
- Completion of practical assignments (exercises, cases or problems) 20%
- Individual work 5%
- Team assignment (problem solving, project design) 25%
ORDINARY CALL: ORIENTATIONS AND RESIGNATION

The percentage of the final grade corresponding to each of the evaluation systems used in the subject is the following:

- 50% Various assignments developed throughout the semester (reinforced concrete practices, problems, work of a truss, work-project...).
- 10% Partial examination of the theory of Reinforced Concrete.
- 40% Final written exam (theory and practical exercise).

In order to pass the subject, the obligation to exceed 40% of the maximum possible score in all the following partial notes:

- in the written final exam (a minimum of 4 out of 10 being required for both the theoretical part and the practical exercise)
- in the exercises corresponding to the calculation of a truss
- in the partial examination of reinforced concrete theory
- in the work-project carried out in a group
- in the practical exercises of reinforced concrete

The student will be qualified in the ordinary call if he/she attends the final test. Therefore, in order to renounce evaluation, it is sufficient not to attend this final test.

In accordance with article 8 of the regulations governing the evaluation of students in official degree programs, evaluation systems, students who request the final evaluation of the subject, in addition to the final written exam, must deliver and defend, on the date that is established, the reports corresponding to the calculation of a truss and the work-project of an industrial structure, as well as complete the examination of the theory and the practical exercise for the sizing of sections of reinforced concrete.

EXTRAORDINARY CALL: ORIENTATIONS AND RESIGNATION

In the extraordinary call will be qualified only students who attend the final written exam.

In accordance with article 9 of the Regulations governing the Evaluation in the Extraordinary Call, students who have not delivered the different tasks developed during the semester must prove attainment of knowledge and competences inherent to the subject through a written final exam, in addition to a specific test, which may include an oral exam and the completion of exercises with the calculation software used in the subject. The evaluation of the competences and learning results developed in the reports corresponding to the calculation of a truss and the work-project will be exigible. For this reason, the delivery of these documents will be allowed up to the date of the final examination, unless other planning is established and communicated through eGela, before the review of the ordinary call. Students who have not participated in the continuous evaluation and do not wish to take advantage of this new delivery, must
communicate before the date established for the extraordinary call their interest in being evaluated in it, in order to prepare the evaluation activities necessary to evaluate and measuring learning outcomes in a comparable way, in accordance with the provisions of the aforementioned article 9.

MATERIALS OF COMPULSORY USE

Standards:
- CTE-DB-SE
- CTE-DB-SE-AE
- CTE-DB-SE-A
- EHE-08

Software:
- Prontuario Informático del Hormigón estructural EHE-08 (Computing Compendium of Structural Concrete EHE-08)
- CESPLA

BIBLIOGRAPHY

BASIC BIBLIOGRAPHY

THEORY OF STRUCTURES:
- Cálculo matricial de estructuras (Matrix calculation of structures), Manuel Vázquez, Col. ITOP Madrid, 1992
- Teoría de Estructuras (Theory of Structures), Vol. 3 Pedro José Landa, José Luis Ramírez, Eduardo Roji, ETSII Bilbao, 1995

LOADS:
- Acciones en la edificación (Loads on buildings), Francisco Fiol Femenia, Francisco Fiol Oliván, 2008

STEEL STRUCTURES:
- Estructuras de acero II. Uniones y sistemas estructurales (Steel structures II. Joints and structural systems), Ramón Argüelles Álvarez, Bellisco, 2007
- Estructuras de acero I. Fundamento y cálculo según CTE, EAE y EC3 (Steel structures I. Basis and calculation according to CTE, EAE and EC3), Ramón Argüelles Alvarez, Bellisco, 2013
- Naves industriales con acero (Industrial buildings with steel), Alfredo Arnedo Peña, APTA, 2009

REINFORCED CONCRETE STRUCTURES:
- Jiménez Montoya: Hormigón armado (Reinforced concrete), Álvaro García Meseguer, Francisco Morán Cabré, Juan Carlos Arroyo Porter, Gustavo Gili, 2010
STANDARDS

- CTE-DB-SE-AB: SEGUROS ESTRUCTURALES: BASES DE CÁLCULO Y ACCIONES EN LA EDIFICACIÓN (STRUCTURAL SECURITY: BASIS OF CALCULATION AND LOADS IN BUILDINGS)
- CTE-DB-SE-A: SEGUROS ESTRUCTURALES: ACERO (STRUCTURAL SAFETY: STEEL)
- EHE-08: INSTRUCCIÓN DE HORMIGÓN ESTRUCTURAL (STRUCTURAL CONCRETE STANDARD)
- UNE 76-201-88. CONSTRUCCIONES METÁLICAS. CAMINOS DE RODADURA DE PUENTES GRÚA (METALLIC CONSTRUCTIONS. RAILS OF BRIDGE CRANES)

SPECIALTY BIBLIOGRAPHY

THEORY OF STRUCTURES:
- Teoría de las estructuras (Theory of structures), Jesús Zurita Gabasa, Univ. Pública Navarra, 2007
- Curso de análisis estructural (Course of structural analysis), Juan Tomás Celigüeta, EUNSA, 2003
- Structural Analysis, R.C. Hibbeler, Prentice Hall, 2006

STEEL STRUCTURES:
- Edificación agroindustrial: estructuras metálicas (Agroindustrial building: metallic structures), Miguel Ángel Garcimartín, Mundi-Prensa, 1999

REINFORCED CONCRETE STRUCTURES:
- Proyecto y cálculo de estructuras de hormigón: en masa, armado y pretensado (Design and calculation of concrete structures: mass concrete, reinforced concrete and prestressed concrete), José Calavera, INTEMAC, 2008

INTERNET ADDRESSES OF INTEREST

STEEL:
www.constructalia.com
www.apta.com.es
www.ascem.org
STANDARDS:
www.codigotecnico.org
www.fomento.es

CESPLA PROGRAM:
http://www.unav.es/adi/servlet/Web2?course=4000002130&action=verWeb&pagina=102866

CONCRETE
www.concrete.org
www.ieca.es
www.e-ache.com

WOOD:
www.infomadera.net

CRANE BRIDGES:
www.apelsl.com
www.stahlcranes.com
In this course, you learn the operation and use of Computational Fluid Dynamics (CFD) codes. Interest in numerical methods in engineering is increasing, both in the scientific and industrial spheres, especially as the computational capacity of the equipment increases, and they are able to solve complex models such as the equations that govern the flows of fluids.

The approach of the course is very applied, and its development requires basic knowledge of Fluid Mechanics and Numerical Methods acquired in previous courses. The tasks that will be developed in this course will allow the students to face a simulation of a CFD problem and choose the appropriate parameters to obtain satisfactory results in certain quality and term. For this, the basic understanding of the Finite Volume Method and different discretization approaches of the governing equations is necessary. The course complements the knowledge acquired throughout the Bachelor's Degree in Mechanical Engineering in a state of the art discipline, such as CFD which is demanded by many different sectors: Automotive, Energy, Construction...

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The learning outcomes of the course are the following:

1. To know, understand and apply the concepts of the science and technology of computational fluid mechanics in order to adapt to new situations.
2. Apply the strategies of the scientific methodology: analyze the problem situation qualitatively and quantitatively, pose hypotheses and solutions to solve problems of computational fluid mechanics.
3. Properly communicate the knowledge, procedures, results, skills and aspects of computational fluid mechanics using the specific vocabulary and terminology and the appropriate means.
4. To develop designs, projects and processes of computational fluid mechanics according to the specific technology applying the legislation, the specifications and the mandatory regulations and working in multidisciplinary and multilingual environments.
5. Carry out measurements, calculations, studies and reports on the operating parameters of the different types of computational fluid dynamics cases.

COURSE CONTENTS, THEORETICAL & APPLIED

Summary of contents: Solution of Fluid Mechanics problems addressed and solved by numerical methods, which implies the use of computer calculation systems.

The theoretical contents:
1. Philosophy and field of application of computational fluid dynamics.
2. Equations that govern the flow: continuity, momentum and energy.
7. Basic computational methods applied to incompressible flow. Resolution of the transport equation. Methods to solve the current function. Boundary conditions. Methods to solve the pressure-velocity equation.
9. Generation of meshes and adequate transformations of the equations
10. Multiphase flow. Eulerian and Lagrangian approximation. VOF method (volume of Fluid)

The practical contents:
1. User-level learning of a commercial code of computational fluid dynamics.

TEACHING METHODS

In this course, different teaching methodologies are used, the most used being problem solving. Individual and in couple
work will be enhanced through the use of computer and bibliographic resources that help students understand the different aspects of the subject.

Master lectures on the conceptual contents of the subject will be taught, with student participation in occasional debates about those contents.

The resolution of issues and problems in the classroom will be done in a participatory manner. Real problems will be provided, which will deepen the theoretical knowledge of the subject and relate the CFD with other related areas. The formulation of questions and open discussion will be encouraged, so that students acquire skills related to oral communication, the ability to synthesize and work in teams.

In computer practices, the concepts studied will be applied to real cases using a commercial program of Computational Fluid Dynamics.

To facilitate and ensure student learning, successive reports will be delivered on the problems raised. Evaluation feedback will be provided, so that students have the opportunity to become aware of their learning, as well as ways to improve it.

**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>
<td>15</td>
<td>30</td>
<td>15</td>
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<tr>
<td>Hours of student work outside the classroom</td>
<td>22.5</td>
<td>45</td>
<td>22.5</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
- **GCL**: Applied clinical-based groups
- **TA**: Workshop
- **TI**: Industrial workshop
- **GCA**: Applied fieldwork groups

**Evaluation methods**
- Continuous evaluation
- End-of-course evaluation

**Evaluation tools and percentages of final mark**
- Exercises, cases or problem sets 10%
- Individual assignments 10%
- Teamwork assignments (problem solving, Project design) 80%

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**
El alumnado que a principio de curso justifique alguno de los motivos recogidos en el artículo 43.1.c de la normativa de gestión de las enseñanzas de grado de la EHU/UPV, podrá obtener el 100% de la nota mediante un examen teórico-práctico.

El resto del alumnado será calificado por las diferentes tareas desarrolladas a lo largo del curso.

Es necesaria la asistencia al 80% de las horas presenciales para poder ser calificado, de lo contrario se calificará como "no presentado".

El estudiante obtendrá la calificación de "no presentado" si participa de menos de la mitad de las tareas que forman parte de la evaluación continua.

En la convocatoria extraordinaria El estudiante que participe de la evaluación continua,
Si el estudiante ha participado de la evaluación continua,La nota obtenida en la evaluación continua se podrá utilizar en la calificación de la convocatoria extraordinaria.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**
Para los alumnos que hayan participado de la evaluación continuada, y no hayan superado la asignatura, se realizará una prueba final complementaria al trabajo realizado a lo largo del curso.

Para los alumnos que NO hayan participado de la evaluación continuada, podrá obtener el 100% de la nota mediante un examen teórico-práctico. En estos casos, es necesario ponerse en contacto con el profesor al menos un mes antes de la fecha del examen.

**MANDATORY MATERIALS**
Apuntes de la asignatura.
Tablas y diagramas de mecánica de fluidos.
Star CCM+ User Guide

**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**


**Journals**

**Web sites of interest**

www.cfd-online.com

**OBSERVATIONS**
Although nowadays there are many available technologies for the development of embedded electronic systems, microprocessor/microcontroller-based system design is still the most demanded and extended approach. In this undergraduate course, you will learn the fundamentals of microcontroller architecture, their most common peripheral modules, and how they can be correctly configured and programmed for various applications with emphasis on embedded control. With that purpose, a Microchip PIC24F family microcontroller will be the reference device for the proposed practical programming exercises and labs.

Competencies: Those specified on the memory of the verified study programme:


Learning outcomes:

A1. Acquiring the capacity to gather and analyze relevant information about electronic embedded systems and their applications.

A2. Obtaining solid knowledge of the basic architecture and operation of microcontroller-based systems.

A3: Developing fundamental skills in the use of EDA tools for programming, debugging and verifying microcontroller-based systems (C language).

A4. Acquiring the capacity to develop a simple but complete application project based on microcontrollers.

A5. Acquiring the abilities to apply embedded software programming skills to the development of an embedded feedback control application.

Lectures:

LECTURE 0: Introduction to embedded systems. A modern perspective.
LECTURE 1: Fundamentals of computer architecture.
LECTURE 2: Microcontrollers. The PIC24F: I/O ports.
LECTURE 4: The PIC24F. Executing programs: CPU and memory organization. Use of pointers.
LECTURE 5: The PIC24F. Resets and interrupts.
LECTURE 6: The PIC24F. Serial communication modules: SPI, I2C and UART.
LECTURE 7: The PIC24F. Capturing signals: Input Capture modules and integrated ADC.
LECTURE 8: The PIC24F. Pulsed signal generation: Output Compare modules.
LECTURE 9: The PIC24F. Microcontroller-based embedded control design.
Labs:

LAB 0: The Microchip development environment: MPLAB-X IDE and MPLAB-ICD3.
LAB 1: Configuring I/O ports.
LAB 2: Configuring clock sources. Loop programming: the use of timers.
LAB 3: A real time chronometer: programming interrupts.
LAB 4: Serial communications: controlling an I2C sonar.
LAB 5: Capturing pulses: programming a frequency meter.
LAB 6: Generating PWM signals.

Project: Development of a simple autonomous vehicle.

Methodology:

The different teaching formats are as follows:

M: Master Classes. Presentation of the topics established in the program of the course. Slides will be used for this purpose.

PA: Complementary to the Master Classes. Exercises and practical questions that help to fix the concepts.

PL: Laboratory practices. Practical complement to the course.

Lectures provide the fundamental knowledge on the architecture and configurability of the microcontroller and its peripherals, as well as practical guidelines for embedded programming. Each week this knowledge is put in practice through proposed practical exercises and labs.

Assessment:

Unless otherwise specified, the "mixed" assessment will apply to you.

In case any student want to be evaluated by means of a final 100% theoretical-practical test (art. 44 of the regulations), he/she must inform the professor, at the latest, four weeks before the end of the lecture period.

A student who does not show up for the second round will have a NOT TAKEN as a grade.

Second call:

Same conditions to the first call apply.
Guidelines

The criteria established in the current regulations on the choice of assessment system (continuous or final), and also for changes to the assessment system (from continuous to final or vice versa).

Continuous assessment:

This will consist of 3 mid-course exams and 6 practical work sessions.

The assessment of the subject is divided into 3 parts. The weight of each of the 3 parts in the final grade of the subject is as follows:

- Part I represents 25% of the final grade
- Part II represents 40% of the final grade
- Part III represents 35% of the final grade

Each of the parts consists of a mid-course exam and 2 practical sessions. All the test will be marked out of 10 points.

The mid-course exams will be done during lecture hours and the dates will be announced at the start of the term.

The practical sessions will be done during the computer work groups and attendance at these is COMPULSORY. Teamwork will be done in all the practical sessions (usually teams of 2 people) and students will not be allowed to work individually. Assessment of the practical sessions will be done during the computer work groups and the grade PASSED/NOT PASSED will be communicated to the student immediately. An unjustified absence from a work group will be graded as NOT PASSED for the corresponding practical work session. The grade for the practical session will be individual and will be made public after it has been completed. The calendar of practical sessions and the corresponding work groups will be announced at the start of the term.

In each of the 3 parts of the subject, it is COMPULSORY to pass the practical sessions to take the mid-course exam. Otherwise, the grading for that part will be 0 points. The deadline for passing the practical sessions will be announced at the start of the term.
It is also COMPULSORY to exceed the minimum grade in all the mid-course exams (3.5/10) and in the weighted average (5/10) of these to pass the subject. If these minimum marks are not reached, the maximum grade for the subject will be 4 points.

The grade for each part of the subject will be calculated using the weighted average between the grade for the mid-course exam (75%) and that of the practical sessions (25%) if the minimum grade is reached in the mid-course exam. Otherwise, the grade will be 0 points.

**Final assessment:**

This will be made through a final written exam and a final practical exam.

The final exams (written and practical) will be done on the day and time officially set by the school, first the final written exam and then the final practical exam. The grade for both exams will be between 0 and 10 points.

Optionally, the final practical exam can be validated by passing the practical laboratory sessions proposed in the modality of continuous assessment.

To pass the subject, the student must pass both final exams, and the final grade will be obtained by calculating the weighted average between the mark for the written exam (75%) and the practical exam (25%). Otherwise, the final grade final may not be higher than 4 points.

**Presentation vs. Withdrawal:**

- The grade obtained will be "Presented" if the student takes the third mid-course exam (in continuous assessment) or any of the final exams (in final assessment).
- The grade obtained will be "Not Presented" if the student does not take either the third mid-course exam (in continuous assessment) or any of the final exams (in final assessment).

**Cheating (copying):**

The criteria stated in Article 67 of the current regulations will apply.
Syllabus summary

• **Module:** Advanced Software Development
• **Code:** 27712
• **Situation:** 6 credits, 4th year, 2nd semester
• **Coordinator / lead lecturer:** Unai Lopez-Novoa (unai.lopez@ehu.eus)
• **Date of this document:** 13 May 2020

This document presents a summary of the syllabus for *Advanced Software Development*, a 4th year optional module.

**Description and context**

Most of the software design and development techniques seen in the first three years of the degree are applied to build desktop or web applications. In this module, students will learn to design and develop mobile applications, by translating the skills they already have into a new framework: the Android development environment.

In order to take this module, students should previously know:

• Object-oriented programming using Java or a similar programming language
• Relational database design and SQL
• Working in groups

**Learning outcomes**

On completion of the module a student should be able to:

• Understand the importance of design as a part of the software development process
• Understand and use third-party software libraries
• Acknowledge, understand and use software design patterns correctly as part of the software development process
• Understand and develop web-service oriented architectures
• Understand the fundamentals of mobile application development

**Content**

This module is arranged in the following topics:

1. Fundamentals of Android
2. User interfaces: layouts and fragments
3. Notifications and dialogs
4. Local storage: files and databases
5. Services and broadcast messages
6. Background work with WorkManager
7. Third party libraries: RxJava and others
8. Google Play Services
9. Remote databases
10. Push notifications with Firebase
11. Cross platform frameworks

Due to the changing nature of the mobile-application development ecosystem, some of these topics might change slightly or get updated over the course of the module.
Assessment methodology

Students can choose between two methods of assessment: continuous and final.

Students who choose continuous assessment will get their grade based on three assignments:
- **1st** individual project, **30% of the final grade.** Development of an Android application, putting into practice what is taught up to topic 4.
- **2nd** individual project, **30% of the final grade.** Development of an Android application, putting into practice what is taught up to topic 10.
- **Group project, 40% of the final grade.** Development of an Android application in a group of 2 or 3 students.

Students who choose final assessment will have to take an exam at the end of the module. In this exam, students will have to develop an Android application following a set of specifications and design constraints, in up to 4 hours.

Recommended Reading

This document is a companion to the syllabus summary for Advanced Software Development, a 6-credit 4th year optional module.

The core of the module is mobile application development, a rapidly evolving field in Computer Science. Thus, most of the documentation and material is online and could get updated over the course of the module.

The main source of reference for the module is the official Android documentation website: [https://developer.android.com/](https://developer.android.com/). In here, students will find tutorials and code examples related to most common Android features. For students with no experience in Android development, we recommend starting off with this article, which details the basics of developing for Android and describes the steps to build a simple "Hello World" app from scratch: [https://developer.android.com/training/basics/firstapp](https://developer.android.com/training/basics/firstapp).

As a complement, we also recommend the Youtube channel Android developers, run by Google: [https://www.youtube.com/user/androiddevelopers/](https://www.youtube.com/user/androiddevelopers/). It holds plenty of 3-5 minute long tutorial videos describing Android components or features. However, we advise to check the date of each video, as some of them might be outdated and present code examples not compliant with the latest versions the feature/component being described.

For reference about particular Android features, we recommend checking the Android sub-forums at Medium ([https://medium.com/androiddevelopers](https://medium.com/androiddevelopers)), where developers describe their experiences in the form of blog posts, usually with code samples. We also recommend students to get familiar with Stack Overflow ([https://stackoverflow.com/](https://stackoverflow.com/)), an online Q&A forum for software developers.
CONTENT OF THE SUBJECT

Roads and airports (1. Semester)

Sections:

1. The road system
   • History of road networks
   • Present-day road networks
   • Road administration
   • The vehicle
   • The driver and the pedestrian

2. Circulation of vehicles and traffic analyses
   • Circulation of vehicles
   • Traffic analyses

3. Capacity, levels of service and road planning
   • Capacity and levels of services
   • Road planning

4. Horizontal alignment
   • Road geometry regulations. Velocity and sight distance
   • Straights and curves
   • Transition curves (clothoids) and grade transitions

5. Vertical alignment
   • Grades and vertical curves
   • Vertical curves
   • Coordination of horizontal and vertical alignment

6. Transverse sections and representation on drawings
   • Transverse section
   • Representation on drawings

7. Crossroads
   • General design considerations
   • Elements and distances
   • Intersections
   • Interchanges
   • Roundabouts
   • Selection of crossroad type

8. Earthworks. Platforms. Use and protection of the roadway
   • Earthworks and mass-diagram
• Use and protection of the roadway

9. Surface and subterranean drainage
   • Surface drainage
   • Subterranean drainage

    • Soil and rock mass classifications
    • Compaction and subgrade strength tests
    • Soil stabilization
    • Granular layers
    • Cement-treated bases
    • PG-3 regulations

11. Bituminous pavements
    • Bituminous binders
    • Bituminous mixes
    • Surface treatments
    • Execution of bituminous pavements

12. Concrete pavements
    • Main concrete pavements
    • Execution

13. Surface characteristics of bases. Pavement design
    • Surface characteristics of pavements. Roughness and skid resistance
    • “Norma 6.1-IC Secciones de firmes” standard
    • Standard for pavement design of the Basque Country

14. Road maintenance
    • Road maintenance and management
    • Remedial maintenance techniques

15. Airport infrastructure. Airport pavements
    • Airport infrastructure
    • Airport pavements

Railways, bridges and tunnels (2. Semester)

Sections:
16. The context of the railway
17. Geometry of the railway line
    • Introduction to the railway structure
    • Horizontal alignment
• Vertical alignment. Grade in curves

18. The rail
  • Characteristic of the steel
  • Rail wear
  • Short bar and Long Welded Bar
  • Welding

19. Rail fastenings

20. Sleepers
  • Timber sleepers
  • Steel sleepers
  • Concrete sleepers

21. Track ballast
  • Ballast and sub-ballast
  • Subgrade layers

22. Joints

23. Rail distressing

24. Track devices
  • Crossover
  • Bretelle

25. Rail machinery
  • Main rail machinery
  • Light rail machinery

26. Railway renewal
  • Track renewal
  • New tracking

27. Track qualification
  • 1st and 2nd levelling
  • Verification of track geometric parameters

28. High Speed Train

29. Bridges

30. Tunnels
  • Rock mass classifications
  • Tunnelling methods: Tunnelling Boring Machines (TBM), roadheader, drill and blast
  • Lining
  • Special Works
ORDINARY CONVOCATION

WRITTEN EXAM (60 % of the mark)

There will be an exam in each of the convocations and the entire subject will be evaluated.

In February, out of the official convocation of January, there will be a partial exam of the first part of the subject. This part will not be included in the ordinary convocation (May/June) if the mark is 6.0 or greater (>= 6.0/10.0). There will not be a partial exam of the second part. Only those with a mark of 6.0 or greater in the partial exam of February will do an exam about the second part of the subject (railways, bridges and tunnels). The rest of students will do a global exam.

In the extraordinary convocation the entire subject will be evaluated.

PRACTICAL PROJECT (40% of the mark)

During the practical lessons of the 2nd semester a project to be developed about a road will be presented.

It has to be finished in the 29th week.

In order to pass the subject, both parts, the written exam and the practical project, must have a mark of 5.0 or over out 10.0.

EXTRAORDINARY CONVOCATION

WRITTEN EXAM (60% of the mark)

In the extraordinary convocation the entire subject will be evaluated.

PRACTICAL PROJECT (40% of the mark)

In case of not passing the practical project in the ordinary convocation, it can be given in the date of the exam of the extraordinary convocation, with the corrections included according to the professor’s suggestions.

In order to pass the subject, both parts, the written exam and the practical project, must have a mark of 5.0 or over out 10.0.
The main aim of the course is to provide the student with a background knowledge in environmental pollution from an engineering point of view. The course is focused on pollution sources, remediation and treatment technologies, environmental impact assessment, environmental management and environmental regulation. Students are introduced to the mechanisms of environmental pollution and treatment methodologies, as well as to the evaluation and remediation of the environmental impact caused.

"Environmental Engineering" is taught during the first semester of the fourth year of the Degree. It requires prior knowledge and skills acquired in previous basic and specific courses, in particular in "Environmental Science and Technology". It is a compulsory course.

The competences acquired in the course will allow students to:
- Apply methodologies in order to perform environmental impact assessment studies.
- Apply environmental technologies, sustainable solutions, and pollution remediation technologies in different environmental media (air, water, waste, and soils).

The theoretical and practical contents comprise six modules and eleven topics:

Module I. Fundamentals of environmental engineering.

Module II. Water

Module III. Air

Module IV. Waste

Module V. Soil

Module VI. Environmental Management

Practice in the field include three visits to industrial facilities:
Session 1. 1.1. - Wastewater treatment plant, 1.2. - Storm tank
Session 2. 2.1. Zabalgarbi - Municipal waste thermal valorization plant. 2.2. Mechanical and biological treatment plant
**TEACHING METHODS**

The course will be delivered by means of:

- Lectures (MC), which will be used to explain core contents in order to develop students' knowledge and understanding of these concepts.
- Classroom practices (CP), which will be used to solve practical activities, problems, etc.
- Practice in the field (FP), which will be used to visit industrial facilities.

If the health situation avoids the development of any teaching or evaluation activity, a non-presential alternative will be used and the students will be promptly informed.

**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
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<th>TI</th>
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</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>37,5</td>
<td>12,5</td>
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<tr>
<td>Hours of student work outside the classroom</td>
<td>56,25</td>
<td>18,75</td>
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Legend:
- M: Lecture-based
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- GA: Applied classroom-based groups
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- GO: Applied computer-based groups
- GCL: Applied clinical-based groups
- TA: Workshop
- TI: Industrial workshop
- GCA: Applied fieldwork groups

**Evaluation methods**

- Continuous evaluation
- End-of-course evaluation

**Evaluation tools and percentages of final mark**

- Written test, open questions: 56%
- Multiple choice test: 24%
- Exercises, cases or problem sets: 12%
- Field practices: 8%

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

Continuous Assessment is used in both ordinary and extraordinary sessions.

Written exams comprising theory and problems (multiple choice test, theoretical questions and exercises)
- Three mid-term exams (eliminatory for students with a minimum grade of 5.0/10 and passing at least two or more mid-term exams).
- A final exam, if the student does not pass two or more mid-term exams: 80% (mid-term exam of one part, with its corresponding grade).
- Practical face-to-face activities: 12%
- Practice in the field: 8%

Notes:
Students will withdraw from the ordinary session by default if they do not take the ordinary final exam.
Any student wishing to waive continuous evaluation and wishing to be marked by Final Assessment instead by continuous assessment in the ordinary session should request this in a written document from the lecturer responsible for the course before the ninth week after the course starts.

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

There are two options:
1) CONTINUOUS ASSESSMENT. This is the default option; students are assessed by means of:
- Final exam: 80%
- Practical activities: 12%
- Practice in the field: 8%
2) FINAL ASSESSMENT, for any student wishing to waive continuous evaluation (see section 6.2). Students are required to take a single exam (100% of the mark), comprising all the concepts and skills covered throughout the course.

**MANDATORY MATERIALS**

Materials required to follow the sessions will be shared with the students through eGela virtual platform:
- Lecture materials and documents
- Problems’ wordings and instructions for practical activities
- Links to useful websites and reports
BIBLIOGRAPHY

Basic bibliography
This section contains a basic bibliography in English (resources in Spanish are included in the corresponding guide).

Detailed bibliography

Journals

Web sites of interest
European Environment Agency (EEA) http://www.eea.eu.int
Ministry for Ecological Transition and Demographic Challenge - MITECO, Spanish Government https://www.miteco.gob.es/es/
Public Society for Environmental Management of the Basque Government &#8211; IHOBE http://www.ihobe.es
United States Environmental Protection Agency (EPA) http://www.epa.gov

OBSERVATIONS

Conditions and clarifications:
If the health situation avoids the development of any evaluation activity, a non-presential alternative will be used and the students will be promptly informed.
1.- Any student that passes the three mid-term exams will be exempt to take the final exam (average grade of 5.0/10), with the exception of those students who not pass practical activities and practice in the field or if the final grade is < 5.0.
2.- The mark obtained in practical activities and in practice in the field will be considered if the student:
- Passes all mid-term exams and he/she is exempt to take the final exam.
- Does not pass one of the mid-term exams, but the grade of the failed part is >=4,0.
- Does not pass the final exam, but her/his grade is >=4,0.
3.- The mark obtained in the practice in the field will be carried over for two academic years.
4.- Any student assumes to obey academic regulation and to take "Environmental Engineering" course with an ethical behaviour and honesty. Hence, plagiarizing exams or activities will be strongly penalized and may lead to fail the course.