The POLITO-Q.A. FRAMEWORK : a possible genetic modification of internal Quality Assurance?

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Abstract

The **QUALITY ASSURANCE FRAMEWORK** developed at Politecnico di Torino (**POLITO**) is a tool for internal Quality Assurance (iQA) and Assessment of Engineering Education.

It was developed aiming at a tool fully compatible with ENQA S&G requirements and, in general, the European trends toward iQA "for enhancement" of Programmes.

Development was guided by the idea that iQA ought to build a frame of clear statements (i.e. demands to HEI's) where creativity and innovation can, at any time, be accommodated easily and freely .. together with academic and scholarly experience. That in no way neither creativity is hampered nor innovation is hindered by iQA.

Moreover, it was never felt that there is a "bureaucracy" problem or risk… rather there may be a problem of "ownership" for iQA.

So, the problem for setting a frame for iQA documentation and actions was:

- to decide "which" are the main /few) point QA should address with priority
- to decide "how" to address them.

The **POLITO-Q.A. FRAMEWORK** deploys appropriate evidence around the following set of core principles:

- the Programme must be clearly designed around functions to be covered by the degree holder in a working context and around the related competencies
- the Programme must be clearly deployed with appropriate Learning Outcomes, which are in agreement (content, amount, level) with the target functions / competencies
  the Programme appropriately certifies that Learning Outcomes have been reached, the exams have a certifying value.

Of course, it contains also a section of objective monitoring data and a section of procedures and responsibilities aimed at ensuring that students' learning is well supported and at obtaining information on how well the methods for achieving quality are known and practised by staff.

The **POLITO-Q.A. FRAMEWORK** is a ICT based tool, and is structured in a modular manner designed for usage in a web medium (screen Tables and formats).

A genetic modification leaves the organism basically the same, but it enhances certain functions and suppresses others. In our case, the **POLITO-Q.A. FRAMEWORK :**

1. stresses to a maximum the fact that a worthy Programme is the one which guarantees a match between external requirements (functions / competencies) and academic requirements (proven learning outcomes)

⇒ *response to external educational demands … what should the student know, why should the student know that*

2. uses the same set of documents, presented exclusively on-line, to inform the public, the internal and the external QA assessors, making it an instrument first for communication, then for transparency and control
   ⇒ *clear and simple though rigorous language … easier to check whether expectations are understood and satisfied*
   ⇒ *designed to be maintained on an ongoing basis rather than as a periodic reporting structure*
   ⇒ *hypertext links to all necessary references, including the academic system of monitoring data*
   ⇒ *links Q.A. with the institutional strategies*

3. it suppresses the need of the self evaluation report, which is substituted by a collection of annual **Q.A. FRAMEWORKS** and related **REVIEW REPORTS**
   ⇒ *systematic, continuously adjourned yet sustainable, dynamic, reliable*
   ⇒ *eliminate useless paperwork*

4. it is at the same time a Programme design & review tool
   ⇒ *ownership*
   and a documented checklist for Programme evaluation & accreditation
   ⇒ *minimal redundancy*

Even though this paper relates about developments at Politecnico di Torino, it is worth saying that the same Q.A. FRAMEWORK has been tested, with minor variations, in the international projects TREE [6] and ALFA-Mirror [7]. Moreover, it is now under early test within the AirQual Tempus IV project [10].

1 - The context

In Italy, the national university system has been reformed in 1999 to be compliant with the Bologna process. A further reform has been issued in 2004, and a last one is currently on the way, setting new modifications of the academic regulations with some impact on Programme organization. Each university has to re-organize its academic offer according to the new rules defined by the shortly called "Ministerial Decree 270" [1].

The implementation of this Decree was accompanied through 2008 by a complex set of measures aimed at reducing the number of Programmes on offer in the Italian University system - effectively overgrown during the last decade – and at forcing individual universities to obey stricter requirements in four areas [2]:

a) the **transparency requirements** i.e. rules for correct and complete communication of features of Programmes to students and all interested parties – later specified [3]
b) the **requirements for quality assurance** of educational processes
c) the **requirements for faculty qualifications and for infrastructural facilities**, which must be available to the Programme, in relation to the scientific / learning areas involved
d) the **dimensional requirements**, i.e. the maximum and minimum number of students that each Programme can effectively sustain.

At the same time, the Ministry of University and Scientific Research (MIUR) issued a new online form named "**RAD-OFF**" which each Programme should fill and submit, at national level, to the approval of CUN (National University Committee; an elective regulatory body reporting to the Ministry) and, locally, to the University Evaluation Board. It is apparent that this **RAD-OFF** form, although not yet fully in line with the complete set of Quality Assurance and ENQA requirements is well in that line, by incorporating several of the necessary features. All Programmes of Italian Universities are to adapt to the new ministerial requirements at the latest by the Academic Year 2010/11.

At Politecnico di Torino, this was considered an opportunity to reorganize curricula following internal Quality Assurance (**iQA**) principles before starting work to fill the new forms. In fact it was recognised that if Politecnico had in place a well organised and systematic documentation of Programmes as dictated by **iQA** requirements, this would automatically allow fulfilment of new Ministerial rules while at the same time putting Politecnico on the European scene.

Therefore the Rector and the Senate decided that the establishment of a comprehensive **iQA** was a necessary preliminary step.

The following schedule was adopted in preparation for the December 15 2009 deadline, when the 2001/11 **RAD-OFF** forms for all Programmes should be ready on the Ministerial site:

- March 2008: Senate decree towards Quality Assurance management of all Programmes at **POLITO**
- June 2008: preparation of the **Q.A. FRAMEWORK** at the care of the Vice-Rector for Quality Evaluation and Accreditation (this author)
- September 2008: selection of the 8 representative test Programmes at the care of the six Deans, appointment of two reference faculty each

- October 2008: start of periodic discussion and development meetings; gradual implementation of the **Q.A. FRAMEWORK** on a purposely developed website;
  at this stage the working group included, besides the appointed faculty, key actors from the University administration and technical bodies (mainly IPSI /process and information system integration/ and GESD /student management /);
  this allowed to coordinate all the necessary services around the common project involving the whole institution; at the same time several problems were solved concerning interfacing of data and information with the Ministerial forms; the final outcome was a unique set of input windows where the different responsible were to introduce the required piece of information, it being designed in such a way that data and descriptive texts would migrate (almost) automatically – at the care of technical services – and edited in the necessary formats;
  in this way, for instance, the **RAD-OFF** forms have become an automatic by-product of the **Q.A. FRAMEWORK** tables.
- June 2009: end of the implementation of the **Q.A. FRAMEWORK** tables for the 8 test Programmes[1], availability of format and contents on the **POLITO** website (now under password until full deployment); the 8 test Programmes are to be used as exemplary case histories to illustrate a variety of possible implementations of the **Q.A. FRAMEWORK**
- July 2009: start of training all Programmes, meeting with Programme representatives of the largest Faculty (1st Engineering Faculty)
- September 2009 (start): programmed handover to all other **POLITO** Programmes; a permanent technical support and advice group is established as a service to all Programmes.

A so tight schedule was made possible by three main factors:

1. the **Q.A. FRAMEWORK** comes from the gradual development of ideas first set in Ministerial pilot document dating back to 2003/04 [4], later expanded and shared by a working group of the CRUI (Standing Conference of Italian Rectors) in 2006/07 [5] followed in 2008 by a more operational working group sponsored by CRUI and CINECA-KION (a society providing information & data services to the Ministry of University)– these later results yet unpublished
2. the Vice-Rector for Quality of **POLITO** is active in Italy and abroad as expert in Quality Assurance of education and as evaluator; ideas pertaining to the **Q.A. FRAMEWORK** presented in this paper were tested first on seven bachelor engineering Programmes (3 in Italy, 1 in Austria, Ireland, Romania, Turkey) in the frame of the 2005/07 Project TREE [6] and on eighteen in Europe and South America (3 in Chile Mexico and Brasil, 2 in Argentina, 1 in Colombia, Costa Rica, Germany, Italy, Peru, Portugal, Spain) in the frame of the 2007/09 ALFA-Mirror Project [7].
3. **POLITO** has a long expertise in pilot projects on **iQA**: participation to two CRUI national projects: Campus (1995-2000) and CampusOne (2002-2004), participation to Programme Accreditations by the Regional Government (2004-2009); moreover the model [4] had already been tested in a small number but of otherwise significant

[1] Aerospace Engineering, Architectural Engineering, Automotive Engineering, Business Organization Engineering, Electronic and Computer Engineering, Electronics Engineering, Industrial Design, Territorial, Urban Environmental and Landscape Planning

universities (Bologna, Ferrara, Roma la Sapienza, **POLITO**) from 2005 on, totalling about 250 Programmes.

It is apparent that a quite significant amount of on-the-field experience was already gathered at the onset of **POLITO** initiative. Ideas have evolved little by little during the application of the **Q.A. FRAMEWORK** to such a variety of cases, going in the direction of reduction rather than addition, i.e. keeping only those factors which are essential and strictly necessary to give a clear and concise picture of the educational Programme on offer for comparison and recognition purposes.

2 - The structure of the POLITO-Q.A. FRAMEWORK

The **POLITO-Q.A. FRAMEWORK** is a communication prospectus which describes an engineering Programme to all those interested.

It is designed to be maintained on an ongoing basis rather than as a periodic reporting structure.

A design attribute for this **Q.A. FRAMEWORK** is that the information must be easily accessible, requiring no expert knowledge, and modular design. The information is not presented in a sequential manner, rather information is contained in individual blocks where stakeholders can obtain specific information; it is organised as follows:

Area	**On screen Table or format**	**Ref. ENQA [8] standards**
Area A - Requisites and objectives	A1 - Educational objectives of the ministerial Class (*general objectives of this class of Programmes*) A2 - Consultation with the organizations of entrepreneurial world, services, professions A3 – Target professional roles and competencies (*Programme specific educational objectives*)	1.2 Approval, monitoring & periodic review of Programmes and Awards
Area B – Degree Course Programme	B1 - Entry qualifications B2 - Expected learning outcomes B3 – Further details of educational activities B4 - Academic calendar, classroom schedule and examination dates	1.2 Approval, monitoring & periodic review of Programmes and Awards 1.3 Assessment of students
Area C – Human resources, Premises and Equipment	C1 - Teaching staff C2 - Premises and equipment C3 - Student services C4 - Special initiatives	1.4 Quality assurance of teaching staff 1.5 Learning resources & student support
Area D – Student Career Monitoring	D1 - Student intake, progression and exit data D2 - Effectiveness of educational activities according to the students D3 - Time to job and job satisfaction	1.6 Information systems 1.7 Public information
Area E - Organisation and Management	E1 - Policy for Quality Assurance E2 - Organizational structure E3 - Review	1.1 Policy & procedures for quality assurance 1.7 Public information

Structure of the **POLITO-Q.A. FRAMEWORK**

Experience proves that the most challenging part of the work for faculty regards Tables A2, A3, B2. This is where the internal academic practice (Learning Outcomes and their assessment, Table B2) is matched with the final qualifications (roles / competencies, Table A3) of the graduates as required by the professional field (consulted as described in Table A2).

This paper dwells in detail on Tables A2, A3, B2 only.

Table A2 shows the relationships between the university and the external organizations interested into the results of the educational program. All types of interaction must be described and properly documented: formal meetings with official organizations, reports from internships, informal exchange of opinions, data coming from common activities or projects. The information may include also Studies and Reports from international or national bodies and professional associations.

The screen format of Table A2 goes as in the example of Fig. 1.

Note that the last column "documents on record" shows hypertext links to all documents proving the scope and extent of consultations.

Table A3 is meant to prove that Programme is clearly designed around external Requisites (professional roles / functions) and related Competencies which are in agreement with the needs of the employers and the labour market; moreover, that such relations should be present already at the design phase, and not only (as it often happens) at the moment of the Stage or of the final project.

The screen format of Table A3 goes as in the example of Fig. 2, truncated at two roles (the expected standard is three to six roles):

Table B2 is meant to force the Programme to precisely define those Learning Outcomes which on one side match the envisaged Roles / Competences, on the other specify the type of knowledge and skills that will be fostered and assessed by (appropriate) course-by-course examinations and final project.

The screen format of Table B2 goes as in the example of Fig. 3, limited to two over four Areas of Learning.

It may be interesting to have a look at other possible solutions (Fig. 4 and 5, from ALFA-Mirror [7]).

Learning Outcomes are described using the Dublin Descriptors, which divided in two subsets, respectively:

- hard skills (knowledge and understanding; applying knowledge and understanding i.e. skills and know-how)
- soft skills (making judgments; communications skills; learning skills).

Hard skills Descriptors are used inside each Area of Learning, while soft skills Descriptors are considered transversal to the whole Programme and described separately and once only.

During the development work it was found that an introductory section was absolutely fundamental as a guide to readers. Therefore, a "Presentation" Section was introduced, in the form of a commented index with introductory information which should be accessed before reading the detail Tables and attached documentation.

A filled version of this Presentation is partially shown in Fig. 6.

3 - Challenges and threats

Quality assurance. To many, outside the enlightened circles, it evokes horrid spectres of bureaucracy, empty talk, useless paperwork, intolerable burdens. Who wants it?

On the contrary Quality Assurance may be just reasonable. Let then me quote Karl Dittrich [9], president of the NVAO:

> *Systems do not have to be bureaucratic and in my years of experience with accreditations I have seen gems of internal quality assurance systems that were 'owned' by the teaching staff! This is one of the reasons why thinking about internal quality assurance systems is so interesting: the questions that are asked are also a new source of inspiration for teaching staff:*
> - *What do I intend to achieve with this course?*
> - *Which information do I need from the professional field in order to define the required final qualifications of the graduates?*
> - *Do I have the right lecturers?*
> - *Which demands do I make on students?*
> - *Which facilities (classrooms, library, ICT, laboratories) do I need?*
> - *Which didactic system do I intend to apply and why?*
> - *Which form of accreditation would be suitable to assess this system?*
> - *How do I check whether graduates have reached the required level and possess the required qualifications?*

The challenge is the acceptance of all this by faculty and staff. In order to gain it, the great effort required at the start must be felt as something useful, meaningful and proportionate to the stated aims.

The **POLITO-Q.A. FRAMEWORK** is designed to explicitly stress the same points put forward by Karl Dittrich, i.e., the **POLITO-Q.A. FRAMEWORK** deploys appropriate evidence around the following set of core principles:

- the Programme must be clearly designed around functions to be covered by the degree holder in a working context and around the related competencies (stressed by Tables A2, A3)
- the Programme must be clearly deployed with appropriate Learning Outcomes, which are in agreement (content, amount, level) with the target functions / competencies (stressed by Table B2)
- the Programme appropriately certifies that Learning Outcomes have been reached by the students, which implies that the exams must be designed to have a proven certifying value.

Student assessment deserves a particular attention. It is very well known that the examination technique will influence the way students learn more than the way the teacher and the way his/her lectures are organised. Moreover, it would be absolutely useless to spend a great effort in precisely defining worthwhile learning outcomes (through Table A3) and knowledge / skill to be transmitted to this end (through Table B2) and then just miss the target simply by careless or non-professional student assessment.

This consideration explains why student assessment ranks so high, at point n. 3 of the ENQA Standards for internal Quality Assurance.

It is also quite clear that response of students to assessment is an important feedback on the effectiveness of the design and implementation of the Programme; quoting from ENQA

S&G :" *Assessment also provides valuable information for institutions about the effectiveness of teaching and learners' support*".

Experience says that the precise definition of Learning Outcomes is absolutely necessary to an evaluator who has to assess a Programme; this must done at general design level by the statements contained in the centre column of Table B2, and at the level of each teaching module (course) by the course descriptions which are recalled through their hypertext links in the right column. This is where also student assessment details must be provided.

Availability of such information is a fundamental pre-requisite to a successful evaluation. It is an unfortunate and not rare experience that self evaluation reports tend to dwell more on ancillary evidence than on precise Learning Outcomes. The **POLITO-Q.A. FRAMEWORK** is designed to discourage this behaviour.

The first, and greatest, threat is compliance to the form but betrayal of the principle. This may happen when Learning Outcomes are a list of chapters to study, rather than knowledge and skills that the learner has to develop, when the quest for roles and competencies at work is just cosmetic, when preservation of teachers' expansion needs is the main driving factor, when the student assessment is considered a private business between the teacher and his/her students.

However there is a second and fatal possible threat. The fact that the Government, a new Agency or individual Universities may judge this type of approach to **iQA** "too costly and highly bureaucratic". In the face of this there may be a very high temptation to:

- (too costly) forget about design declarations (roles, competencies, learning outcomes, student assessment), reduce the whole game to some so-called "objective output indicator" of a statistical nature – and thus adopt a purely ex-post "statistical outcome" approach (*many believe that this is more "objective" thus reliable, but forget that it deprives the Programme of all means to compare stated objectives with the result of co-operative individual behaviours and, then, to effectively and timely "steer" the Programme*)
- (highly bureaucratic) refuse of to fill huge expensive and quite ineffective documents, written by specialists for specialists, incapable of modifying the behaviour of the individual instructor by one inch (unfortunately, examples of this type are not rare, not to the benefit of effective quality assurance).

The pressure of these threats was felt during development of the **POLITO-Q.A. FRAMEWORK.** In order to overcome them all efforts were made to produce one integrated document for all uses, satisfying multiple conditions:

- duly consider that internal Quality Assurance, external evaluation and accreditation are very time consuming processes, and may easily generate fatigue and rejection; therefore capture the critical information which is required by stakeholders such as employers, the labour market, students, educational policy makers, educational establishments but collect only those details which are strictly necessary
- be a design tool posing the right questions to be answered when a Programme is designed
- be a communication protocol, which should allow efficient exposure of the Requisites around which the Programme is designed and of the means through which it is delivered

- be at the same time a checklist for programme evaluation, a guideline for the implementation of internal Quality Assurance, a tool for any internal review (audit)
- marshal the essential information that provides the basis for regarding a Programme as "assessable for accreditation purposes"
- be structured in a modular manner, making it possible to be effectively used in a web medium, therefore allowing access by the public at large (clear student and family information) while providing hypertext links to supporting documents, making it a real instrument for transparency and control on the specialist's side
- use a format of the Tables that facilitates comparability between Programmes and is effective in allowing an appropriate evaluation of the Programme by third parties: the information is not presented in a sequential manner, rather is contained in individual "parallel" modules where stakeholders can obtain specific information
- be integrated with an annual Review Report; their combination will suppress the need of the self evaluation report, which is substituted by a collection of annual **Q.A. FRAMEWORKS** and related **REVIEW REPORTS**; i.e., allow maintenance on an ongoing basis rather than as a periodic or as a on-demand reporting structure.

4 - Conclusions open to discussion and questions

The **POLITO-Q.A. FRAMEWORK** is the result of a long developmental work done at Politecnico di Torino but experimented also in an international (projects TREE, ALFA-Mirror and national (Regional Accreditation) context. Similar ideas were thoroughly discussed and partly shared in the years 2005/2008 with the universities of Bologna, Ferrara, Roma la Sapienza where similar approaches are on the way.

We claim that the tool developed at **POLITO** satisfies the essential requirements for content and form so that degree Programmes of the same or similar type offered by different institutions can be readily and efficiently compared.

It was suggested in the title of this paper that the **POLITO-Q.A. FRAMEWORK**, although strictly complying with ENQA Standards and Guidelines, contains the seeds of a genetic modification of internal Quality Assurance in the way documents are written and used.

Four main questions are here submitted to the attention of the audience.

1. *Do we agree that a **Q.A. FRAMEWORK** should stress to a maximum the fact that a worthy Programme is the one which guarantees a match between external requirements (functions / competencies) and academic requirements (proven learning outcomes)?*

The **POLITO-Q.A. FRAMEWORK** enhances this point to a maximum, and is meant to force Academic Institutions to precisely define the triad: a) Learning Outcomes which on one side match b) the envisaged Roles / Competences, on the other specify the type of knowledge and skills that will be fostered and assessed by c) appropriate examinations. We should agree that if this triad is not satisfied, no other Quality Assurance aspect (organisation, infrastructure, …) nor even a good reputation can compensate for this deficiency. And that the required documentation should reflect this in full.

2. *Do we agree that it is a winning idea to use the same set of documents, presented exclusively on-line, to inform the public, the internal and the external QA assessors, making it an instrument first for communication, then for transparency and control and finally for evaluation / accreditation?*

Experience at **POLITO** shows that there is reluctance to eliminate the traditional means of communication to the public in favour of the **Q.A. FRAMEWORK**, even is this is fully up to the task. So, a duplication for some time will have to be tolerated.

However, one first battle was won. During the developmental work it became apparent that it is a strategic advantage to have one-only input window for all types of raw data and descriptive information (e.g. intake and progression statistics, learning outcomes, available infrastructure, … …) which could later migrate to different documents (the already mentioned **RAD-OFF** Ministerial Forms required by Italian law, the Diploma Supplement, the online information to students / stakeholders / auditors / evaluators …).

3. *Do we agree that a collection of annual **Q.A. FRAMEWORKS** and related **REVIEW REPORTS** can suppress the need of the traditional self evaluation report?*

The **POLITO-Q.A. FRAMEWORK** is based on the idea that **iQA** documentation should not be the object of periodic or on-demand reports, but it should rather reflect everyday's working conditions of the Programme; it should then maintained on an ongoing basis.

It should be stressed that the presence of a **Q.A. FRAMEWORKS** & **REVIEW REPORTS** for each Programme may be the crucial step towards a meaningful "process accreditation" at School level, which then, and only then, might dwell on general processes with random checks on a small percent of Programmes. However, implementation of the whole tool for each of the Programmes is a necessary first step.

4. *Is it convenient to have a tool that it is at the same time a Programme design & review tool and a documented checklist for Programme evaluation & accreditation?*

In the case of external evaluation (Regional Accreditation experience), assessors are provided with a special password which allows them to access not only the public document, but also all the uploaded supporting documents retrievable with a click of the mouse. A short evaluators' visit if opportune just to check that **iQA** is effectively at work in all its aspects, and not just paperwork. Experience says that the external assessor has a much easier life and can do a better job. Moreover it is guaranteed that whatever is seen by the learners and by the instructors is also seen by the assessor.

A final word.

It is all too evident that on-line management of information necessary to **iQA** may open the way to on-line coaching of faculty and staff appointed for the development of a new Programme. It is also clear that online availability of best practices, may be assisted by experts, can boost the quality of produced documents just by an imitation process. Universities, or other organisations, may like to consider this type of service a useful development. Another possible genetic modification.

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Figures

Academic body or person representing the institution	External stakeholders	Type and frequency of interactions	Documents on record
Local Steering Committee	Representative of ICT firms and trade unions	2 meetings every year	Minutes of the meetings: - CLI_2002_06_20 - CLI_2003_07_08 - CLI_2004_06_09 - CLI_2005_06_27 - CLI_2006_01_19 - CLI_2006_06_15 - CLI_2007_09_19
Faculty Internship Committee	Companies which receive students	1 report every year analyzing the results of the internships and the feedback coming from the companies	
Faculty Steering Committee	Gruppo Elettronica (GE)	1 meeting every year	http://www.gruppoelettronica.org
	Gruppo Ingegneria Informatica (GII)	1 meeting every year	http://gii.consorzio-cini.it/
	Gruppo nazionale Telecomunicazioni e Teoria dell'Informazione (GTTI)	1 meeting every year	http://www.gtti.it/
	Italian Chamber of Commerce (CCIAA)	Periodical analysis of Research studies about the professional roles and learning outcomes required	http://excelsior.unioncamere.net/
	Council of European Professional Informatics Societies (CEPIS)	Periodical analysis of Research studies about the ICT skills profiles for the ICT industry	http://www.eucip.it/standard-eucip
	European Committee for Standardization (CEN)	Periodical analysis of Research studies about the ICT skills profiles for the ICT industry	http://www.cen.eu/cenorm/sectors/sectors/iss/cen+workshop+agreements/ict-skills.asp
	European Centre for the Development of Vocational Training (CEDEFOP)	Periodical analysis of Research studies about the ICT skills profiles	http://www.voced.edu.au/td/tnc_79.316

Fig. 1 – screen image of Table A2, Reduced sample from Electronic Engineering, **POLITO** July 09

Main professional roles or further study for which the graduate will be prepared	Competencies required to fill role / functions exercised in role
· *System Designer*	Functions: A system designer will typically be asked to identify the technical requirements from specifications, and then to design an electronic system composed of electronic components. The system could be defined at different level of integration (from a board of components to a system of boards). Typically the electronic components are commercially available (COTS components) and the activity of the designer will be mainly focused on the integration of such components. The activity of the engineer will be mainly focused on the design of electronic system typically used in an industrial environment (from the production control, to the special purpose application normally adopted in an embedded system). Competencies: For this role, focus is on electronic devices and systems principles, design methodology (HW/SW tradeoff, design optimization, and testing techniques). It is required to be able to manage the production and installation of an electronic system. In this design activity the engineer must be able to consider the trade off among different parameters: performance, power consumption, cost, and reliability.
RF and Communication Systems Designer	Functions: A electronic RF and communication designer will typically be asked to design electronic systems operating in the telecommunication field, both wireless (mobile system, satellite systems, home automation, wireless LAN, broadcasting) and wireline (optoelectronics, LAN, WAN, automotive system application) fields. His/her activity will be mainly focused on the design of the system and the functional units, selecting and integrating functional units and integrated circuits at different complexity level: from the single transistor amplifier to the single-chip complete radio system. Competencies: It is required to know the analog and digital electronics, including Radio Frequency and microwaves, reconfigurable systems, ACD and DAC selection and operation, the design methods (HW/SW tradeoff, design optimization, and testing techniques) for wireless and wireline systems. It is required to be able to manage the installation of an electronic communication system.

Fig. 2 – screen image of Table A3, Reduced sample from Electronic Engineering, polito July 09

Learning Area	Learning Outcomes for Knowledge and Understanding	Level	Modules
Electronic Engineering	Semiconductor physics and technology	Advanced	Electronic Devices, Electronic Circuits Measurements Applied Electronics Digital Electronic Systems Radio-frequency techniques
	Analysis of circuits with MOS and BJT transistors	Advanced	
	Technology and structure of semiconductor memories	Intermediate	
	Difference between analog and digital circuit	Advanced	
	Electronic devices and systems interface	Advanced	
	Operational amplifiers and negative feedback	Intermediate	
	basic HW/SW interconnection strategies	Intermediate	
	Signal generators, oscillators	Intermediate	
	Power supply systems and energy conversion	Basic	
	use of the electronic instrumentation (both analog and digital)	Intermediate	
	Design of measurement experiments	Intermediate	
	Programmable measurement systems (IEEE-488 interface) and PC-based instrumentation	Basic	
	Non linear circuits	Intermediate	
	Study of distributed parameter circuits	Advanced	
	Maxwell equations: electromagnetic parameters of materials	Basic	
	VHDL Language	Intermediate	
	Commercial Standards for System Communication Buses	Basic	
	Microprocessors, Microcontrollers, DSP	Intermediate	
Computer Engineering	Internal organization of a computer Architecture (CPU, memory, Input/Output)	Advanced	Computer Programming Computer Architecture and algorithms
	C programming language	Advanced	
	Classical computer algorithms	Intermediate	
	Abstract data types	Intermediate	

Learning Area	Learning Outcomes for applying Knowledge and Understanding	Level	Modules
Electronic Engineering	Basic elements for a correct approach to the experimental activities in an electronic laboratory	Intermediate	Electronic Devices, Electronic Circuits Measurements Applied Electronics Digital Electronic Systems Radio-frequency techniques
	Design an electronic system	Intermediate	
	Design of data acquisition systems	Intermediate	
	Know how to use an oscilloscope and know how to use voltmeters and signal generators	Advanced	
	Design an electronic system with operational amplifiers	Intermediate	
	Use a software tool to develop printed boards	Intermediate	
	Measurement of an antenna radiation pattern	Intermediate	
	Measurement of scattering parameters of microstrip components by a network analyzer	Intermediate	
	Slotted line impedance measurement.	Intermediate	
	Programmable systems and data acquisition boards Software for managing instrumentation and DAQ boards	Intermediate	
	Design of electronic circuits with hardware description languages	Intermediate	
	Design of in interconnections between electronic subsystems	Intermediate	
	Design, simulation and FPGA implementation of simple digital circuits	Basic	
Computer Engineering	To be able to use a Personal Computer	Advanced	Computer Programming Computer Architecture and algorithms
	Write a program in C language to solve scientific problems	Advanced	
	Problem solving to real problem trough software programs	Intermediate	
	Develop a software program design	Basic	

Fig. 3 – screen image of Table B2, Reduced sample from Electronic Engineering, polito July 09

Subject areas	**Knowledge, understanding and skills expected of the student in order to demonstrate achievement**	**Course work and other educational activities** For each activity (course, laboratory, off-site work, final examination): link to corresponding course description (see Annex 3)
Mathematics	Apply definitions, characteristics and/or properties of numeric systems, functions of real variables, techniques to solve equations and inequations, vector algebra and differential calculus, in modeling and solving problems associated with simple systems typical of Mechanical Engineering. Apply integral calculus and linear algebra in modeling and in solving problems associated with simple systems typical of Mechanical Engineering. Apply vector analysis in modeling and solving problems associated with simple systems typical of Mechanical Engineering. Apply methods to solve ordinary differential equations and partial derivatives associated with typical mechanical engineering systems like stress on beams, fluid movements, heat transfer Employ descriptive statistics to study and represent different types of data. Establish tendencies and probability predictions applied, for example, to quality control in manufacturing processes. Solve numerically, equations that represent common phenomena found in Mechanical Engineering. Recognize which problems are able to be solved analytically and which ones solved numerically. Apply computing and programming procedures to analyze and solve Mechanical Engineering problems. Use commercially available software(like MathCAD, Excel or equivalents) to solve said problems as well as use high-level programming languages (Like C, Java or equivalents)	Mathematics I 08 ECTS Mathematics II 06 ECTS Mathematics III 06 ECTS Differential Equations 06 ECTS Probability and Statistics 06 ECTS Numeric Methods for Engineering 04 ECTS Programming and Computation 04 ECTS

Fig.4 – screen image of Table B2, Reduced sample from Mech. Eng., Univ. of Talca (Chile), June 09

Oil Engineering (optional) ***28 Credits***	***Knowledge and Understanding*** Understanding of concepts in oil engineering: wells completion, perforation, production, reservoir engineering and offshore operations. Oil geology, exploitation, perforation, production and refinement. Completion equipments. Recovery and stimulation of wells Perforation of wells and its safety. Behavior and operability criteria of floating systems. Properties and behaviors of reservoir fluids. Natural and artificial oil elevation Properties of reservoir rocks. Single and dual phase flow in porous media. Mechanisms of production and analysis of reserves. ***Skills and Know how*** To calculate and analyze problems related to oil exploitation. To design a well completion. To calculate losses of pressure within a multiphase flow.	*Introduction to Oil Engineering* *Completion Engineering* *Perforation Engineering* *Engineering of Offshore operations* *Oil Production Engineering* *Reservoir Engineering* *Characterization of Oil Reservoirs* *Multiphase Oil Flow*

Fig.5 – screen image of Table B2, Reduced sample from Mech. Eng., Univ. of Campinas (Brasil), June 09

Bachelor Programme ELECTRONIC ENGINEERING 2010/11 - Presentation

A1 - Educational objectives of the Ministerial Class

This Degree Course is in accordance with the Decree of the Classes of Degree Courses that, according to article 4 of the Ministerial Decree 22 October 2004, n. 270, defines Classes of Degree Courses and respective educational objectives.
The Electronic engineering degree programme is designed to provide students with a solid foundation in applied physics and mathematics together with the knowledge and skills in information and communication technologies engineering, and in particular in the electronic field, that will prepare graduates for professional practice in designing and maintaining typical electronic systems.
This course has just one program of study that gives students knowledge of the main features of components, devices and systems. Moreover it gives students the tools that enable them to:
 # Identify and formulate engineering problems by using up-to-date methods, techniques and tools;
 # Apply analysis and project methodologies to concrete situations;
 # Understand business environments and their economic, managing and organizing aspects;
 # Work in a group and be able to communicate with both written and oral skills, even in an international context;
 # Constant self-update by individual study, thanks to the basic scientific knowledge and to the methodologies acquired.
During the 1st year basic topics, such as mathematics, physics, chemistry, and computer science are studied. During the 2nd year computer science, telecommunication, electronics and automation fields are studied in depth. During the 3rd year more specific topics are studied.

see A1 - Educational objectives of the ministerial Class

A2 - Consultation with the organizations of entrepreneurial world, services, professions

The stakeholders who provide professional outlets for programme graduates chiefly consist of the major Information and Communication Technologies (ICT) industries.
The university's representatives who interact with these stakeholders or who apply input from these interactions to educational programs are detailed in Table A2: Interactions with external stakeholders together with the documentary evidence for their past and current work.

see A2 - Consultation with the organizations of entrepreneurial world, services, professions

A3 - Educational objectives, target roles and competencies

Course content ensures a solid mathematical and methodological grounding, combined with an understanding of the classic concepts in the information and communication technology fields (electronics, telecommunications, control, computer science). In the more innovative curriculum tracks, courses also focus on advanced concepts in design and measurements of electronic systems.

Electronic engineering graduates deal with all facets of electronic systems design and development (both analog and digital systems). A graduate in electronic engineering can be employed both in companies that produce objects and electronic systems (i.e. computers and mobile phones), and in companies that use electronics in their products: for example automation of systems, terrestrial and satellite telecommunication, automotive sector, etc.

see A3 - Educational objectives, target roles and competencies

B1 - Entry qualifications

For admission to the Electronic Engineering degree programme, students must take an entrance examination, which is designed to assist student orientation and is identical for all undergraduate degree courses offered by the School of Engineering. The entrance examination is divided into sections with questions covering prospective students' basic qualifications for the program they wish to enter.

see B1 - Entry qualifications

B2 - Expected learning outcomes

The educational programme has just one program of study that gives students knowledge of the main features of components, devices and systems. The educational programme thus includes subjects common to both curriculum tracks and subjects specific to each. The first year consists chiefly of subjects in basic science (mathematics, physics and chemistry), computer science and English.

During the 2nd year computer science, telecommunication, electronics and automation fields are studied in depth. During the 3rd year more specific topics are studied. Apart from training some lectures oriented towards employment will also be arranged.

see B2 - Expected learning outcomes

B3 – Further details of educational activities

B3a - Study plans, B3b - List of course work, B3c - Enterprise Internship, B3d - Final Project

see B3 – Further educational activities

B4 - Academic calendar, classroom schedule and examination dates

see B4 - Academic calendar, classroom schedule and examination date

… … … … follows with C, D, E; refer to Tab. 1 in the text

Fig. 6 – screen image of Presentation Section, Reduced sample from Electronic Engineering, **POLITO** July 09