

## **Adapting Telecommunication Engineering Degree to the European Higher Education Area requirements at the University of Vigo**

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### **Introduction**

The Telecommunication Engineering School at University of Vigo has a continuous experience of twenty-five years lecturing engineers in the ambit of telecommunications, including topics related to radio; signal processing; telematics; electronics; and sound and image technologies. The former students from up to twenty generations (more than 2300) are currently very well considered workers both in Spain and even in other countries where they are developing their professional careers. They represent one of the bases of the previous experience.

Last years, the mobility of ending year students along Spain and Europe has been constantly increased, and the percentage of graduates that has stayed in other University or research centers for some months before their graduation is around 40 %. The School staff is proud of this students vocation to mobility, which represent the second power of the School. We try to move our students to go after different grants to support these stages. Thus, Erasmus and Socrates programs have several candidates each year, and contacts with Universities all around Europe have been established, maintaining regular students interchange with institutions in Austria, Belgium, Check Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Poland, Portugal, and Turkey.

This is our local framework when the European convergence is launched in Spain: a degree in Telecommunications Engineering with large experience in years and in former students, and an increasing vocation to national and international mobility. When the adaptation to the European Higher Education Area (EHEA) is begun, the School staff thought that both characteristics must be sustained. However, we also thought that it could be the best chance to solve problems of current formation programs, like the excess of topics to be selected by the student in the last years, or the lack of coordination between related topics.

In conclusion, the work of adapting the current degree to a Graduate degree within the EHEA has been seen as an opportunity to maintain our identities and to overpass the problems of the previous programs, whereas the regulations were fitted. And this was the work philosophy along the process.

The paper is organized in several sections, after this introduction. The second section draws the regulatory environment: the regulations, norms, and requirements that define the Graduate degree. Then, the third section describes the procedure followed during the elaboration of the formation program. The description of the program itself is the aim of the fourth section, including the different modules and itineraries. The fifth section depicts the way for implementing the new program and the cohabitation with the in-extinction current programs. Finally, the sixth section contains the conclusions of the paper.

### **Regulatory environment**

The new Spanish Graduate degrees adapted to the EHEA have to accomplish some regulations. Most of them are general and applicable to all the Graduate degree programs [1], but there are some additional requirements when talking about degrees that habilitate for some regulated professions [2-4]: engineers, architects, and so on. The case under study falls in this category; consequently, the regulations are stronger than other degrees.

Concretely, the regulations of Telecommunication Engineering [4] define four possible branches: Communication Systems; Electronic Systems; Telematics; and Sound and Image.

Even more, the University of Vigo is integrated in the Galician University System, depending on the autonomous government of Galicia (Xunta de Galicia), which has imposed additional requirements for the new Graduate degree programs [5], in order to maintain the three Universities of the area within sustainable parameters in terms of economics and efficiency.

## Elaboration procedure

The formation program was elaborated by a Commission composed by professors from the Departments that teach at the School, and some student representatives. Each Department representative maintained previous weekly meetings with their colleagues to defend the opinion of a pool of professors during the Commission weekly meetings.

The first stage was the definition of the modular structure of the program, and then, the topics were designed. Along this process, attention to the coordination among contents of the topics was carefully paid.

The first version of the program was revised by a pool of external experts, both from the University and from telecommunication companies. Their suggestions were discussed and, in most of the cases, assumed and incorporated to the formation program [6].

## Formation program

The formation program extends along four years, divided each in two semesters. Each topic takes 6 ECTS. Some topics could be grouped into matters, and some matters into modules. Each semester takes 30 ECTS; consequently, it has five topics. So, the student is expected to follow a maximum of five topics in parallel, which allows an easy organization of his time: one topic for each working day.

The following subsections define the main characteristics of the formation program: its general guidelines; the structure along time, in four academic years; the contents of the modules of basic topics, telecommunications, itineraries and projects; and the possibilities of selection by the student or the national and international mobility window.

*General guidelines.* As previously indicates, the program is organized in eight semesters of five topics each (except the last one). As the topics are grouped into modules, these general guidelines may be explained based on such classification.

The first module is the so called “Basic formation”. This module takes 60 ECTS, i.e. ten topics, and provides the student the basic competences for engineers, oriented to the information and communications society needing. The teaching of this first module is mainly imparted along the first year, with one topic in the first half of the second year. The contents of such module are defined by the national guidelines [4].

The second module is called “Telecommunication”, and it contains the competences that are common to all the four branches of the Telecommunication Engineering. The module takes 72 ECTS, 60 of which are defined by the national guidelines [4]. This module is mainly placed along the second year (third and fourth semesters), with one topic in the second semester and the other two topics in the fifth semester.

At this point, when the student accesses the third year, he has to decide the branch or itinerary he wants to follow. Four technology modules, conformed by 48 ECTS (eight topics) each, are offered to select one among them. There is a technology module focused to each branch:

Communication Systems; Electronic Systems; Telematics; and Sound and Image. This group of topics is intended to be followed along the third year: three topics in the fifth semester, and five topics in the sixth.

When passing one of those technology modules, the student has obtained the competences needed to get the Graduate degree, except those related to engineering projects. This is the reason for constructing a quite different fourth year: the seventh semester is structured as an optional 30 ECTS curricula definition. The student could follow topics from one of the four optional matters, or he could follow some of the topics from other technology module (those topics followed by his companions at fifth semester), or he could realize a stage in a company, or he could follow 30 ECTS in other University, helped by any mobility program. This definition allows the maintenance of the vocation to mobility, which is a mark of the School, as well as it permits to solve the excess of optional topics in the previous programs

Finally, the last semester is devoted to a module of Engineering Projects, with 18 ECTS, and the Final Graduate Work, with 12 ECTS.

*Structure.* The structure of the formative program is depicted in table 1, which represents the yearly scheme, where the color code indicates the different modules.

**Table 1.** Yearly scheme of the program

year	first semester	second semester
1	Basic formation	Basic formation
		Telecommunication
2	Basic formation	Telecommunication
	Telecommunication	
3	Telecommunication	Technology
	Technology	
4	Mobility Optional	Engineering Projects
		Final Graduate Work

Table 1 could help to summarize what we tried to explain in the general guidelines subsection.

*Module “Basic formation”.* The module “Basic formation”, as can be observed in table 2, is taught along the first year and the third semester. The topics of this module are those defined in the National legislation as basics [4], and they are grouped in four matters: Mathematics, Physics, Informatics, and Business. The different topics, as well as its location in the formative program, are defined in table 2.

The matter “Mathematics” contains the knowledge related to mathematics and statistics that are needed to support the technical formation the student has to acquire in following years. The contents of the matter “Physics” give the students the introduction to different concepts that

will be enlarged after: electronics, circuits, fields and waves, mechanics and thermodynamics. Finally, the matters “Business” and “Informatics” are related to introductory knowledge in both fields of interest.

**Table 2.** Module “Basic formation”

year	first semester	second semester
1	Calculus I	Calculus II
	Linear Algebra	Probability and Statistics
	Mechanics and Thermodynamics	Fields and Waves
	Business	Linear Circuits
	Computer Architecture	
2	Fundamentals of Electronics	

*Module “Telecommunication”.* The module “Telecommunication” occupies the second year and small parts of the second and fifth semesters. The table 3 details the topics involved in this module. Most of the contents of this module correspond to the mandatory skills indicated in the legislation for the ambit of telecommunications [4].

**Table 3.** Module “Telecommunication”

year	first semester	second semester
1		
		Programming I
2	Digital Signal Processing	Electronic Technology
	Electromagnetic Transmission	Digital Electronics
	Data Communication	Signal Transmission and Reception Techniques
		Fundamentals of Sound and Image
		Computer Networks
3	Programming II	
	Internet Services	
	Electronic Programming Circuits	

The module consists of three matters. The matter “Electronic Circuits” is devoted to electronics contents. The matter “Networks and Services” is related to programming and networking knowledge. The matter “Signals” contains elements of Electromagnetism, signal theory and sound.

*Modules related to itineraries.* The third year is mainly occupied by the technology modules: the student has to select one among the four proposals. Each module consists of eight topics.

The table 4 shows the topics on module “Communication Systems”.

**Table 4.** Module “Communication Systems”

year	first semester	second semester
3		Microwave Circuits
		Radio Electric Management and Certification
	Radiofrequency Systems	Principles of Digital Communications
	Radio Communication Systems	Optic Infrastructures for Telecommunication
	Multimedia Signals Processing	Wireless Networks and Systems

The table 5 shows the topics on module “Electronic Systems”.

**Table 5.** Module “Electronic Systems”

year	first semester	second semester
3		Analogue Electronics
		Power Electronics
	Data Acquisition Systems	Electronic Instrumentation and Sensors
	Electronic Systems for Signal Processing	Microelectronic Design
	Electronic Equipment Engineering	Electronic Systems for Digital Communications

The table 6 shows the topics on module “Sound and Image”.

**Table 6.** Module “Sound and Image”

year	first semester	second semester
3		Architectonic Acoustics
		Sound Processing
	Fundamentals of Acoustic Engineering	Fundamentals of Image Processing
	Audio Systems	Image Systems
	Video and Television	Audiovisual Technology

The table 7 shows the topics on module “Telematics”.

**Table 7.** Module “Telematics”

year	first semester	second semester
3		Concurrent and Distributed Programming
		Network and Computation Theory
	Operating Systems	Multimedia Networks
	Network Architecture and Technology	Information Systems
	Security	Telematics Architecture and Services

At the end of any of these itinerary modules, the student has acquired the legal skills needed to obtain the Graduate degree, but those related to the final work. This allows the student to design his last year curriculum.

*Mobility/optional module.* The seventh semester (the first of the fourth year) is intended to optional topics. The student must select up to 30 ECTS among the following alternatives.

- Five topics offered within the same itinerary he has attended during the third year.
- Nine topics corresponding to the three offered in the fifth semester by the itineraries other than that attended by the student.
- Up to 12 ECTS traded by staging in a technology company.
- Up to 30 ECTS passed in other faculty or other University, by means of a mobility program.

As the competences provided by these optional topics are not needed to fit the legal requirements of the Graduate degree, but the 30 ECTS are compulsory to reach the total 240 ECTS, the student is free to design this part of his curricula, which represents the 12.5% of the total charge of the degree.

*Project managing and developing.* The last semester contains the module “Engineering Projects”, with two topics: “Research and Development Management” and “Project Workshop”. This workshop (12 ECTS) tries to

force the students to work in a team with students from other itineraries to solve a complex engineering project, which needs the knowledge and abilities of the different members of the team. This workshop allows the students to acquire skills on working together integrated in a team, and on sharing his knowledge in order to reach a common objective.

Finally, a Final Graduate Work, individually realized, has to be defended by the student to obtain his degree.

### Implementation

The extinction of the current degrees has to be performed in a yearly basis, due to legal restrictions. As the interest of the School is to move the more students to the new Graduate degree, the validations between old and new topics have been obviously anticipated, following three different strategies.

- By blocks, adapting years completely passed.
- By “what I have passed”, in the classical correspondence between old and new topics.
- By “what I need to pass”, depending on the topics not yet passed in the old degree, the student has to attend some topics in the new Graduate degree.

### Conclusions

The new formation program for Telecommunication Engineering at the Universidade de Vigo has been presented, highlighting the large possibilities in terms of mobility and project learning, as well as, the strong knowledge in basic topics.

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**I. Cuiñas, E. de Lorenzo. Adapting Telecommunication Engineering Degree to the European Higher Education Area requirements at the University of Vigo // Electronics and Electrical Engineering. – Kaunas: Technologija, 2010. – No. 6(102). – P. 123–126.**

The adaptation of the formative program to the European Higher Education Areas requirements has constitute almost a revolution in the Spanish Universities, as it could represent a complete change in the way of teaching and, what is probably more significant, in the organization of the degrees. The new formative program for Telecommunication Engineering at the Universidade de Vigo is presented along this paper, including the main constraints during the design process, as well as the complete module-matter-topic structure and the time sequence of the contents along the four years. Bibl. 6, tabl. 7 (in English; abstracts in English, Russian and Lithuanian).

**И. Куинас, Е. де Лорензо. Определение высшего образования в Европе на основе опыта университетов Испании // Электроника и электротехника. – Каунас: Технологія, 2010. – № 6(102). – С. 123–126.**

Представлена новая программа по изучению телекоммуникационных модулей в Вигском университете. Программа учитывает опыт последних четырех лет и включает в себя основные принципы ограничения научного процесса. Библ. 6, табл. 7 (на английском языке; рефераты на английском, русском и литовском яз.).

**I. Cuiñas, E. de Lorenzo. Europos aukštojo mokslo išsilavinimo reikalavimų įvertinimas telekomunikacijų inžinerijos pagrindinėms studijoms Vigo universitete // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 6(102). – P. 123–126.**

Studijų programų keitimas pagal Europos aukštojo mokslo srities reikalavimus sukėlė sumaištį Ispanijos universitetuose. Pristatoma nauja Vigo universiteto (Universidade de Vigo) telekomunikacijų inžinerijos pagrindinių studijų programa, sudaryta atsižvelgiant pagrindinius kūrimo proceso apribojimus ir visą studijų programos struktūrą per ketverius metus. Bibl. 6, lent. 7 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).

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