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CAMPUS
DE EXCELENCIA
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INTERIM REPORT TELECOMMUNICATION TECHNOLOGIES AND SERVICES ENGINEERING, B. ENG. PROGRAM

ETS INGENIEROS DE TELECOMUNICACIÓN

Vice-Rectorate of Quality and Efficiency

Version 1.0

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- CALENDAR OF THE PROCESS
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  - November 24, 2015 7 Days Response
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II. Program Weaknesses

This section describes the weakness detected by the evaluator team and then the set of measures that have been set up to solve it.

II.1. CRITERION 4: CONTINUOUS IMPROVEMENT

4.A: This criterion requires that the program regularly uses appropriate, documented **processes for assessing and evaluating the extent to which the student outcomes are being attained**. The program does not have a complete process for assessing and evaluating the extent to which these student outcomes are being attained. Instead, the program implements a more general assessment process that measures the program-defined outcomes in a general course-level assessment that is based primarily on student grades and **does not directly address specific elements of the Criterion 3** (a) through (k) student outcomes. In addition, **the program has not specified levels of attainment that are expected of the students**, so it is not possible to determine whether attainment of student outcomes is meeting expectations. Since the data gathered in the assessment process is not used to determine the extent to which the Criterion 3 (a) through (k) student outcomes have been attained, the program lacks strength of compliance with this criterion.

30-day due-process response: the EAC acknowledges receipt of documentation describing a revised assessment process that specifically identifies the assessment of student outcomes (a) through (k) with specific levels of student performance identified to indicate attainment of the outcome. The new assessment process has not been fully implemented, however, so there are only limited data available to gauge its effectiveness.

The weakness remains unresolved and will be focus of the next review. In preparation for this review, the EAC anticipates documentation describing appropriate processes for assessing and evaluating the extent to which the student outcomes are being attained and the systematic use of results as input for the continuous improvement of the program.

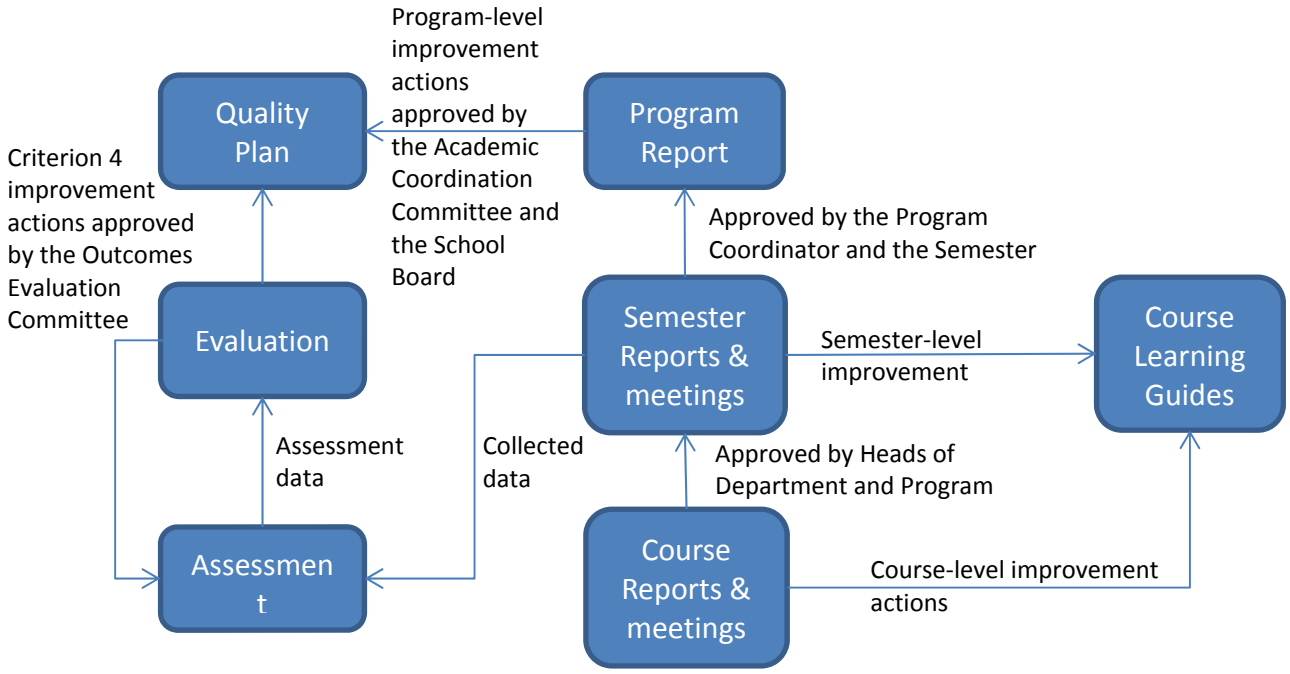
II.1.1. Improvements made to resolve weakness

In this section we document the new processes for assessing and evaluating the extent to which the student outcomes are being attained and the systematic use of results as input for the continuous improvement of the program.

II.1.1.1. Continuous improvement and quality assurance

Continuous improvement of a program at Universidad Politécnica de Madrid is articulated through the Internal Quality Assurance System (SIGC[1]). The SIGC follows a general UPM model under the guidelines from ANECA[2], guaranteeing that the system is consistent throughout our University and complies with the Spanish regulations. Three of the SGIC processes are implementing the continuous improvement of the program according to ABET Criterion 4:

- Process PR/ES/003: it is responsible for course-level, semester-level and program-level coordination and **assessment**
- Process PR/ES/001: it periodically creates and reviews a Quality Plan for the ETSIT center and, **it evaluates and it continuously improves** the programs (specifically, the Telecommunication Technologies and Services Engineering, B. Eng. Program, according to ABET Criterion 4)
- Process PR/CL/001: it periodically creates (or modifies) the Course Learning Guides, which contain the syllabus, the evaluation activities and criteria, etc. of each course (**some of the improvement actions** may provoke changes in these Guides)



Criterion 4: assessment and evaluation processes

[1] SIGC is the Spanish acronym for Sistema Interno de Garantía de Calidad. A more detailed description of the process related to assessment and evaluation is included in Appendix VI
[2] ANECA is the national agency for accreditation in Spain

II.1.1.2. Assessment

The Course Coordinators who participate in the Semester Committee meetings **provide** the Program Coordinator with the measured values of the **performance indicators** available from their courses each semester, according to the approved Course Learning Guides. This data identification and collection process is the first step for the assessment of Criterion 4.

The Semester Committees of the first and second semester collect more than 200 performance indicators that could be used as part of the evaluation under Criterion 4. They are not just the overall average grades of each course (traditionally used for course-level coordination and improvement). This **new set of performance indicators** includes scores of written, oral or computer-based examinations or tests in each course, and scores assigned to student assignments, reports or presentations, and any other scored activity in the courses that is directly related to a Student Outcome.

Compared to previous academic years, the **number of collected performance indicators was significantly increased** in the academic year 2015-2016 (in previous years, there was only one overall indicator per course) and they are directly related to the Student Outcomes. The criteria for selecting the reduced set of performance indicators from the courses were:

- Most of the courses of the two final years (the fourth and the third) in our four-year Bachelor program must provide these more specific indicators
    - however, the two courses on English for academic and professional communication (IGL1 and IGL2, from the second year of the program) are included in the list because of their direct relationship with Student Outcome *g. communicate effectively*
- The contribution of both semesters should be balanced
- Courses of the four majors (Telecommunication Systems, Telematics, Electronic Systems and Audiovisual Systems) in the Bachelor program should provide indicators
- Each indicator must be directly related to one specific Student Outcome to be evaluated: (a) to apply basic knowledge; (b) to carry out experiments and to analyze data; (c) to design; (d) to work in a team; (e) to solve engineering problems; (f) to understand the social and economic aspects; (g) to communicate effectively; (h) to engage in life-long learning; (i) to know about contemporary issues; (k) to use techniques and tools for engineering practice
- each indicator would be used for the evaluation of one Student Outcome, generally speaking

In addition to these indicators, the Program Coordinator collects information from other traditionally available sources:

- 11 average scores (in a 1-5 scale) assigned to the Bachelor Thesis work, reports and presentations by the Bachelor Thesis Grading Committees

(these measured performance indicators and the associated Student Outcomes are detailed in Appendix II)

- 14 average scores (in a 1-5 scale) assigned by the professional supervisors of the students participating in internships in companies, with academic credit hour recognition (these measured performance indicators and the associated Student Outcomes are detailed in Appendix III)

Once all the information was collected, the Course Coordinators and the Program Coordinator selected **a reduced set of 82 indicators directly related to the performance on the Student Outcomes**. These indicator were grouped into just one average performance indicator per Student Outcome (the reduced set of selected indicators and the associated Student Outcomes are included in Appendix I). Similarly, the Bachelor Thesis indicators and the Internship indicators were grouped and averaged per Student Outcome (see Appendix II and Appendix III).

II.1.1.3. Evaluation and approved actions on the academic year 2015-2016

The **Outcomes Evaluation Committee** (OEC) evaluated the assessed data resulting in the following performance table:

Student Outcome	Average level of attainment measured on 2015-2016 (1-5 scale)	Course indicators	Internship indicators	B. Thesis indicators
a. apply knowledge	**3.8**	3.8		
b. experiments	**4.2**	4.2		
c. design	**4.2**	4.0		4.5
d. teams	**4.3**	4.1	4.5	
e. engineering problems	**3.9**	3.6	4.2	
f. professional responsibility	**4.6**		4.6	
g. communicate effectively	**4.3**	4.1	4.1	4.6
h. impact of solutions	**4.2**	3.9		4.5
i. lifelong learning	**4.5**		4.5	
k. engineering practice	**4.1**	4.1		

The OEC concluded that:

- There was an outcome that could not be directly fully evaluated yet because direct assessment data was missing: namely, outcome *j. contemporary issues*. There were indirect evidences that contemporary issues were not a severe problem, as in an alumni survey, the level of attainment of this Student Outcome was a 5.1 in 0-10 scale (not a high value, but in the top half of the scale[3])

[3] In the Spanish Grading System, 5 (in a 0-10 scale) is the threshold for passing an examination

  - **Approved action**: in order to directly measure the performance on *j. contemporary issues*, the decision was **to collect direct evaluation data from the supervisors of the Bachelor's Theses** in the following academic years, using the scale included in Appendix IV
- The bachelor's end-of-degree Thesis was used for just evaluating three Student Outcomes and four of the other outcomes were only evaluated through specific questions and scores from the courses, and they were not evaluated through the mandatory Bachelor Thesis. The reason for only evaluating three Student Outcomes was the use of data from the final Bachelor Thesis Grading Committees, which read the written report and listened to the oral presentation by the student, and finally asked questions about the student's work. However, the Thesis Supervisor has more information about the student performance because it was supervising the student's project during one semester and can evaluate all the outcomes, from applying knowledge to engineering practice
  - **Approved action**: in order to improve the evaluation of all the Student Outcomes, the **Bachelor Thesis Supervisors will score their Students using the scale included in Appendix IV**
- **A threshold for the level of attainment of the Student Outcomes was established: 3.5 in a 1-5 scale**
  - As the level of attainment was higher or equal than the threshold, no additional actions were required
- Once the processes and thresholds for evaluating the level of attainment were established, and an assessment and evaluation cycle had to be defined. The cycle comprises three stages (1, 2 and 3). Every academic year, each Student Outcome will be in any of those stages. On the following academic year, Student Outcomes on stage 1 will move to stage 2, or those on stage 2 to stage 3 and those in stage 3 will go back to stage 1. In the first stage, there will be an assessment and evaluation process; on the second stage, the courses and support activities will be prepared and implementation will begin; on the third stage, the improvement actions will be fully implemented
  - **Approved special action**: As additional data had to be collected, affecting the evaluation of several Student Outcomes, **all of them were exceptionally assessed and re-evaluated on 2016-2017**. However, as this interim report for ABET had to be submitted on June 2017, and not all the performance indicators were available on that month, results on 2016-2017 are be based on first-semester courses, on internships and on Bachelor Thesis

II.1.1.4. Evaluation and approved actions on the academic year 2016-2017

Following the procedures above described, new assessment and evaluation data table was collected:

Student Outcome	Average level of attainment in 2016-2017 (1-5 scale)	Internship indicators	B. Thesis Committee indicators	B. Thesis Supervisor indicators	Course indicators	Average level of attainment in 2015-2016
a. apply knowledge	**4.0**			4.2	3.7	3.8
b. experiments	**4.0**			4.0	4.1	4.2
c. design	**4.3**		4.4	4.2	4.1	4.2
d. teams	**4.3**	4.5		4.5	4.0	4.3
e. engineering problems	**4.0**	4.1		4.2	3.5	3.9
f. professional responsibility	**4.6**	4.6		4.6		4.6
g. communicate effectively	**4.2**	4.3	4.4	4.1	4.0	4.3
h. impact of solutions	**4.2**		4.4	4.0		4.2
i. lifelong learning	**4.6**	4.6		4.6		4.5
j. contemporary issues	**3.8**			3.8		
k. engineering practice	**4.1**			4.4	3.8	4.1

According to the results, the Outcomes Evaluation Committee concluded that:

- **All the levels of attainment were higher or equal than the reference threshold (3.5)**
- The Student Outcomes that were close to the threshold (lower than 4.0) are now slightly higher
- A couple of levels are now closer to the threshold, but are still higher than 4.0
- The lowest level corresponds to *j. contemporary issues*. Some actions have been defined to improve the level and to measure it as precisely as possible:
    - **Approved action**: **Internship supervisors and Bachelor Thesis supervisors should also score this Student Outcome**, because this scoring will reinforce the importance of contemporary issues in our program
    - **Approved action**: **To create a *credit passport***. There are many activities related to contemporary issues in our center, and some of those activities can provide the students with some curricular extra credit hours; however, the requirements for getting these extra credits are still a bit restrictive and a new *credit passport* mechanism can be defined in order to increase the impact of these activities related to contemporary issues. The students participating in any of these activities can accumulate the hours they spent, and when they get to a certain minimum number of hours, they could apply for the

recognition of a new curricular credit[4]. The set of available activities included are slightly different every year, but they can be summarized as:

- Courses, contests, etc. organized by our more than 20 student associations (such the IEEE or the EURIELEC student branches)
- Scientific conferences and workshops organized by any of our (more than 30) international R+D groups,
- Presentations by our student-exchange University Partners all over the world
- Book presentations
- Presentations by technology companies for introducing their latest products, projects and job offers to our students (15 of these companies directly finance 15 chairs in our center)

II.1.1.5. Calendar

As stated above, an assessment and evaluation cycle has been defined. The cycle comprises three stages (1, 2 and 3). Every academic year, each Student Outcome is in any of those stages. In the first stage, there is an assessment and evaluation process; on the second stage, the courses and support activities are prepared and implementation begins; on the third stage, the improvement actions are fully implemented[5].

	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.
2015-2016	1	1	1	1	1	1	1	1	1	0	1
2016-2017	1	2	1	2	1	1	2	1	1	1	1
2017-2018	1	3	1	3	1	2	3	2	2	2	1
2018-2019	2	1	2	1	2	3	1	3	3	3	2
2019-2020	3	2	3	2	3	1	2	1	1	1	3
2020-2021	1	3	1	3	1	2	3	2	2	2	1

Each year, the approximate calendar of activities related to Criterion 4 is:

Activities	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Course Reports and course coordination meetings		X						X				
Semester Reports and semester coordination meetings			X						X			
Course Learning Guides			X	X					X	X		

[4] Currently, credits can only be obtained if a minimum number of hours were spent on just one activity, limiting the number of activities that can provide credits
[5] Exceptionally, on 2015-2016 and 2016-2017, as we have modified the procedures for continuous improvement, we have collected data for all the Student Outcomes

Yearly Program Report							X	X				
Outcomes Evaluation Committee meetings			X	X					X	X		
COA meetings	X	X	X	X	X	X	X	X	X	X	X	
School Board meetings		X		X		X		X		X		

APPENDIX I: Performance Indicators selected from courses

I.1 Academic year 2015-2016

These are the performance indicators selected from courses, the related Student Outcomes and the values measured on 2015-2016 (in a 0-10 scale).

Course Performance Indicator	Average value measured on 2015-2016 (0-10 scale)	Related Student Outcome	Description of the indicator	Course Acronym[6]
PI_1	9.2	d. teams	grade on the oral exam (teamwork)	CELT
PI_2	8.5	b. experiments	grade on milestone 1 (measurements)	CELT
PI_3	9.2	g. communicate effectively	grade on the oral exam	CELT
PI_4	6.3	c. design	grade on the oral exam + grade on design of improvements	CELT
PI_5	6.6	e. engineering problems	grade on midterm exam P2 (problems)	TINF
PI_6	7.0	d. teams	grade on the final assignment (teamwork)	TDSÑ
PI_7	7.0	k. engineering practice	grade on the laboratory test	TDSÑ
PI_8	7.5	a. apply knowledge	grade on the 2nd midterm exam (applied knowledge)	STRA
PI_9	6.7	e. engineering problems	grade on midterm exam 1 and midterm exam 2 (problems)	STRA
PI_10	7.3	c. design	grade on assignment 3 (design)	RDOR
PI_11	8.0	e. engineering problems	grade on written exam (problems)	RDOR
PI_12	6.8	k. engineering practice	grade on the assignment 4 about configuration (laboratory practice)	RDOR
PI_13	7.4	a. apply knowledge	grade on personalized home assignments on computer networks (applied knowledge)	RDOR
PI_14	4.8	a. apply knowledge	grade on applied basic knowledge on midterm exam 1	RDPR
PI_15	5.9	e. engineering problems	grade from midterm exam 2 (problems)	RDPR
PI_16	9.7	c. design	grade on the web test about design assignment 2	RDPR
PI_17	6.4	h. impact of solutions	grade on the test	ORGE
PI_18	7.3	d. teams	grade on the practical case (teamwork)	ORGE
PI_19	7.3	g. communicate effectively	grade on oral presentation and written report	ORGE
PI_20	8.1	b. experiments	grade on the oral exam (laboratory practice)	COPT
PI_21	8.2	k. engineering practice	grade on the use of tools (laboratory practice)	COPT
PI_22	5.0	c. design	grade on midterm exam 2 (filter design)	COPT
PI_23	5.3	e. engineering problems	grade on written exam (problems)	ECOM

[6] Course names are listed on Appendix V

PI_24	6.6	k. engineering practice	grade on laboratory practice 1	ECOM
PI_25	8.0	k. engineering practice	grade on techniques and instrumentation (laboratory practice)	MICR
PI_26	6.0	a. apply knowledge	grade on midterm exam 1 (applied knowledge)	MICR
PI_27	6.9	g. communicate effectively	grade on the written report	RCOM
PI_28	7.8	d. teams	grade on the project (teamwork)	RCOM
PI_29	8.0	k. engineering practice	grade on simulation tools (laboratory practice)	RCOM
PI_30	7.8	k. engineering practice	grade on design tools and analysis of antennas (laboratory practice)	ANTE
PI_31	8.1	g. communicate effectively	grade on oral presentation and written report	ANTE
PI_32	6.1	e. engineering problems	grade on midterm exam 3 (problems)	ANTE
PI_33	8.5	d. teams	grade on the project (teamwork)	STEL
PI_34	8.4	b. experiments	grade on measurements and interpretation of results (laboratory practice)	CMOV
PI_35	8.9	d. teams	grade on laboratory practice 3 (teamwork)	CMOV
PI_36	6.2	e. engineering problems	grade on midterm exam 1 (problems)	RDET
PI_37	4.2	a. apply knowledge	grade on midterm exam 1 (applied knowledge)	RDET
PI_38	7.1	k. engineering practice	grade on SDN-switch configuration and SDN-CTRL (laboratory practice)	RECO
PI_39	7.0	e. engineering problems	grade on midterm exam 2 (problems)	RECO
PI_40	6.0	b. experiments	grade on traffic and MPLS (laboratory practice)	RECO
PI_41	9.2	b. experiments	grade on laboratory assignment 1	SEGU
PI_42	8.0	k. engineering practice	grade on laboratory assignment 2	SEGU
PI_43	8.0	d. teams	grade on report 2 (teamwork)	RCMO
PI_44	7.9	g. communicate effectively	grade on oral presentation	RCMO
PI_45	8.1	c. design	grade on design and implementation of an application (laboratory practice)	IWEB
PI_46	8.6	k. engineering practice	grade on the use of the Integrated Development Environment tool (laboratory practice)	IWEB
PI_47	7.2	a. apply knowledge	grade on web service access (laboratory practice)	IWEB
PI_48	7.0	a. apply knowledge	grade on midterm exam 1 (applied knowledge)	RSRD
PI_49	7.9	e. engineering problems	grade on problem test	RSRD
PI_50	7.1	h. impact of solutions	grade about social-economic aspects	DORE
PI_51	7.0	d. teams	grade on project presentation 1 (teamwork)	ISST
PI_52	7.5	c. design	grade on project design presentation 2	ISST
PI_53	8.0	d. teams	grade on CPU-GPU compilation and CPU-OpenMP compilation (laboratory practice)	ARQU
PI_54	7.8	k. engineering practice	grade on the simulation tool (laboratory practice)	ARQU
PI_55	6.3	k. engineering practice	grade on discussion of the simulation practice	SEAM
PI_56	8.2	a. apply knowledge	grade on the basic applied knowledge in midterm exam P1	SEAM

PI_57	6.7	g. communicate effectively	grade on written report	SEAM
PI_58	8.6	k. engineering practice	grade on virtual instrumentation (laboratory practice)	IELE
PI_59	8.2	b. experiments	grade on ElectroCardioGraphy (laboratory practice)	IELE
PI_60	6.0	b. experiments	grade on experimental modelling E1.3	SECO
PI_61	6.1	d. teams	grade on assignment E2.2 (teamwork)	SECO
PI_62	7.9	a. apply knowledge	grade on theoretical-analytical assignment E1.1	SECO
PI_63	7.2	e. engineering problems	grade on analysis and design of control systems E2.2 (problems)	SECO
PI_64	8.8	k. engineering practice	grade on laboratory practices	SCON
PI_65	8.6	h. impact of solutions	grade on the final product designed	ELCO
PI_66	8.3	g. communicate effectively	grade on oral presentation and written report	ELCO
PI_67	8.7	d. teams	grade on the final project (teamwork)	ELCO
PI_68	6.5	e. engineering problems	grade on the last exam (problems)	ISEL
PI_69	8.2	c. design	grade on the final project (design)	TDVA
PI_70	8.1	b. experiments	grade on voice measurements (laboratory practice)	TDVA
PI_71	7.2	a. apply knowledge	grade on home assignment (applied knowledge)	TDIV
PI_72	8.6	k. engineering practice	grade on Matlab (laboratory practice)	TDIV
PI_73	8.2	c. design	grade on design P3 (laboratory practice)	EQSA
PI_74	6.9	d. teams	grade on introduction to audio Practice 1 (teamwork)	EQSA
PI_75	4.7	e. engineering problems	grade on written exam (problems)	TV
PI_76	8.9	a. apply knowledge	grade on basic applied knowledge on midterm exam 2	DSRE
PI_77	9.0	b. experiments	grade on practice 1 (experimental laboratory practice)	DSRE
PI_78	8.0	d. teams	grade on audio and video recording laboratory practices (teamwork)	PROD
PI_79	7.4	k. engineering practice	grade on video editing (laboratory practice)	PROD
PI_80	8.1	b. experiments	grade on audio signal acquisition and processing (laboratory practice)	PROD
PI_81	7.8	g. communicate effectively	grade on written report	IGL1
PI_82	8.1	g. communicate effectively	grade on oral presentation	IGL2

This 0-10 scale, commonly used in Spain, can be linearly transformed in a 1-5 scale in order to allow the computation of an overall performance on each Student Outcome. In the 1-5 scale, 1 corresponds to very low performance and 5 to very high performance, being 3 an adequate performance.

0-10 scale	Equivalent score on a 1-5 scale
0	1
2.5	2
5.0	3
7.5	4
10.0	5

Grouping the indicators by the associated Student Outcome and mapping them into a 1-5 scale, these detailed course indicators can be summarized as:

Student Outcome	Average course indicators measured on 2015-2016 (1-5 scale)
a. apply knowledge	3.8
b. experiments	4.2
c. design	4.0
d. teams	4.1
e. engineering problems	3.6
g. communicate effectively	4.1
h. impact of solutions	3.9
k. engineering practice	4.1

I.2 Academic year 2016-2017

On current academic year (2016-2017), the available values measured on the first semester are:

Course Performance Indicator	Average value measured on 2016-2017 (0-10 scale)	Related Student Outcome	Description of the indicator	Course Acronym [7]
PI_1	8.5	d. teams	grade on the oral exam (teamwork)	CELT
PI_2	9.0	b. experiments	grade on milestone 1 (measurements)	CELT
PI_3	8.5	g. communicate effectively	grade on the oral exam	CELT
PI_4	7.7	c. design	grade on the oral exam + grade on design of improvements	CELT
PI_5	5.5	e. engineering problems	grade on midterm exam P2 (problems)	TINF
PI_6	7.1	d. teams	grade on the final assignment (teamwork)	TDSÑ
PI_7	7.4	k. engineering practice	grade on the laboratory test	TDSÑ
PI_8	5.0	a. apply knowledge	grade on the 2nd midterm exam (applied theory)	STRA
PI_9	5.8	e. engineering problems	grade on midterm exam 1 and midterm exam 2 (problems)	STRA
PI_10	6.8	c. design	grade on assignment 3 (design)	RDOR
PI_11	7.9	e. engineering problems	grade on written exam (problems)	RDOR
PI_12	7.1	k. engineering practice	grade on the assignment 4 about configuration (laboratory practice)	RDOR
PI_13	7.3	a. apply knowledge	grade on home assignments	RDOR

[7] Course names are included in Appendix V

PI_14	5.2	a. apply knowledge	grade on applied basic knowledge on midterm exam 1	RDPR
PI_15	6.5	e. engineering problems	grade from midterm exam 2 (problems)	RDPR
PI_16	9.1	c. design	grade on the web test about design assignment 2	RDPR
PI_25	7.1	k. engineering practice	grade on techniques and instrumentation (laboratory practice)	MICR
PI_26	6.4	a. apply knowledge	grade on midterm exam 1 (applied knowledge)	MICR
PI_28	8.1	d. teams	grade on the project (teamwork)	RCOM
PI_29	8.3	k. engineering practice	grade on simulation tools (laboratory practice)	RCOM
PI_30	7.2	k. engineering practice	grade on design tools and analysis of antennas (laboratory practice)	ANTE
PI_31	7.5	g. communicate effectively	grade on oral presentation and written report	ANTE
PI_32	5.4	e. engineering problems	grade on midterm exam 3 (problems)	ANTE
PI_33	6.7	d. teams	grade on the project (teamwork)	STEL
PI_36	5.3	e. engineering problems	grade on midterm exam 1 (problems)	RDET
PI_37	6.5	a. apply knowledge	grade on midterm exam 1 (basic applied knowledge)	RDET
PI_38	4.9	k. engineering practice	grade on SDN-switch configuration and SDN-CTRL (laboratory practice)	RECO
PI_39	5.6	e. engineering problems	grade on midterm exam 2 (problems)	RECO
PI_40	5.4	b. experiments	grade on traffic and MPLS (laboratory practice)	RECO
PI_41	8.1	b. experiments	grade on laboratory assignment 1	SEGU
PI_42	6.5	k. engineering practice	grade on laboratory assignment 2	SEGU
PI_43	7.7	d. teams	grade on report 2 (teamwork)	RCMO
PI_44	7.6	g. communicate effectively	grade on oral presentation	RCMO
PI_45	7.5	c. design	grade on design and implementation of an application (laboratory practice)	IWEB
PI_46	8.1	k. engineering practice	grade on the use of the Integrated Development Environment tool (laboratory practice)	IWEB
PI_47	6.7	a. apply knowledge	grade on web service access (laboratory practice)	IWEB
PI_48	6.8	a. apply knowledge	grade on midterm exam 1 (basic applied knowledge)	RSRD
PI_49	6.7	e. engineering problems	grade on problem test	RSRD
PI_53	8.1	d. teams	grade on CPU-GPU compilation and CPU-OpenMP compilation (laboratory practice)	ARQU
PI_54	8.6	k. engineering practice	grade on the simulation tool (laboratory practice)	ARQU
PI_55	5.1	k. engineering practice	grade on discussion of the simulation practice	SEAM
PI_56	8.2	a. apply knowledge	grade on the basic applied knowledge in midterm exam P1	SEAM
PI_57	6.4	g. communicate effectively	grade on written report	SEAM
PI_58	7.7	k. engineering practice	grade on virtual instrumentation (laboratory practice)	IELE
PI_59	7.9	b. experiments	grade on ElectroCardioGraphy (laboratory practice)	IELE
PI_69	7.8	c. design	grade on the final project (design)	TDVA
PI_70	7.9	b. experiments	grade on voice measurements (laboratory practice)	TDVA
PI_71	7.8	a. apply knowledge	grade on home assignment (applied basic knowledge)	TDIV
PI_72	5.9	k. engineering practice	grade on Matlab (laboratory practice)	TDIV

PI_73	8.5	c. design	grade on design P3 (laboratory practice)	EQSA
PI_74	6.5	d. teams	grade on introduction to audio Practice 1 (teamwork)	EQSA
PI_75	6.4	e. engineering problems	grade on written exam (problems)	TV
PI_81	8.5	g. communicate effectively	grade on written report	IGL1
PI_82	6.6	g. communicate effectively	grade on oral presentation	IGL2

Grouping the available Course Performance Indicators by their associated Student Outcome and mapping them into the rubric, these scores can be summarized as:

Student Outcome	**Average course indicators measured on 2016-2017 (1-5 scale)**
a. apply knowledge	3.7
b. experiments	4.1
c. design	4.1
d. teams	4.0
e. engineering problems	3.5
g. communicate effectively (orally, written)	4.0
k. engineering practice	3.8

APPENDIX II: Performance Indicators from Bachelor Theses

II.1 Academic year 2015-2016

The members of the grading committee of a Bachelor Thesis, in addition to assigning an overall mark to the student, score the student's work in 11 performance indicators (from q1 to q11) using a 1-5 scale[8]. This scoring is based on the written report written by the student, his oral presentation and the answers of the student to the questions from the members of the grading Committee:

B. Thesis Performance Indicator	Average value measured on 2015-2016 (1-5 scale)	ABET Student Outcome	Description of the indicator
q1	4.6	c. design	DEFINITION OF OBJECTIVES: Problem approach and specific objectives
q2	4.5	c. design	COMPLEXITY OF WORK: Difficulty of the problem
q3	4.5	c. design	EXPLORATION AND ANALYSIS OF SOLUTIONS: Search and analysis of existing solutions and technologies
q4	4.4	c. design	INNOVATION / CREATIVITY / ORIGINALITY: Proposed new solutions
q5	4.5	h. impact of solutions	RESULTS OBTAINED: Satisfaction of objectives and potential impact
q6	4.6	g. communicate effectively	WRITTEN REPORT STRUCTURE: Introduction, objectives, development, conclusions and bibliography
q7	4.5	g. communicate effectively	WRITTEN REPORT CONTENT: Clarity of writing, rigor in the use of technical language, correct references to the work of others
q8	4.6	g. communicate effectively	WRITTEN REPORT EDITION: Format of the text, tables, graphs and figures. Text free of spelling, syntactic and typographical errors
q9	4.7	g. communicate effectively	ORAL PRESENTATION STRUCTURE: Organization and extension of the presentation. Use of support resources
q10	4.6	g. communicate effectively	ORAL PRESENTATION: Quality of the oral presentation, highlighting the fundamental aspects. Correct use of verbal and non-verbal languages (fluency, tone, intonation, gestures, etc.)
q11	4.5	g. communicate effectively	ORAL PRESENTATION DISCUSSION (WITH THE GRADING COMMITTEE): Broad knowledge of the subject, clarity of the answers, rigor when arguing, etc.

These detailed B. Thesis Performance Indicators can be grouped (and averaged) in just 3 values (one per evaluated Student Outcome):

[8] As previously described, this scale goes from 1 (very low performance) to 5 (very high performance), being 3 an adequate performance

ABET Student Outcome	Average B. Thesis performance measured on 2015-2016 (1-5 scale)
c. design	4.5
g. communicate effectively	4.6
h. impact of solutions	4.5

II.2 Academic year 2016-2017

On current academic year, the available measured values are:

Performance Indicator	Average value measured on 2016-2016 (1-5 scale)	ABET Student Outcome	Description of the indicator
q1	4.5	c. design	DEFINITION OF OBJECTIVES: Problem approach and specific objectives
q2	4.6	c. design	COMPLEXITY OF WORK: Difficulty of the problem
q3	4.4	c. design	EXPLORATION AND ANALYSIS OF SOLUTIONS: Search and analysis of existing solutions and technologies
q4	4.3	c. design	INNOVATION / CREATIVITY / ORIGINALITY: Proposed new solutions
q5	4.4	h. impact of solutions	RESULTS OBTAINED: Satisfaction of objectives and potential impact
q6	4.5	g. communicate effectively	WRITTEN REPORT STRUCTURE: Introduction, objectives, development, conclusions and bibliography
q7	4.3	g. communicate effectively	WRITTEN REPORT CONTENT: Clarity of writing, rigor in the use of technical language, correct references to the work of others
q8	4.4	g. communicate effectively	WRITTEN REPORT EDITION: Format of the text, tables, graphs and figures. Text free of spelling, syntactic and typographical errors
q9	4.6	g. communicate effectively	ORAL PRESENTATION STRUCTURE: Organization and extension of the presentation. Use of support resources
q10	4.4	g. communicate effectively	ORAL PRESENTATION: Quality of the oral presentation, highlighting the fundamental aspects. Correct use of verbal and non-verbal languages (fluency, tone, intonation, gestures, etc.)
q11	4.5	g. communicate effectively	ORAL PRESENTATION DISCUSSION (WITH THE GRADING COMMITTEE): Broad knowledge of the subject, clarity of the answers, rigor when arguing, etc.

After grouping these detailed B. Thesis Performance Indicators in just 3 values (one per associated Student Outcome), the results are:

ABET Student Outcome	Average B. Thesis indicators measured on 2016-2017 (1-5 scale)
c. design	4.4
g. communicate effectively	4.4
h. impact of solutions	4.4

APPENDIX III: Performance Indicators from student internships in companies

III.1 Academic year 2015-2016

The professional supervisors of the internships score up to 31 indicators[9] of the performance of the student interns, in order to allow them to get the corresponding curricular credit hour recognition from an academic supervisor. A reduced set of 14 indicators (directly related to the Student Outcomes) was selected:

Internship Performance Indicator	Average value measured on 2015-2016 (1-5 scale)	ABET Student Outcome	Indicator description
P25	4.5	d. teams	P25 Responsive to criticism
P15	4.6	d. teams	P15 Ease of relationship and communication with co-workers
P12	4.5	d. teams	P12 Ease of teamwork
P6	4.1	e. engineering problems	P6 Ability to analyze problems
P9	4.2	e. engineering problems	P9 Work planning capacity
P7	4.2	e. engineering problems	P7 Ability to apply appropriate skills in problem solving
P1	4.7	f. professional responsibility	P1 Acceptance of assigned tasks
P25	4.5	f. professional responsibility	P25 Responsive to criticism
P13	4.5	f. professional responsibility	P13 Constancy at work
P16	4.6	f. professional responsibility	P16 Respect / adaptation to the rules of the company
P26	4.7	f. professional responsibility	P26 Punctuality
P14	4.2	g. communicate effectively	P14 Easy of exhibition of points of view
P19	4.5	g. communicate effectively	P19 Oral communication skills
P18	4.6	i. lifelong learning	P18 Learning ability

[9] As previously described, the scale goes from 1 (very low performance) to 5 (very high performance), being 3 an adequate performance

These detailed Internship Performance Indicators were grouped and averaged in just 5 values (one per evaluated Student Outcome):

ABET Student Outcome	Average internship indicators measured on 2015-2016 (1-5 scale)
d. teams	4.5
e. engineering problems	4.2
f. professional responsibility	4.6
g. communicate effectively	4.1
i. lifelong learning	4.5

III.2 Academic year 2016-2017

On current academic year, the measured values are:

Internship Performance Indicator	Average value measured on 2016-2017 (1-5 scale)	ABET Student Outcome	Indicator description
P25	4.5	d. teams	P25 Responsive to criticism
P15	4.5	d. teams	P15 Ease of relationship and communication with co-workers
P12	4.5	d. teams	P12 Ease of teamwork
P6	4.1	e. engineering problems	P6 Ability to analyze problems
P9	4.2	e. engineering problems	P9 Work planning capacity
P7	4.1	e. engineering problems	P7 Ability to apply appropriate skills in problem solving
P1	4.7	f. professional responsibility	P1 Acceptance of assigned tasks
P25	4.5	f. professional responsibility	P25 Responsive to criticism
P13	4.5	f. professional responsibility	P13 Constancy at work
P16	4.6	f. professional responsibility	P16 Respect / adaptation to the rules of the company
P26	4.7	f. professional responsibility	P26 Punctuality
P14	4.2	g. communicate effectively	P14 Easy of exhibition of points of view
P19	4.4	g. communicate effectively	P19 Oral communication skills
P18	4.6	i. lifelong learning	P18 Learning ability

These detailed Internship Performance Indicators were grouped and averaged in just 5 values (one per evaluated Student Outcome):

ABET Student Outcome	Average internship indicators measured on 2016-2017 (1-5 scale)
d. teams	4.5
e. engineering problems	4.1
f. professional responsibility	4.6
g. communicate effectively	4.3
i. lifelong learning	4.6

APPENDIX IV: Performance Indicators from Bachelor Thesis supervisors

IV.1 Academic year 2016-2017

This are the new 31 indicators from the Bachelor Thesis Supervisors collected in the academic year 2016-2017[10] for the first time. As there are two main periods (one in January and another one in July) for the defense and grading of the theses, the data is collected after each of these periods[11].

ABET Student Outcome	New B. Thesis Performance Indicator	Description of the indicator	Average value measured on 2016-2017 (1-5 scale)
a. apply knowledge	A1	The graduate is able to use the formulas, parameters, functions ... of mathematics, science or engineering related to Telecommunication Engineering	4.2
a. apply knowledge	A2	The graduate is able to apply principles of mathematics, science or engineering related to Telecommunication Engineering	4.3
a. apply knowledge	A3	The graduate is able to analyze the coherence of the results of the application of math, science or engineering related to the Engineering of Telecommunication	4.1
b. experiments	B1	The graduate is able to follow an experimental protocol using the available measuring equipment or means	4.1
b. experiments	B2	The graduate is able to analyze and represent the measured data	4.0
b. experiments	B3	The graduate able to interpret the results and draw conclusions	4.0
c. design	C1	The graduate is able to define the objectives and requirements of a system, component or process	4.2
c. design	C2	The graduate is able to explore and analyze existing solutions and technologies, taking into account realistic constraints	4.4
c. design	C3	The graduate is able to propose new solutions and design a system, component or process	4.0
d. teams	D1	The graduate is able to actively participate in working group meetings, being receptive to criticism	4.6
d. teams	D2	The graduate is able to relate and communicate with teammates	4.4
d. teams	D3	The graduate is able to contribute to the development of work within the team	4.5

[10] As previously described, the scale goes from 1 (very low performance) to 5 (very high performance), being 3 an adequate performance
[11] When writing this report, only data from the January period was available

e. engineering problems	E1	The graduate is able to analyze a problem, identifying the relevant parameters	4.3
e. engineering problems	E2	The graduate is able to establish and plan a process or method of solving the problem	4.1
e. engineering problems	E3	The graduate is able to solve the problem by applying the method or process established in an organized way	4.3
e. engineering problems	E4	The graduate is able to evaluate the results obtained	4.2
f. professional responsibility	F1	The graduate demonstrates knowledge of the responsibility professionalism of an engineer (respect and adaptation to norms and regulations, punctuality, diligence ...)	4.7
f. professional responsibility	F2	The graduate knows the ethical codes related to plagiarism and the recognition of the work of others (quotations and references)	4.5
g. communicate effectively	G1	The graduate organizes and structures information in oral and written communications	4.2
g. communicate effectively	G2	The graduate writes clearly and is rigorous in the language, in the references and in the edition	3.9
g. communicate effectively	G3	The graduate presents his work with quality and correctness	4.2
g. communicate effectively	G4	The graduate it is clear when answering and rigorous when arguing, speaking or debating on its work	4.0
h. impact of solutions	H1	The graduate identifies the potential impact of an engineering solution in a global, economic, environmental and social context	4.0
h. impact of solutions	H2	The graduate assesses the potential impact of engineering solutions in global, economic, environmental and social context	3.9
i. lifelong learning	I1	The graduate recognizes the need for lifelong learning	4.7
i. lifelong learning	I2	The graduate is able to carry out lifelong learning throughout life	4.6
j. contemporary issues	J1	The graduate identifies contemporary issues related to Telecommunication Engineering	3.8
j. contemporary issues	J2	The graduate is up to date with the latest developments related to Telecommunication Engineering	3.7
k. engineering practice	K1	The graduate uses techniques suitable for the practice of engineering	4.3
k. engineering practice	K2	The graduate has adequate skills for the practice of engineering.	4.4
k. engineering practice	K3	The graduate uses tools and equipment suitable for the practice of engineering (design, simulation, validation ...)	4.4

These new B. Thesis Performance Indicators (from A1 to K3) were grouped in just 11 values (one per evaluated Student Outcome), and were averaged:

ABET Student Outcome	Average new B. Thesis indicators measured on 2016-2017 (1-5 scale)
a. apply knowledge	4.2
b. experiments	4.0
c. design	4.2
d. teams	4.5
e. engineering problems	4.2
f. professional responsibility	4.6
g. communicate effectively	4.1
h. impact of solutions	4.0
i. lifelong learning	4.6
j. contemporary issues	3.8
k. engineering practice	4.4

APPENDIX V: Names and acronyms of the referenced courses

Course acronym	Course Name
ANTE	ANTENNAS
ARQU	PROCESSOR ARCHITECTURE
CELT	ELECTRONIC CIRCUITS
CMOV	MOBILE COMMUNICATIONS
COPT	OPTICAL COMMUNICATIONS
DORE	NETWORK DIMENSIONING & OPERATION
DSRE	BROADCASTING AND NETWORK SERVICES
ECOM	COMMUNICATIONS ELECTRONICS
ELCO	CONSUMER ELECTRONICS
EQSA	AUDIOVISUAL EQUIPMENT AND SYSTEMS
IELE	ELECTRONIC INSTRUMENTATION
IGL1	ENGLISH FOR ACADEMIC AND PROFESSIONAL COMMUNICATION 1. READING AND WRITING SKILLS
IGL2	ENGLISH FOR ACADEMIC AND PROFESSIONAL COMMUNICATION 2. LISTENING AND SPEAKING SKILLS
ISEL	ELECTRONIC SYSTEMS ENGINEERING
ISST	TELEMATIC SYSTEMS AND SERVICE ENGINEERING
IWEB	WEB ENGINEERING
MICR	MICROWAVE ENGINEERING
ORGE	BUSINESS ADMINISTRATION
PROD	MULTIMEDIA PRODUCTION
RCMO	MOBILE COMMUNICATION NETWORKS
RCOM	RADIOCOMMUNICATIONS
RDET	RADIODETERMINATION SYSTEMS
RDOR	COMPUTER NETWORKS
RDPR	RADIATION AND WAVE PROPAGATION
RECO	CORPORATE NETWORKS
RSRD	RADIO NETWORKS AND SERVICES
SCON	CONNECTIVITY TECHNOLOGIES
SEAM	ANALOG AND MIXED ELECTRONIC SYSTEMS
SECO	ELECTRONIC CONTROL SYSTEMS
SEGU	SECURITY IN TELECOMMUNICATION NETWORKS AND SYSTEMS
STEL	TELECOMMUNICATION SYSTEMS
STRA	TRANSMISSION SYSTEMS
TDIV	DIGITAL IMAGE AND VIDEO PROCESSING
TDSÑ	DIGITAL SIGNAL PROCESSING
TDVA	SPEECH AND AUDIO SIGNAL PROCESSING
TINF	INFORMATION THEORY
TV	TELEVISION

APPENDIX VI: Main Quality Assurance processes

VI.1 Process PR/ES/003: data assessment

The agents participating in this process are: Course Coordinators, Heads of Department, Semester Committees, the Program Coordinator, the Academic Coordination Committee (COA) and the School Board of the ETSIT.

Course Coordinators generate the Course Reports (which must be approved by the Heads of the Department and by the Program Coordinator) and **collect data for assessment**. Based on these Course Reports and collected data, the Semester Committees (including the Course Coordinators of that semester and the Program Coordinator) meet and generate the Semester Reports. Each Course Report and its corresponding Semester Report are inputs for the Course Coordinator to create the Course Learning Guides of the following academic year (which must be also approved by the Heads of Department and by the Program Coordinator). Finally, the Program Coordinator generates the yearly Program Report, which is improved and approved by the Academic Coordination Committee and the School Board.

Data collected through this process are used for the evaluation at course level[12] and for **data assessment** for Criterion 4 (as described below), and specific actions for course-level improvement are defined in the Course Reports, the Semester Reports and implemented through Course Coordination Meetings and the Course Learning Guides.

VI.2 Process PR/ES/001: data evaluation

Process PR/ES/001 periodically evaluates and continuously improves the programs, specifically the Telecommunication Technologies and Services Engineering, B. Eng. Program, according to ABET Criterion 4.

This evaluation helps **interpret the performance indicators** acquired through the assessment process in order to determine how well the ABET Student Outcomes of the program are being attained. If necessary, some **improvement actions** can be designed and implemented, closing the loop by re-assessing and evaluating the program again.

[12] This course-level evaluation scheme is necessary for the mandatory periodic accreditation of the program in Spain.

The agents involved in this process (**Outcomes Evaluation Committee,** hereafter referred as OEC) are also members of the Quality Commission and the School Governing Team: the Program Coordinator, the Vice-Dean for Quality and Accreditation, the Vice-Dean "Head of Studies" and the Dean of ETSIT. These agents analyze the results of the performance table and approve continuous improvement actions.