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.

<table>
<thead>
<tr>
<th>FACULTY OF ENGINEERING – BILBAO (345)</th>
<th>SEMESTER</th>
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<td>25981 Electrónica Industrial</td>
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<td>27308 Fundamentos de Ciencia de Materiales</td>
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<td>27310 Electrotecnia</td>
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<td>27323 Proyectos</td>
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<td>27374 Redes de Acceso</td>
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### FACULTY OF ENGINEERING – BILBAO (363)

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1 SCHEDULE: Morning (M)/ Afternoon (A): begins at 13.30.
By clicking the subject’s name, its Syllabus will appear.
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 Matching

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 based 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>
<thead>
<tr>
<th>Type of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
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Legend:
- M: Lecture
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- GA: Pract.Class.Work
- GL: Pract.Lab work
- GO: Pract.computer work
- GCL: Clinical Practice
- TA: Workshop
- TI: Ind. workshop
- GCA: Field workshop

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
- 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:

\[ 0,6 \times \text{Section 1} + 0,4 \times \text{Section 2} \]

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, IEE

Microwave Magazine, IEE

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**
SUBJECT
27306 - Graphics in Engineering  
ECTS Credits: 6

DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

This course provides knowledge of geometrical features (i.e. curves, surfaces, and volumes) with technical applications as well as a complete view of the different representation systems in technical drawing together with some geometric problems and different methods to solve them.

At the same time, this course provides the student with the standards affecting graphic representations in technical drawing.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

This subject qualifies the student for the creation of technical designs, particularly in the field of mechanical engineering, and for its communication (read-write processes) by means of a precise and universal graphic language.

It provides knowledge of the design process of an industrial product and the specific standardization of the technical drawing according to its application field. The student exercises his/her ‘sketching’ ability with the classical drawing instruments (compass, square, and bevel) together with computer-aided design systems.

The main competences acquired by the student are the following:

* Ability to visualize geometrical features and industrial designs.
* Ability to use technical information, as a sender-receiver, in a precise and universal graphic language, this is, technical drawing, to communicate a great variety of design proposals in the different fields of engineering.
* Ability to analyze complex three-dimensional geometric shapes as a combination of basic geometric features.
* Ability to propose and solve geometrical problems in the industrial design field.
* Practice and expertise in the use of drawing instruments ('traditional' instruments and CAD systems) and in sketching within technical drawing.

THEORETICAL/PRACTICAL CONTENT

The contents of the subject can be summarized in the following sections: geometric foundations, curves and surfaces in industrial design, representation systems: dihedral, axonometric and topographic drawings, basic standards in technical drawing and introduction to computer-aided design.

SHORT PROGRAM:

1. SPACE AND GEOMETRIC FEATURES. PROPERTIES AND APPLICATION TO INDUSTRIAL DESIGN.
2. REPRESENTATION SYSTEMS: DIHEDRAL, AXONOMETRIC AND TOPOGRAPHICAL DRAWINGS: ALPHABET AND INVARIENTS. INTERRELATION. METHODS. INCIDENCE, METRICS AND POSITION ISSUES.
3. BASIC STANDARDIZATION. DIMENSIONING AND METROLOGY. TOLERANCES, SETTINGS AND SURFACE FINISHING.
4. BASIC MECHANICAL JOINTS.
5. INTRODUCTION TO COMPUTER-AIDED DESIGN SYSTEMS.

METHODS

Theoretical and practical classes, always maintaining the ratio between theory and practice.

Lectures: Theoretical expositions to teach basic concepts of the subject including the approach to problems and the discussion of possible solutions.

Practical Classes: Focused on problem solving, aiming at strengthening and deepening into conceptual foundations, putting a special emphasis on the use of auxiliary methods in the representation of technical drawings. Skill integration exercises are included.
TOOLS USED & GRADING PERCENTAGES

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</table>


ASSESSMENT SYSTEMS

- Final assessment system

ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

There will be a final individual exam with traditional drawing tools. The performance of the student in the final examination will be a mark (F) in a range from 0 to 10 points.

A minimum of 5 points is generally required in the mark of the final exam to pass the subject.

During the four-month period, a practical assessment (P) will be carried out. It will consist of weekly practices, Lab classes, and partial controls. The performance of the student in the practical evaluation will be made in a qualification (P) in a range from 0 to 10 points.

The qualification (P) may be averaged with the score of the final examination (F), provided that in the latter a minimum rating is exceeded. The final examination (F) will have a minimum weight of 70% and the practical assessment (P) a maximum weight of 30%.

The practical assessment will not be compulsory and therefore it will not be necessary to request its withdrawal. This qualification (P) will only be taken into account if the final exam mark is improved.

Students not taking the final exam in the ordinary call will appear in the official records as &quot;not attended&quot;.

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

There will be a final individual exam with traditional drawing tools. The performance of the student in the final examination will be a mark (F) in a range from 0 to 10 points.

A minimum of 5 points is generally required in the mark of the final exam to pass the subject.

The qualification (P) may be averaged with the score of the final examination (F), provided that in the latter a minimum rating is exceeded. The final examination (F) will have a minimum weight of 70% and the practical assessment (P) a maximum weight of 30%. This qualification (P) will only be taken into account if the final exam mark is improved.

Students not taking the final exam in the ordinary call will appear in the official records as &quot;not attended&quot;.

COMPULSORY MATERIALS

BIBLIOGRAPHY

Basic bibliography

* Dibujo Técnico. Sistemas de Representación < Zorrilla, E. y Muniozguren, J > Servicio de Publicaciones ETSI-Bilbao
* Dibujo de Ingeniería < Zorrilla, E. y Muniozguren, J > Servicio de Publicaciones ETSI-Bilbao
* Normalización Básica. Dibujo Técnico < Zorrilla, E. y Muniozguren, J > Servicio de Publicaciones ETSI-Bilbao
* Ejercicios Prácticos de Gráficos de Ingeniería < varios autores > Servicio de Publicaciones ETSI-Bilbao
* Ejercicios Prácticos de Ampliación de Gráficos de Ingeniería < varios autores > Servicio de Publicaciones ETSI-Bilbao
* Manual de Normas UNE sobre Dibujo < AENOR >
* Dibujo de Ingeniería Industrial < Urraza, G. y otros > ARTE KOPI S.L.
* Dibujo Industrial < Félez, J. y Martínez, M.L. > Editorial Síntesis
* Sistemas de Representación. Sistema Diédrico (Tomo I) <González García, V. y otros> Ediciones TEXGRAF
* Diédrico Directo (Tomas I y II) < Giménez Peris, V. > Tip. Mazuelos S.L.
* Fundamentos de Dibujo en Ingeniería <Luzadder, W.J.> PRENTICE-HALL
* Dibujo y diseño en ingeniería <Jensen, C. et all> McGraw-Hill
* Dibujo en Ingeniería y Comunicación Gráfica <Bertoline, G.R. et all> McGraw-Hill
* cadcam < Barry Hawkes > Edit. Paraninfo

In-depth bibliography

* Geometría Descriptiva. < Leighton Wellman, B. > Editorial Reverté S.A.
* Geometría Constructiva Aplicada a la Técnica. < Hohemberg, F. > Editorial Labor, S.A.
* Geometría Descriptiva Práctica. < Grant Hiran, E.> Ediciones del Castillo, S.A.
* Geometría descriptiva superior y aplicada <Izquierdo Asensi, F.> Edit. Dossat, S.A.
* Ejercicios de geometría descriptiva I (sistema diédrico) <Izquierdo Asensi, F.> ORYMU
* Ejercicios de geometría descriptiva II (acotado y axonométrico) <Izquierdo Asensi, F.> ORYMU
* Dibujo Técnico. < Bachmann, A. y Forberg, R. > Edit. Labor
* Dibujo Industrial. < Chevalier, A. > Grupo Noriega Editores
* Engineering Drawing and Graphic Technology < French, T.E. et all > McGraw-Hill
* Engineering Graphics < F.E. Giesecke, F. E. et all > MacMillan Publishing Company
* Fundamental of Interactive Computer Graphics. < Foley, J.D. and Van Dan, A. > Addison Wesley
* Computational Geometry for Design ad Manufacture. < Faux, I.D. and Pratt, M.J. > Ellis Horwood
* Geometric Modeling. < Mortenson, M.E. > John Wiley & Sons
* Engineering Drawing & Design <Madsen, D.A. & Madsen D.P.> DELMAR

Journals

Useful websites

REMARKS
## TEACHING GUIDE

**Centre**: 345 - Faculty of Engineering - Bilbao  
**Plan**: GIAMBI30 - Bachelor's Degree in Environmental Engineering  
**Cycle**: Indiferente  
**Year**: First year  
**ECTS Credits**: 6  

### SUBJECT

27307 - Extended Engineering Graphics

### DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT

Compared to course #27306 engineering graphics classes, the lessons and lectures of this in-depth course constitute a step forward in the approach to engineering graphics.

The course provides a thorough knowledge of geometrical features (i.e. curves, surfaces, and volumes) with technical applications as well as a complete view of the different representation systems in technical drawing together with some geometric problems and different methods to solve them.

At the same time, this course provides the student with the standards affecting graphic representations in technical drawing.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

This subject fully qualifies the student for the creation of technical designs, particularly in the field of mechanical engineering, and for its communication (read-write processes) by means of a precise and universal graphic language.

It provides a full knowledge of the design process of an industrial product and the specific standardization of the technical drawing according to its application field. The student exercises his/her 'sketching' ability with the classical drawing instruments (compass, square, and bevel) together with computer-aided design systems.

The main competences acquired by the student are the following:

* Ability to design conceptualization and spatial visualization, fostering the creativity of the student for industrial design.

* Ability to understand and make technical drawings of industrial assemblies knowing the graphic standardization of their elements and subassemblies (read-write).

* Proficiency in the design of parts and industrial mechanisms from technical specifications, sometimes incomplete, and from functional conditions.

* Notice of the meaning of the technical specifications in a drawing (forms and dimensions, geometric dimensioning and tolerancing, surface quality, etc.) and their impact on the feasibility of the manufacture of the designed product.

* Ability to obtain and analyze the required information to propose and solve industrial design problems.

* Proficiency in the application of graphic language in different technologies.

### THEORETICAL/PRACTICAL CONTENT

The contents of the subject can be summarized in the following sections: technical specifications for design and manufacturing, standardization in industrial design, technical application of complex surfaces and curves, computer-aided design applications.

### SHORT PROGRAM:

1. ANALYSIS OF FORM AND FUNCTION OF AN INDUSTRIAL ELEMENT. FORMAL CONDITIONS ACCORDING TO THE SPECIFICATIONS OF THE MANUFACTURING PROCESS.
2. DESIGN AND REPRESENTATION OF MECHANICAL JOINTS.
3. MANUFACTURING AND ASSEMBLY SPECIFICATIONS. APPLICATION OF GEOMETRIC DIMENSIONING AND TOLERANCING, SURFACE QUALITY, FITTINGS AND FUNCTIONAL DIMENSIONING.
4. DESIGN AND REPRESENTATION OF TOOLS AND MECHANISMS. MECHANISMS TO TRANSFORM MOVEMENT AND POWER TRANSMISSION MECHANISMS.
5. GRAPHIC REPRESENTATION IN DIFFERENT TECHNOLOGIES. CIVIL ENGINEERING DRAWINGS.
6. TECHNICAL SURFACES. APPLICATION TO CIVIL ENGINEERING
7. APPROACH, RESOLUTION AND REPRESENTATION OF INDUSTRIAL DESIGN PROBLEMS WITH GRAPHIC AND DESIGN COMPUTER-AIDED TOOLS.

### METHODS

Theoretical and practical classes, always maintaining the ratio between theory and practice.
Lectures: Theoretical expositions to teach basic concepts of the subject including the approach to problems and the discussion of possible solutions.

Practical Classes: Focused on problem solving, aiming at strengthening and deepening into conceptual foundations, putting a special emphasis on the use of auxiliary methods in the representation of technical drawings. Skill integration exercises are included.

## TYPES OF TEACHING

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<thead>
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<tr>
<td>Classroom hours</td>
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<td>22,5</td>
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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

- **Extended written exam** 100%

## ORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

There will be a final individual exam with traditional drawing tools. The performance of the student in the final examination will be a mark (F) in a range from 0 to 10 points.

A minimum of 5 points is generally required in the mark of the final exam to pass the subject.

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## EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

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A minimum of 5 points is generally required in the mark of the final exam to pass the subject.

The qualification (P) may be averaged with the score of the final examination (F), provided that in the latter a minimum rating is exceeded. The final examination (F) will have a minimum weight of 70% and the practical assessment (P) a maximum weight of 30%. This qualification (P) will only be taken into account if the final exam mark is improved.

Students not taking the final exam in the ordinary call will appear in the official records as "not attended".

## COMPULSORY MATERIALS
BIBLIOGRAPHY

Basic bibliography

* Dibujo Técnico. Sistemas de Representación < Zorrilla, E. y Muniozguren, J > Servicio de Publicaciones ETSI-Bilbao
* Dibujo de Ingeniería < Zorrilla, E. y Muniozguren, J > Servicio de Publicaciones ETSI-Bilbao
* Normalización Básica. Dibujo Técnico < Zorrilla, E. y Muniozguren, J > Servicio de Publicaciones ETSI-Bilbao
* Ejercicios Prácticos de Gráficos de Ingeniería < varios autores > Servicio de Publicaciones ETSI-Bilbao
* Ejercicios Prácticos de Ampliación de Gráficos de Ingeniería < varios autores > Servicio de Publicaciones ETSI-Bilbao
* Manual de Normas UNE sobre Dibujo < AENOR >
* Dibujo de Ingeniería Industrial < Urraza, G. y otros > ARTE KOPI S.L.
* Dibujo Industrial < Félez, J. y Martínez, M.L. > Editorial Síntesis
* Sistemas de Representación. Sistema Diédrico (Tomo I) < González García, V. y otros > Ediciones TEXGRAF
* Diédrico Directo (Tomos I y II) < Giménez Peris, V. > Tip. Mazuelos S.L.
* Fundamentos de Dibujo en Ingeniería < Luzadder, W.J. > PRENTICE-HALL
* Dibujo y diseño en ingeniería < Jensen, C. et all > McGraw-Hill
* Dibujo en Ingeniería y Comunicación Gráfica < Bertoline, G.R. et all > McGraw-Hill
* cadcam < Barry Hawkes > Edit. Paraninfo

In-depth bibliography

* Geometría Descriptiva. < Leighton Wellman, B. > Editorial Reverté S.A.
* Geometría Constructiva Aplicada a la Técnica. < Hoemberg, F. > Editorial Labor, S.A.
* Geometría Descriptiva Práctica. < Grant Hiran, E. > Ediciones del Castillo, S.A.
* Geometría descriptiva superior y aplicada < Izquierdo Asensi, F. > Edit. Dossat, S.A.
* Ejercicios de geometría descriptiva I (sistema diédrico) < Izquierdo Asensi, F. > ORYMU
* Ejercicios de geometría descriptiva II (acotado y axonométrico) < Izquierdo Asensi, F. > ORYMU
* Dibujo Técnico. < Bachmann, A. y Forberg, R. > Edit. Labor
* Dibujo Industrial. < Chevalier, A. > Grupo Noriega Editores
* Engineering Drawing and Graphic Technology < French, T.E. et all > McGraw-Hill
* Engineering Graphics < F.E. Giesecke, F. E. et all > MacMillan Publishing Company
* Fundamental of Interactive Computer Graphics. < Foley, J.D. and Van Dan, A. > Addison Wesley
* Computational Geometry for Design ad Manufacture. < Faux, I.D. and Pratt, M.J. > Ellis Horwood
* Geometric Modeling. < Mortenson, M.E. > John Wiley & Sons
* Engineering Drawing & Design < Madsen, D.A. & Madsen D.P. > DELMAR

Journals

Useful websites

REMARKS
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.

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.
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.
TOOLS USED & GRADING PERCENTAGES

<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>45</td>
<td>7,5</td>
<td>30</td>
<td>5</td>
<td>2,5</td>
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<tr>
<td>Hours of study outside the classroom</td>
<td>67,5</td>
<td>11,25</td>
<td>45</td>
<td>7,5</td>
<td>3,75</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</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

TOOL USED & GRADING PERCENTAGES
- Extended written exam: 95%
- 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.

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**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.; Urizar, 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.
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

REMARKS
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, &8230;) . 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: Linearized 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

<table>
<thead>
<tr>
<th>Types of Teaching</th>
<th>Classroom hours</th>
<th>Hours of study outside the classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>M: Lecture</td>
<td>37,5</td>
<td>56,25</td>
</tr>
<tr>
<td>S: Seminario</td>
<td>10,5</td>
<td>15,75</td>
</tr>
<tr>
<td>GA: Pract. Class. Work</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>GL: Pract. Lab work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GO: Pract. computer work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCL: Clinical Practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA: Workshop</td>
<td>56,25</td>
<td>15,75</td>
</tr>
<tr>
<td>TI: Ind. workshop</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>GCA: Field workshop</td>
<td></td>
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</tr>
</tbody>
</table>

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

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 &quot;No-Show&quot; 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
Revista Iberoamericana de Automática e Informática Industrial. http://ria.i.isa.upv.es/

Useful websites
Comité Español de Automática. http://www.cea-ifac.es/
# Engineering Projects

## Subject Context

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 develop 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. QUALITY 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.
### TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Type of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
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Legend:
- M: Lecture
- S: Seminar
- 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
- Extended written exam 40%
- Practical work (exercises, case studies & problems set) 60%

### ORDINARY 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". 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**

- PMI, https://www.pmi.org/
- IPMA http://www.ipma.world/

### REMARKS
- 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 telecommunication 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

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- **TA**: Workshop
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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 * 0.05 + B * 0.25 + C * 0.20 + D * 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 * 0.2 + B * 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 * 0.05 + B * 0.25 + D * 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 (Aord * 0.05 + Bord * 0.25 + Yextra * 0.20 + Dord * 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?l=63

### 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 -designg of architecture-)

* Empirically evaluate the obtained performance and propose posible 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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Legend:  
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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**
SUBJECT
27364 - Laboratory of Communications Electronics
ECTS Credits: 4.5

DESCRIPTION & CONTEXTUALISATION OF THE SUBJECT
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
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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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. Atrie. 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.radioelectronicschool.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

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

<table>
<thead>
<tr>
<th>Type of teaching</th>
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<td>22,5</td>
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</table>

Legend:


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
- $N(Lab)$ 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.

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  

Curso de Comunicaciones digitales:  

**Journals**

**Useful websites**


Different Tutorials in digital communications :  
http://www.complextoreal.com/tutorial.htm

**REMARKS**
## SUBJECT

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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<tbody>
<tr>
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<td>Transport Networks</td>
<td>6</td>
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### 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

<table>
<thead>
<tr>
<th>Section</th>
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</thead>
<tbody>
<tr>
<td>0. INTRODUCTION</td>
</tr>
<tr>
<td>0.1. Introduction to this subject</td>
</tr>
<tr>
<td>0.2. Introduction to main concepts related to transport networks: routing, transmission, switching and signalling.</td>
</tr>
</tbody>
</table>

**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
3.3 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 signage
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 SS7 Signaling
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>
<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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<td>Classroom hours</td>
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</table>

Legend:  
M: Lecture  
S: Seminario  
GA: Pract.Class.Work  
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GO: Pract.computer wo  
GCL: Clinical Practice  
TA: Workshop  
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GCA: Field workshop

ASSESSMENT SYSTEMS

- Final assessment system

TOOLS USED & GRADING PERCENTAGES

- Extended written exam  70%
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
"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.

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 GeneratorsSources Circuit Topology
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/sister 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.

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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:
   - Basic knowledge topics 1 and 2: 13% of the final grade.
   - Basic knowledge topics 3 and 4: 13% of the final grade.

Laboratory
   - Pre-lab exercises presented before lab sessions start: 3.5% of the final grade.
   - Questionnaires (3) during lab sessions: 10.5% of the final grade.
   - Laboratory written exam, a practical exercise using PSPICE: 21% of the final grade.

2. Final individual exam: 39% of the final grade.
   - 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
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. Circuital 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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<th>Type of teaching</th>
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- GCA: Field workshop

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.urinus.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).
SUBJECT

27388 - Radar & Satellite Navigation Systems

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 lectures, 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 lectures 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%)

EXTRAORDINARY EXAM CALL: GUIDELINES & DECLINING TO SIT

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%)

COMPULSORY MATERIALS

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.

BIBLIOGRAPHY

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. Hovanessian, 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)

Journals

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

REMARKS
"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.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

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 responsiblity 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.

THEORETICAL/PRACTICAL CONTENT

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

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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.

**COMPULSORY MATERIALS**

**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**
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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### 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:

- Individual basic practices (20%)
- 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
The subject of Digital Electronics is interdisciplinary in nature, and is part of the Specific Industrial and Automatic Electronic Technology Module, which also includes: Analog Electronics, Power Electronics and Electronic Technology (sharing the first four-month period) and Digital Electronic Systems, Industrial Automation, Industrial Informatics, Robotics, Automatic Regulation and Electronic Instrumentation (subjects of the second four-month period).

As an interdisciplinary subject, it is important to provide the students with adequate knowledge for the assimilation and deepening of other subjects in the career; which will help to avoid neither unnecessary overlaps nor gaps in their content. It is highly convenient to adequately analyze aspects that have been introduced in other subjects but that acquire their own particularities. This background can be classified as follows:

I) Subjects from previous courses. From the second course: in the Industrial Electronics subject, the basic concepts of Digital Electronics are studied.

II) Subjects after the first quarter from the third year: Digital Electronics provides skills, knowledge and abilities that are applied from then on, in the following subjects: Digital Electronic Systems, Electronic Instrumentation, Virtual Instrumentation, Digital Control Systems, System Modeling and Simulation and in the End-of-Degree Work (TFG).

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

**SPECIFIC COMPETENCIES.**

SC1. Ability to design a digital system, both at the level of integrated circuits available on the market and at the level of designing based on functional blocks.

SC2. Ability to select the most suitable integrated circuit for a specific design.

SC3. Ability to analyze any type of integrated circuit, from its datasheets.

SC4. Ability to analyze and detect errors from any digital circuit, both combinational and sequential.

**TRANSVERSAL COMPETENCIES.**

CT0. Ability to work in a multilingual and multidisciplinary environment.

CT1. Ability to solve problems with initiative, decision making, creativity, critical thinking and to communicate and transmit knowledge, skills and know-how in the field of Industrial Engineering.

The transversal competencies of the module are focused on achieving the following skills:

TC1. To be able to work on the knowledge inherent to the subject for the correct application to digital electronic devices, using a specific technical vocabulary and terminology.

TC2. Discipline: respecting the established deadlines.

TC3. Work as a team, adopting flexible attitudes when faced with proposals from other colleagues.

TC4. To enliven the spirit of deepening in the matter.

### THEORETICAL/PRACTICAL CONTENT

- Topics of the course:
  0. Presentation of the subject.
  2. Boolean algebra and basic logic circuits.
  3. Introduction to VHDL.
  4. Combined circuits developed using modules.
  5. Elements with memory.
  6. Sequential circuits.
  7. Registers and counters.

### METHODS

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. The approach is both individual and group.
- **PL:** Laboratory practices. Practical complement to the course.
For the concept of non-presential work, there is a weekly questionnaire to be carried out through e-gela sessions (virtual platform) and a monographic work.

### TYPES OF TEACHING

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### ASSESSMENT SYSTEMS

- Continuous assessment system
- Final assessment system

### TOOLS USED & GRADING PERCENTAGES

- Extended written exam 50%
- Multiple choice test 10%
- Individual work 25%
- Team work (problem solving, project design) 15%

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

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

A) Personal work. A score of 10% of the final classification will be given from a test to be carried out during the 12 or 13 weeks throughout the course. The test will be performed using an 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 be open on Friday afternoons and closed on Monday afternoons. Answering the questions is a serious job, so a minimum of 9 sessions will be required to be evaluated 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. Such an examination shall consist of a previously completed practice, part of it, or a proposed exercise different from those previously completed. The remaining 10% corresponds to the continuous evaluation of the laboratory sessions. This continuous evaluation includes the reading, understanding and preparation of the practices and their corresponding 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 evaluated. 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% evaluate the knowledge of theory and exercises.

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

**MINIMUMS**

All the grades specified above will be added together in the January call for applications, 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 losing a call (the one in January); thus, if a student does not take the written exam or does not pass the minimum test, he or she will have 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 evaluation but do not take the exam will have a grade of NOT TAKEN.

**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.

**FINAL EXAM**

Exam aimed to the rest of the students (those who have not been evaluated under the criteria of the mixed evaluation).
The student who copies both the mixed or the final evaluation will FAIL the subject.

When the student requests it (always through the SECRETARIAT OF THE SCHOOL and under 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 can be evaluated for the 100% of the course.

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

In the second call, all students must choose whether to continue under the criteria of the mixed evaluation or to take a 100% theoretical-practical test (art. 44 of the regulations).

A student who does not show up for the second round will have a NOT TAKEN as a grade.

**COMPULSORY MATERIALS**

M: Theoretical guide to the subject.
PA: Practical guide to classroom practice exercises.
GL: Laboratory practice booklet.

**BIBLIOGRAPHY**

**Basic bibliography**


**In-depth bibliography**


**Journals**

**Useful websites**

http://www.xilinx.com
http://www.altera.com
http://www.redeweb.com
http://irf.com/indexsw.html
http://www.ipes.ethz.ch

**REMARKS**

Students are reminded that the subject is taught in person, consequently the activities planned, as well as the learning results and the mixed evaluation itself implies regular attendance at class.
**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.

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ASSESSMENT SYSTEMS
- Final assessment system
- 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**

- 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]
- Organización de computadores V.C. Hamacher et al. [Mc. Graw Hill]
  Computer organization V.C. Hamacher et al. [Mc. Graw Hill]
- Organización de computadores: un enfoque estructurado A. S. Tanenbaum [Pearson Education]
  Structured computer organization A. S. Tanenbaum [Pearson Education]
- The indispensable PC hardware book H. P. Messmer [Addison-Wesley]
- El PC: hardware y componentes J. E. Herrerrías Rey [Anaya multimedia] (tema 6)
  Sistemas digitales y tecnología de computadores J. García Zubia [Thomosn] (chapter 1)
  Nivel de lenguaje máquina. Una aproximación, O. Arbelaitz et al. [Arquitectura y Tecnología de Computadores, 2004.]
  Introducción a la informática, A. Prieto et al. [Ed. McGraw-Hill, 2006]
  Arquitectura del PC, M. Ujaldón. [Ciencia-3, 2003]

**Journals**

- Byte (https://archive.org/details/byte-magazine)
- Personal Computer & Internet
- PC Actual
- PC World
- PC Magazine

**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
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.

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ASSESSMENT SYSTEMS
- 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
Assessment parts and weighting: over 10.0 pts
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Two requirements must be satisfied:
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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:
1. Achieve, at least, 40% on both parts i.e. minimum 1.6 points at labs and 2.4 points at the exam.
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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

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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/
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.