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Teaching in the Subject 'Systems Interconnection' at Extremadura University

Abstract

This work describes the teaching of the subject "Systems Interconnection" taught in the Higher School of Telecommunications Engineering of the University of Extremadura, Spain. As soon as students finish the course, they will acquire all the theoretical and practical contents that are taught in the subject, which are detailed in different sections of the subject. In addition, a summary is made of the teaching methodology used and learning results. Finally, the article concludes by detailing the evaluation methodology and, above all, the academic results of the previous courses, where an improvement in results is observed, especially in the percentage of students that have passed all the exams of the subject (approved students onwards), namely by reducing the sum of percentages of those that have not changed their results or have failed the subject's exams. This improvement has been achieved based on the introduction of continuous assessment in the theoretical section of the subject. In short, it is a descriptive study of the current situation of the subject of "Systems Interconnection."

K e y w o r d s: teaching, telematics, engineers, higher education

The teaching-learning process in the subject "Systems Interconnection" is complex, because it is important to have a comprehensive abstract knowledge to understand the convenience of level communication according to the OSI model (Open systems interconnection (OSI), n.d.) of the ISO (ISO – International Organization for Standardization, n.d.) and its practical implementation. Consequently, as teachers, we must make it easy by relying on available resources and, among them, the use of New Technologies (Arias Masa et al., 2004) that provide substantial advantages for the acquisition of new knowledge. This subject is compulsory in the degree of Telematics Engineering in Telecommunications and is taught at the University Center of Merida (CUM, n.d.) at the University of Extremadura, Spain (UEx, n.d.). It is taught in the fourth semester of the degree, has 6 credits, and is divided into 3 theoretical credits and 3 practical credits (Arias Masa, 2018). Consequently, the weekly timetable encompasses two hours for the mostly theoretical content and another two hours dedicated to the development of purely practical content.

The topic belongs to the matter of "Communications", which also contains the subjects of "Communications Electronics", "Data Transmission", "Transmission Media", and "Network Fundamentals". On the other hand, this subject, together with the subjects of "Software and Programming Engineer", "Architecture", and "Physical Electronics", form the module called "Common" in the Telecommunications area, which are a total of 60 ECTS credits (European Credit Transfer and Accumulation System).

The objective of this work is to show what the current situation of this subject in the teaching-learning process is. For this, each of the essential sections which contextualize the subject are described and listed. Therefore, we begin with a review of the existing literature, where this subject is contextualized and the scientific field to which it belongs is indicated. Next, the competences pertinent to the subject are listed from the basic, through the general ones, to specific. Later, the theoretical and practical contents to be taught are listed; these should be assimilated by the students in order to successfully pass the subject before they continue on with their studies. The teaching methodology used to teach the theoretical and practical contents by the teaching team is described below. The learning outcomes list the pieces of knowledge that students should end up having once they pass the course. In the evaluation section, in addition to reflecting the weighting of each section that students examine, we have described how the evaluation method has evolved over time and showed how this improvement is reflected in the final section on academic results.

Literature Review

According to Pallisera et al. (2010), in 2007, Spain decided that its Higher Education should have 240 ECTS credits, just like other countries such as Scotland, Turkey, and several others in Eastern Europe, while the majority of countries in Europe opted for 180 credits, which is known as the short cycle. Thus, in 2009, the teaching of the Degree in Telematic Engineering began and in the academic year 2010–2011, the "Systems Interconnection" course was taught for the first time. All this was built based upon the legislation of the Royal Decree 1393/207 of October 29 (Ministerio de educación y Ciencia, 2007).

For the design of the subject, whose detailed description is provided in the following sections, appropriate consultations were made with different sources and references:

- Internal sources from our own university. With these consultations, a contrast could be made with the rest of the subjects taught as part of the degree so that there was neither duplication of content, nor possible "gaps" in the lack of information. Finally, the first publication of the title was made in State Official Newsletter (BOE 4/2010, 2015).
- External sources from other Spanish universities. In Spain, where the Degree in Telematic Engineering from the University of Extremadura was designed, the same title had already been awarded in other universities such as the Carlos III University (BOE 71/2009, 2009), Universidad Politecnica de Madrid (Universidad Politecnica de Madrid, n.d.), etc.
- External sources of companies in the ICT sector. In this case, the publications of Curricula (2005) were consulted and included in the report entitled "The Overview Report 2005" where the profile called "Computer Engineering" is clearly identified.

For the structuring of the contents of "Systems Interconnection", similar subjects taught at other universities (for example at the Open University of Catalonia) and whose contents coincide were analyzed (Lara et al., 2011).

On the other hand, in Arias Masa et al. (2006), the full descriptive content had already been displayed in all its sections of the "Computer Networks" subject, which is the previous version of the current "Systems Interconnection". In this publication, the didactic and learning objectives, the contents of the subject, its structure and presentation, the teaching-learning model in "Computer Networks", the class methodology, and the generation of theoretical content are described, as well as the generation of practical content, the evaluation model, and, finally, a study of student data and evaluations by academic year. This scheme is very similar to the one followed in this theoretical work on the description of "Systems

Interconnection". For this, an adaptation has been made to the model that the University of Extremadura has implemented and in each of the following sections, there are theoretical justification and bibliographical references on which these sections are based.

Competences Pertinent to the Subject

This subject assumes the development of basic, general, specific, and transversal competences, like all the subjects of the degree. Basic competences are common to all university degrees; they are the ones that enable the student to integrate successfully into work and social life. These are the guidelines set by the current European Higher Education Area (EHEA) on training in basic skills and are the ones that point the way to educators for the implementation of active teaching modalities, which is necessary for the development of lifelong learning (Redalyc et al., 2003). In our case, they include the following areas:

- CB1 – That students have demonstrated to possess and understand knowledge in an area of study which starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks; it also includes some aspects which imply knowledge coming from the forefront of their field of study.
- CB2 – The students know how to apply their knowledge in practice in a professional way and possess necessary skills, which are usually demonstrated by the elaboration and defense of arguments and the resolution of problems within their area of study.
- CB3 – The students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include reflection on relevant social, scientific or ethical issues.
- CB4 – The students are able to communicate information, ideas, problems, and their solution to a specialized and non-specialized public.
- CB5 – The students have developed learning skills necessary to take up further studies with a high degree of autonomy.

General competences refer to the set of knowledge, attitudes, values, and abilities which are related to each other and, together, they allow satisfactory performances of the person who aspires to reach goals higher than the basic ones. These skills are also used as attributes, characteristics, and qualities, since they are capable of being developed in everyday learning. In the case of the "Systems Interconnection" course, these are:

- CG3 – Knowledge of basic subjects and technologies, which enables you to learn new methods and technologies, as well as cultivates versatility to adapt to new situations.
- CG4 – The ability to solve problems with initiative, decision making, and creativity, and to communicate and transmit knowledge, skills, and abilities while understanding the ethical and professional responsibilities of the Telecommunications Technical Engineer's activity.

Specific skills are those of the degree, specialization, and work profile for which the student is prepared. These are acquired by the student thanks to the transmission and assimilation of a series of contents related to the basic areas of knowledge. Therefore, they encompass knowledge that every graduate must have for the purpose of correct performance of the professional profile, in our case, Telecommunications Telematics Engineers. Accordingly, we put forward specific competences which belongs to the subject of Communications:

- **CE6** – The ability to learn new knowledge and techniques suitable for the conception, development or exploitation of telecommunication systems and services for yourself.
- **CE8** – The ability to use computer tools to search for bibliographic resources or information related to telecommunications and electronics.
- CE9 – The ability to analyze and specify the fundamental parameters of a communications system.
- CEl0 – The ability to evaluate the advantages and disadvantages of different technological alternatives for the deployment or implementation of communications systems, from the point of view of signal spaces, disturbances and noise, and analog and digital modulation systems.
- CEl3 – The ability to understand the mechanisms of propagation and transmission of electromagnetic and acoustic waves, and their emitting and receiving devices.
- **CE17** – Knowledge and use of the concepts of network architecture, protocols, and communication interfaces.
- CEl8 – The ability to differentiate between differing concepts of access and transport networks, circuit and packet switching networks, fixed and mobile networks, as well as distributed network systems and applications, voice, data, audio, video, and interactive and multimedia services.
- CE20 – Knowledge of the telecommunication regulations and rules in national, European, and international scopes.
- **CE24** – The ability to describe, program, validate, and optimize protocols and communication interfaces at different levels of a network architecture.

In the previous list, we have highlighted in bold the competences CE6, CE8, CE17, and CE24, which are those acquired in the "Systems Interconnection"

subject and are also taught in other subjects. Thus, CE6 is shared with "Fundamentals of Networks, Data Transmission and Transmission Media". CE8 is shared with "Data Transmission and Communications Electronics". CE17 is shared with "Fundamentals of Networks".

CE24 competence is assigned exclusively to the "Systems Interconnection" subject. This makes the practical part of the subject where different protocols of different levels of network architecture will be very important. As described later in this paper, it is essentially developed in practice III and IV.

Contents of the Subject

When the curriculum of the Degree in Telematics Engineering was produced in 2009, the description of contents published in the ANECA's report (ANECA, n.d.) was: "Link level. Link layer services. Programming and study of the protocols and functions of link control. General and theoretical aspects of the network level".

Based on this short description of the contents and competences, especially the specific ones which the students should have acquired once they finish the subject, the theoretical and practical contents are proposed in the following subsections.

Theoretical Contents

This section outlines the theoretical development to achieve the expected competences, as well as a brief description of the contents which are planned; the following topics have to be taught:

- Unit 1. Introduction to the link layer.
  - Simple review of the OSI Model.
  - Basic functions of the link level.
- Unit 2. Sublayer of Access control to the medium.
  - Ethernet.
  - IEEE 802.
  - Packet driver.
- Unit 3. Elementary Link Protocols.
  - Simplex protocol without restrictions.
  - Simplex stop and wait protocol.
  - Simplex protocol for noisy channel.
- Unit 4. Flow control.
  - Sliding window protocol concept.
  - Simple rejection sliding window protocol.

        ○ Selective rejection sliding window protocol.
- Unit 5. Detection and correction of errors.
  - ○ Types of errors.
  - ○ Detection.
  - ○ Redundancy.
  - ○ Redundancy verification.
  - ○ Checksum.
  - ○ Bug fixes.
- Unit 6. Character oriented protocol.
  - ○ Introduction.
  - ○ Framing and synchronization.
  - ○ Character oriented protocols.
  - ○ BSC protocol
- Unit 7. Bit-oriented protocols.
  - ○ Introduction.
  - ○ Introduction to X.25.
  - ○ Basic HDLC features.
  - ○ Frame structure.
  - ○ Operation of the LAPB protocol.
- Unit 8. The data link on the Internet.
  - ○ PPP and SLIP protocols.
  - ○ Levels of the PPP protocol.
  - ○ LCP link control protocol.
- Unit 9. ARP protocol.
  - ○ Introduction.
  - ○ ARP tables or caches.
  - ○ Structure of ARP packages.
  - ○ ARP proxies.
  - ○ Coding in JAVA for packet driver.
- Unit 10. Introduction to the network level.
  - ○ Description of network level functions.
  - ○ Datagram versus virtual circuit.

Most of these contents are described in Tanenbaum and Wetherall (2012) and in Stalling (2004). Of course, these contents are included in many more books but these are the basic and most important for our students, and especially for these specific topics of the link level and the introduction to the network level.

Practical Contents

The practical contents are developed around four sequential practices which are developed throughout the semester, namely:

- Practice I. Presentation of practices in the programming environment.
- Practice II. Packet driver specification.
- Practice III. Implementation of one of these protocols.
- Practice IV. Simulation of error control in practice protocol III.

As students of the 4th semester of the degree, they have already taken basic programming subjects which are needed to be able to practice the above skills because they are done in the JAVA language. The practices are based on the use of the laboratory's Ethernet network, with Internet Access and IP addresses.

```
run:
------------------------------------------------------
Programa Practica 1  modulo 1.1
Autor: Juan Arias Masa
Fecha: 29 enero 2020
Descripcion:
     ***Determina las tarjetas de red que tiene la maquina
Por favor ten paciencia y espera un momento
------------------------------------------------------

Buscando las tarjetas....
----------------Tarjeta: 0--------------------
 +Nombre: \Device\NPF_{514E3FAF-800D-4100-A027-F97D39823AC7}
   -descripcion: Intel(R) 82574L Gigabit Network Connection
 +Nombre del Enlace: EN10MB
   -descripcion del enlance: Ethernet
Bucle loopback desactivado
Dirección MAC: 0:1c:42:39:ae:ab:
Dirección 1:
        dirección: /fe80:0:0:0:8999:ced0:e810:b94e
          máscara: null
          difusion: null
        destino P2P: null
Dirección 2:
        dirección: /192.168.1.101
          máscara: /255.255.255.0
          difusion: /255.
--------------Fin tarjeta: 0--------------------

En total esta máquina tiene: 1 tarjetas de red
Pulsa INTRO para terminar
```

Figure 1. Example of Ethernet Card Information.
S o u r c e: Own work.

Practice I serves as an introduction to the programming environment that will be used throughout the course. Specifically, JAVA and packet drivers with access from the Windows environment are used. The general use of the packet driver is learned in practice II, where it is studied, step by step, how to access the internal core of the Ethernet cards, that is, its basic configuration data set, as its own

Ethernet address comes from the factory, and different IP addresses assigned, both version 4 and version 6. In Figure 1, we can see an example of what information the program developed by students in the first module shows.

Once the card information is located using the "see interfaces" module, the next module to be carried out is a package reception module, where the final program to be developed will be limited to showing all the packages that arrive at the Workstation. In Figure 2, we can see an example of how the information of an Ethernet packet or frame that has just arrived at the station is shown.

The third module of this second practice is to form Ethernet frames and insert them into the network. For this, it is necessary to define the destination address that will be used; in this case, it will be a broadcast address (0xffffffffffff) and, also, the source address having the Factory card. The type/longitude field will be used as the length field and the size or number of bytes (always less than 1500) of the information string will be entered in the data field of the ethernet frame. Finally, data or information will go in the data field. Once the ethernet frame is formed, it will be put on the network.

```
Iniciamos la recepcion para la tarjeta: 0 Dirección MAC: 0:1c:42:4:b4:76
Mi mac es: 0:1c:42:4:b4:76
 ========================================================
Mac Destino: 1:0:5e:0:0:fb    Mac Origen: 0:1c:42:0:0:9
Paquete con campo tipo 2048
caplen:227
len:227
sec:1594186581
longitud header:42 contenido Cabecera:1 0 94 0 0 -5 0 28 66 0 0 9 8 0 69 0 0 -43 -65 -39 0 0 -1 17 -113 27 10 37 -127 2 -32 0 0 -5 20
-23 20 -23 0 -63 -102 -71
datos IP:(14)69 (15)0 (16)0 (17)-43 (18)-65 (19)-39 (20)0 (21)0 (22)-1 (23)17 (24)-113 (25)27 (26)10 (27)37 (28)-127 (29)2 (30)-32
(31)0 (32)0 (33)-5 (34)20 (35)-23 (36)20 (37)-23 (38)0 (39)-63 (40)-102 (41)-71
longitud  data:185 contenido Datos:0 0 -124 0 0 0 0 10 0 0 0 13 108 111 99 97 108 104 111 115 116 95 112 114 108 0 0 1 0 1 0 0 0 0
0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0
1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127
0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1 -64 12 0 1 0 1 0 0 0 0 0 4 127 0 0 1
:::::::::::::::Datos Ethernet: Dir Destino: 01:00:5e:00:00:fb Dir Fuente: 00:1c:42:00:00:09 Tipo/Longitud: 2048
 paquete IP
version 4
version 4
Version: 4
Dir Ip origen con toString: /10.37.129.2
Dir Ip destino con toString: /224.0.0.251
Dir Ip origen con getHostAddress: 10.37.129.2
Dir Ip destino con getHostAddress: 224.0.0.251
Protocolo que transporta: numero: 17 nombre null
Caplen: 227
long cabecera213
lon 227
Version: 4
Dir Ip origen con toString: /10.37.129.2
Dir Ip destino con toString: /224.0.0.251
Dir Ip origen con getHostAddress: 10.37.129.2
Dir Ip destino con getHostAddress: 224.0.0.251
Protocolo que transporta: numero: 17 nombre null
Caplen: 227
long cabecera213
lon 227
 ========================================================
```

Figure 2. Example of receiving Ethernet packets.
S o u r c e: Own work.

The fourth and final module of this second practice consists of recovering the frames that we insert into the network in module 3. That is, we will be able to review what we have sent. Having reached this last objective, we are ready

to start refining the important aspects of the subject because we already have the transmission vehicle of our packages for the protocol to be developed in practice III.
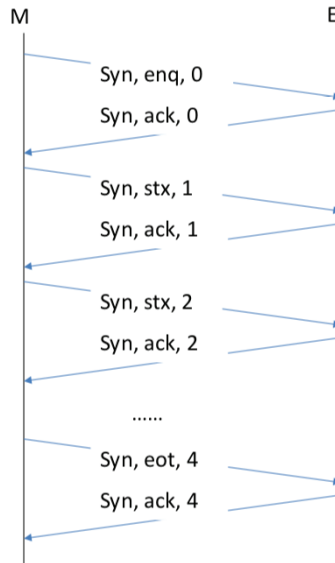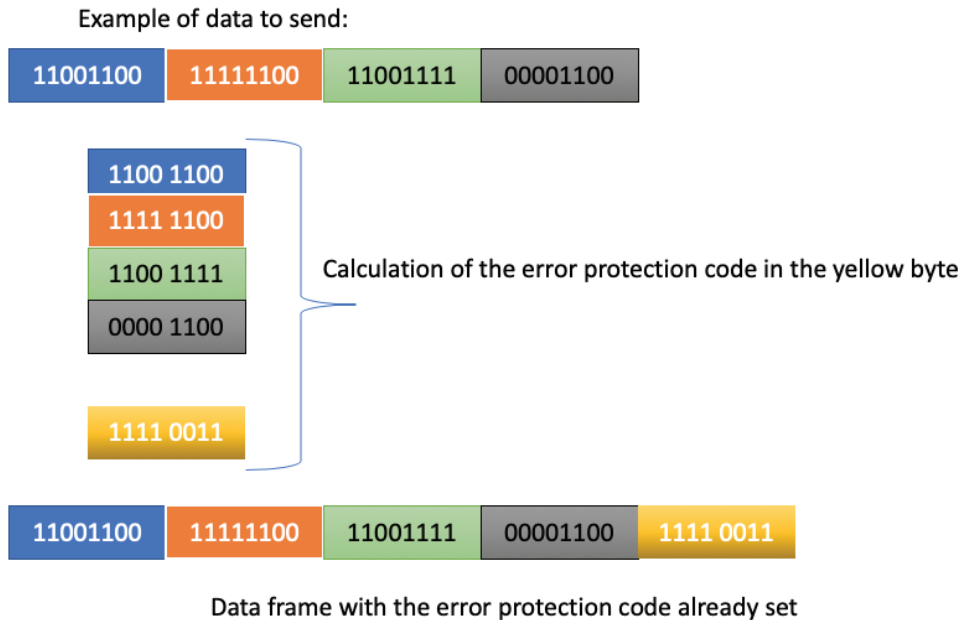

Figure 3. Basic scheme of the operation of the IS protocol.
S o u r c e: Own work.

Practice III consists of the complete implementation of a stop and wait protocol, which is called the IS protocol. In practice IV, error detection is added to this protocol by means of a cyclic redundancy code added to the frames of the IS protocol. The basic scheme of the IS protocol is a connection-oriented protocol based on the BSC (Binary Synchronous Communication) protocol developed by IBM (International Business Machine Corporation) in 1962 but it has a basic structure for easy learning by students. As we have seen in our years of teaching experience, it allows them to establish the theoretical and practical foundations of the current communication protocols, since all that is learned for the OSI model link level is transferable to the transport level, i.e., the level that the future Telecommunications Engineers whom we teach will work with. In *Figure 3* you can see an example of the operation of the protocol oriented towards connection with the three phases of establishment (sending the "enq" frame and its confirmation), transfer ("stx" frames, where the Exchange of information), and release ("eot" frame and its corresponding confirmation). The master entity of communication is represented in the left column and the slave entity in the right column. It is a one-way transmission of information from the master to the slave. Finally, we must point out that

all the frames must be positively agreed with the "ack" commanPractice IV errors control is a bit parity control, as shown in *Figure 4*. This errors control applies to all bytes of the IS frame. The above figure shows only one example for four bytes. In the real protocol, it will be applied to all the bytes of the frame. The operation performed for parity control is an XOR, the result of which is 1 if the number of ones is odd and is 0 if the number of ones is even.

Example of data to send:

| 11001100 | 11111100 | 11001111 | 00001100 |

| 1100 1100 |
| 1111 1100 |
| 1100 1111 |
| 0000 1100 |

Calculation of the error protection code in the yellow byte

| 1111 0011 |

| 11001100 | 11111100 | 11001111 | 00001100 | 1111 0011 |

Data frame with the error protection code already set

Figure 4. Example of error handling with even parity checking.
S o u r c e: Own work.

Coherence of Theoretical and Practical Content

These contents (theoretical and practical) try to respond to the specific competences C17 and C24, especially to the latter, which we have described in the previous section. The contents focus on the link level during most of the course which ends with the introduction of the network level to prepare students for the next subject – "Computer Networks". There is a great connection between the theoretical and practical section of the subjects; in fact, both progress in parallel. While in topic 2, Ethernet is basically explained in practice II, access is made through the packet drivers to all the Ethernet frames that arrive at the work station where the student programs.

Practice III is the practical application of everything explained in topics 3, 4, and 6; where, on the one hand, the operation of the protocols is explained

in topic 3 and 4 and, on the other, in topic 6, it is detailed how it is carried out with a character-oriented protocol implemented in practice III using real Ethernet.

Finally, practice IV uses one of the error control methods explained in topic 5. This topic explains various error control methods from parity control, through cyclic redundancy codes with divisor polynomials, as used by Ethernet, for example up to frame verification sequences, as used by the IP protocol or TCP (Transmission Control Protocol). The last part of topic 5 is dedicated to correcting errors with Hamming codes.

Teaching Methodologies

Academic discourse (oral and written) is necessary to establish which teaching methodology is to be used. At present, according to Gómez Trigueros and Ruiz Bañuls (2018), the incorporation of Information and Communication Technologies (ICT) into classrooms as a mechanism for innovation is absolutely necessary. Therefore, this subject is structured in the use of the following teaching methodologies:

- Expository classes of theory and problems: Presentation of the subject's contents and planning of the participation of all students in different tasks. Discussion of theoretical aspects.
- Participatory education: Practical work in medium or small groups.
- Tutoring: A follow-up activity for the supervision of directed work, queries, and doubts; advice (individual or in small groups).
- Autonomous learning through the analysis of written documents; preparation of reports; the study of the subject taught and the development of practical skills.
- Virtual learning. The use of virtual communication tools between teacher and student, and even between students.

Learning Results

According to Adam (2004), learning outcomes are one of the main components for higher education systems and transparent qualifications. In fact, Gosling and Moon

(2001) pointed out that this focus, based on results, is becoming better known in international education.

But, to be able to design the learning process, the key point of departure is set by the learning outcomes which are intended to be achieved in the subject and as part of the degree. By **learning outcomes**, we understand what a student is expected to know, understand, and be able to demonstrate. It refers to the changes that have occurred in the knowledge, understanding, and competence level of the student as a result of the learning process. These are:

- to know the level of link and its basic protocols well.
- to know how to program communication protocols at the link level.
- to increase knowledge of the network level.
- to show an ability to detect and correct errors in frame transmission.
- to know the flow control for the transmission of information well.

Evaluation

For Kennedy (2007), evaluation can be defined as the ability to judge the value of the elements for specific purposes. Likewise, Guerra-López (2007) believes that

> The concept that the most important purpose of the evaluation is no to prove but to improve, must be the basis of all future efforts in the field of evaluation. Each and every one of the components of the evaluation must be aligned with those objectives and expectations that organizations value, and with the decisions that must be taken from the results of the information obtained from that evaluation. These decisions are essentially focused on how to improve and measure performance, at all organizational levels (p. 11).

The evaluation of the subject is structured in different percentages, depending on the regulations of the subject. These, however, are adjustable by the teaching staff and, in this case, the structure is shown in *Figure 5*. All these sections are the division of the total of the subject and, in each of them, there is a part which corresponds to the theoretical contents and the one which corresponds to the practical contents.

Both in the practical and in the theoretical part, a continuous evaluation system is employed throughout the course, which is followed by the vast majority of stu-

dents in this subject. This continuous evaluation is made up of different sections which determine the student's final grade. For the practical part, control will be carried out by means of questionnaires at the end of the teaching of each subject, where there will be questions not only of the subject that has just been studied; it will also include all the previous ones. Thanks to this teaching method, we get the students to acquire all the competences which are taught and put them to use despite the passage time.

The weight of the theoretical part is 50% of the final grade. That of the practice on the other hand, is further divided. 10% of the practical test, which is made of each practice that is carried out, is devoted to the task during which the student has to demonstrate their authorship of a modification of a part of the program developed. In addition, the practical part has 20% assigned to the evaluation of the documents delivered in the task associated with each of the practices. The remaining 20% of the total is divided into three subsections. On the one hand, there is 10% allocated for the active participation of the student in class – attendance, solving problems, raising problems, generating information for those concepts which are present in both the theoretical and practical classes that have been taught. In other words, it is the one connected to "participatory teaching", which we have exposed in the "Teaching Methodology". On the other hand, there is 5% allocated for the oral presentation of the works delivered, where transversal competencies are evaluated, such as communication and oral expression, which are of utmost necessity for the professional development of the future engineer.
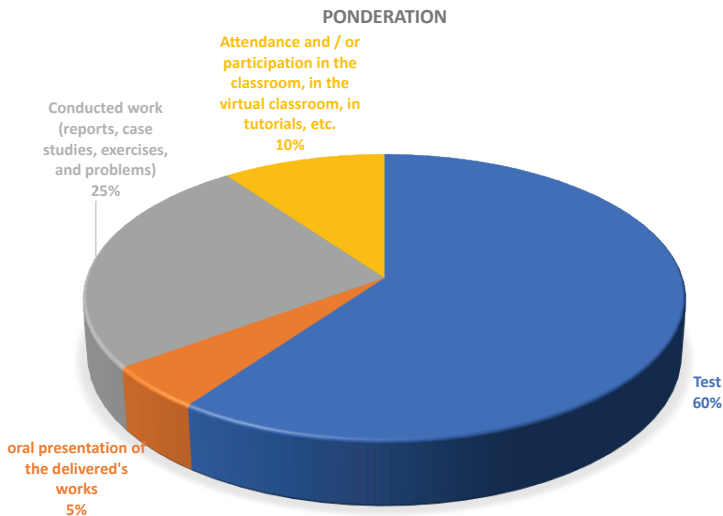

Figure 5. Specification of the "Systems Interconnection" evaluation regulations.
S o u r c e: Own work.

And, finally, the remaining 5% is used to evaluate the "format" (not the content – this is evaluated in the section where applicable), namely, the reports which are delivered in all the works that are elaborated upon in the subject, both in terms of conducted practices and theory. With this last percentage we intend to validate and help achieve the transversal competences of written communication, synthesis, etc.

This section of Evaluation is where its modification or adaptation has been added for its inclusion in the continuous evaluation. It has been introduced little by little throughout the previous academic years, the positive results of which can be seen in the following section on academic results.

Continuous evaluation has been introduced from the academic year 2017–18 in the theoretical part of the subject, since the practical part has a continuous and independent evaluation of each practice. The continuous evaluation of "Systems Interconnection" is not only a continuous, but also a summative evaluation. Summative assessment is based on the levels or grades and involves periodic evaluations which assess what students know and do not know. Such an assessment provides teachers and students with information about the level of achievement in a specific learning context.

Our summative assessment aims to assess student's learning at the end of the teaching unit by comparing its results with a standard or group measure; in our case, it is compared with the standard for each topic that the teaching team prepared in the academic year 2017–18 when it was first introduced. However, in the following academic year, 2018–19, it was already possible to compare not only with the teaching team standard, but also with the results of the academic year 2017–18.

Academic Results

Based on all the data reflected in the previous sections, in which we have shown how the subject is structured, in this section, we will show the academic results our students have obtained in the previous courses where they applied everything that they were exposed to before, as can be seen in the following figures.
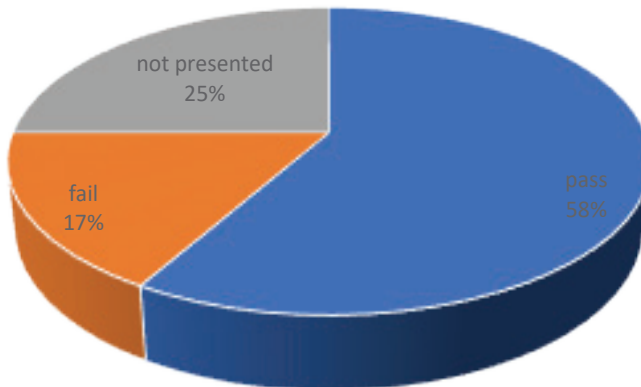
Course 2018-19
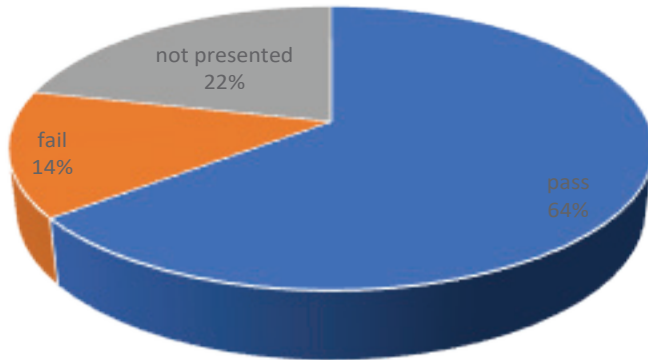
Figure 6. Academic results of the academic year 2018–19 in the first call (June 2019).
S o u r c e: Own work.

Course 2017-18

Figure 7. Academic results of the academic year 2017–18 in the first call (June 2018).
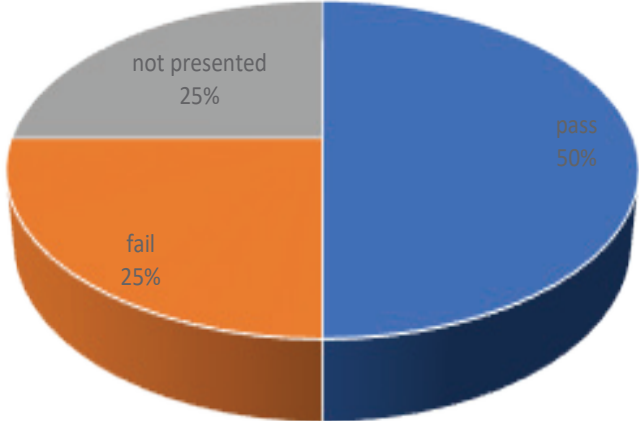S o u r c e: Own work.

Course 2016-17

Figure 8. Academic results of the academic year 2016–17 in the first call (June 2017).
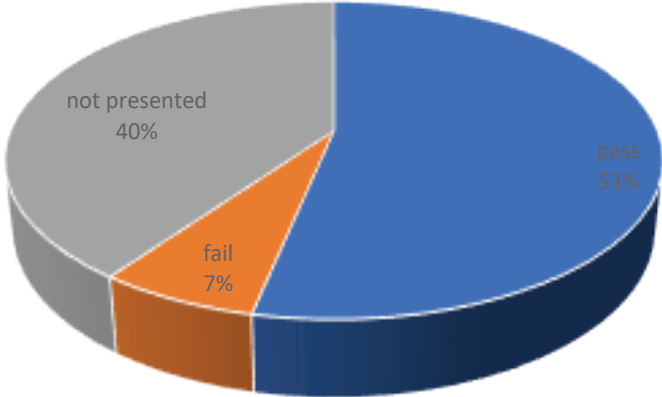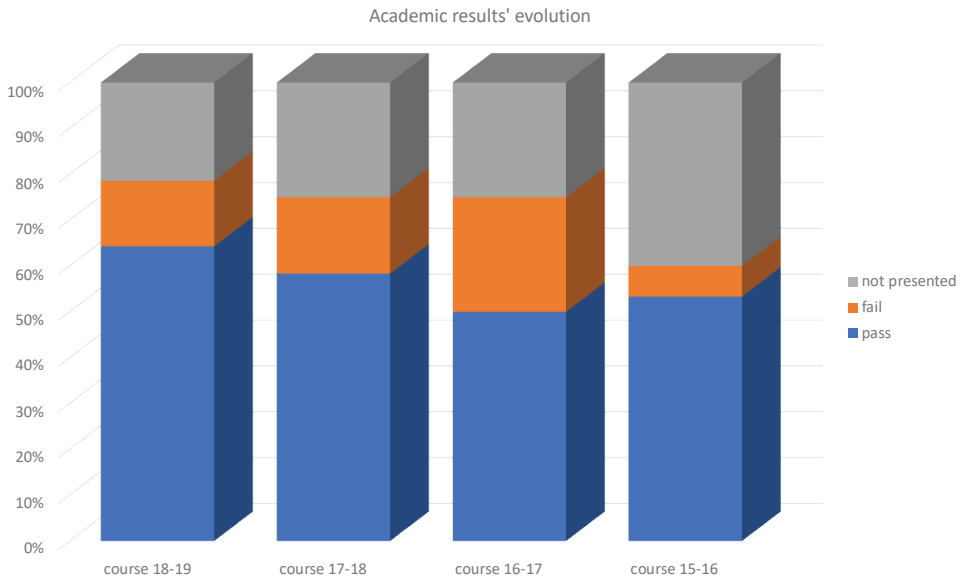S o u r c e: Own work.

Course 2015-16

Figure 9. Academic results of the academic year 2015–16 in the first call (June 2016).
S o u r c e: Own work.

Figure 10. Academic results' evolution.
S o u r c e: Own work.

In *Figure 10*, we show the evolution of academic results. If we look only at that image, it may not provide us with enough information, of course, not much more than knowing that the subject has a high % of passing marks. But, above all, what can be seen is the increase in this percentage if we compare it to the sum of failing marks and not presented, which, in the end, are formed by students who did not pass the subject. Therefore, the subject evolves favorably towards the goal of students: pass all the exams; which, among other goals or objectives, is one of the most important ones to achieve and, of course, it is a training course for engineers.

The introduction of the summative assessment that took place in the academic year 2017–18 has led to the increase in the positive results in terms of passing marks and the general decrease in the percentage of students who did not pass the course, either because they did not appear or because they failed.

Conclusions

Throughout this work, we have described how the subject "Systems Interconnection", which is a fundamental subject for Telecommunications Engineers at

the University of Extremadura, Spain, is organized. We have started from the competences developed as part of the subject: basic, general, and specific competences. Then, the contents of the subject have been described and segmented into theoretical and practical. The practical contents have been detailed, explaining how they should be put into practice (see Practice I–IV). Teaching methodologies used have been described, as well as the learning outcomes and the evaluation of the subject. At the end of the article, academic results were presented.

In the analysis of academic results, we have highlighted how the increase in the number of students approved in the June exam has evolved positively, compared to the number of suspended and not present, which tends to decrease. However, this should not lower the alarms and should heighten the awareness of all methodological changes and innovative processes that can be implemented to refine the teaching-learning process.

The most important modification of the teaching-learning process that has been introduced was in the academic year 2017–18. It consisted in the inclusion of the summative evaluation whose positive results have been shown in the academic results section. We can see how in the academic year 2018–19, when the summative evaluation is applied not only against the standard benchmark of the teaching team, but also against the group of the previous course, it improves as compared to the results from 2017–18.

Although there are only two academic courses within this teaching modification, we believe that this modification has been very beneficial, based on the academic results. Therefore, we think that it is the horizon that we must follow in this subject and it is the intention of the teaching team to introduce the aforementioned summative assessment in other subjects for which this team is responsible.

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Teaching in the Subject "Systems Interconnection" at Extremadura University

Juan Arias Masa, Rafael Martín Espada, Juan Arias Abelaira

Nauczanie przedmiotu „Połączenie systemów" na Uniwersytecie Estremadura

S t r e s z c z e n i e

Niniejsza praca opisuje proces nauczania przedmiotu „Połączenie systemów" w Wyższej Szkole Inżynierii Telekomunikacyjnej Uniwersytetu w Estremadurze w Hiszpanii. Wnikliwie opisuje każdą z części składowych przedmiotu i obejmuje zarówno kompetencje uzyskane przez studentów po ukończeniu kursu, jak i nauczane w ramach kursu treści teoretyczne i praktyczne. Ponadto dokonano podsumowania zastosowanej metodologii nauczania oraz wyników uczenia się. Artykuł zamyka szczegółowa metodologia oceny i wyniki akademickie ostatnich kursów, na podstawie których zaobserwowano poprawę wyników studentów, zwłaszcza w zakresie procentowej liczby studentów niezdających przedmiotu. Poprawę odnotowano dzięki wprowadzeniu oceny ciągłej części teoretycznej przedmiotu. W skrócie, artykuł stanowi opis obecnej koncepcji przedmiotu „Połączenie systemów".

S ł o w a   k l u c z o w e: nauczanie, telematyka, inżynierowie, szkolnictwo wyższe

Хуан Ариас Маса, Рафаэль Мартин Эспада, Хуан Ариас Абелаира

Преподавание предмета «Взаимосвязь систем» в Университете Эстремадуры

А н н о т а ц и я

В данной работе описывается преподавание предмета «Взаимосвязь систем», который преподается в Высшей школе телекоммуникационной инженерии Университета Эстремадуры, Испания. Каждый из разделов, составляющих предмет, подробно описан и охватывает как компетенции, приобретенные студентами после завершения курса, так и теоретическое и практическое содержание, преподаваемое в ходе курса. Кроме того, были обобщены использованная методика преподавания и результаты обучения. Статья завершается подробным описанием методологии оценки и успеваемости последних курсов, на основании которых наблюдалось улучшение успеваемости студентов, особенно с точки зрения процента студентов, не сдавших предмет. Улучшение отмечено благодаря введению непрерывной оценки теоретической части предмета. В статье описывается актуальная концепция преподавания предмета «Взаимосвязь систем».

К л ю ч е в ы е   с л о в а: педагогика, телематика, инженеры, высшее образование

Docencia en la asignatura "Interconexión de Sistemas" de la Universidad de Extremadura

Resumen

Este trabajo describe la enseñanza que se utiliza en la asignatura de „Interconexión de Sistemas" que se imparte en la Ingeniería Superior de Telecomunicaciones de la Universidad de Extremadura. Una vez finalizado el curso, el alumno adquirirá todos los contenidos teóricos y prácticos que se imparten en la asignatura, los cuales se detallan en diferentes apartados de la asignatura. Además, se hace un resumen de la metodología de enseñanza utilizada y los resultados del aprendizaje. Finalmente, el artículo concluye detallando la metodología de evaluación y, sobre todo, los resultados académicos de los cursos anteriores, donde se observa una mejora en los resultados, especialmente en el porcentaje de alumnos que han superado todos los exámenes de la asignatura (alumnos aprobados en adelante), es decir, reduciendo la suma de los porcentajes de los que no han modificado sus resultados o han reprobado los exámenes de la asignatura. Esta mejora se ha conseguido a partir de la introducción de la evaluación continua en el apartado teórico de la asignatura. En definitiva, se trata de un estudio descriptivo de la situación actual de la asignatura de "Interconexión de Sistemas".

Palabras Clave: enseñanza, telemática, ingenieros, educación superior