STRUCTURE FOR A CURRICULUM FOR 4 YEARS BACHELOR DEGREE IN ELECTRONICS ENGINEERING

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The aim of the Bologna Declaration is the construction of the European Higher Education Area until 2010. The European Association for Education in Electrical and Information Engineering offered by the THEIERE project a definition of our area of interest and by EUR – ACE standards a unified method to evaluate the curricula.

The authors present a new Structure for a Curriculum for 4 years Bachelor degree in Electronics Engineering, elaborated for an Applied Electronics and Information Technology specialization at the German section of the Faculty of Engineering in Foreign Languages from the POLITEHNICA University Bucharest.

The curricula pay a special attention to the outcomes of educational process in order to assure to the students a good start position on labour market and to assure the accreditation of the proposed Engineering Education Programme according to EUR – ACE accreditation standards. We hope that in this way we contribute to the creation of the European Higher Education Area.

Keywords: Bologna process, Curriculum, accreditation standards, outcomes

1. INTRODUCTION

The aim of the Bologna Declaration is the construction of the European Higher Education Area (AHEA) until 2010. This declaration is at the origin of the Bologna Process. The main objective of the process is to create a competitive and world – wide attractive higher education system in Europe with great mobility and employability for students and graduates [1], [2], [3].

In order to achieve these objectives some conditions must be fulfilled:

- Comparable degrees organized in two main cycles,
- The use of ECTS as a compatible credit system,
- The use of a Diploma Supplement,
- The development of European dimension by establishing a framework of recognition of qualifications and of joint degrees,
- The development of the necessary Quality Assurance System.

A common framework of comparable and compatible qualifications is another objective of the Bologna Process. These frameworks should describe qualifications in terms of workload level, learning outcomes, competences and profile [2], [3].

The use of learning outcomes as a common language to define programes will enhance readability of qualifications by employers and academic institutions and will transfer the focus from teaching to learning. In the some times the Bologna Process

should lean room for diversity which is one of the characteristics of the European reality.

2. THE ENGINEERING EDUCATION

The engineering education in Continental Europe is organized into two different professional levels:

- An application – oriented short term program typically of three years full time.
- A scientifically – oriented five years full time program.

The following two cycle's degree structures are agreed for the EHEA:

- First degree (Bachelor) should require 180 to 240 credit points (3 or 4 years full time)
- The second degree (Master's) should require 90 to 120 credit points after the first degree.

For the Bachelor degree there are two main orientations: one application oriented program (IEng) or a scientifically oriented program with broad engineering education, facilitating the mobility of the students.

In the second level of engineering education (Master's) the same two main orientations can be identified: an application oriented professional Master, a scientifically oriented Master (CENG.) that aims educating professionals for the engineering profession and a profile of Engineering Scientist (Eng. Sc.) aiming at research as is presented in Fig. 1 from the THEIERE Report [5]

These programmes can be organized sequentially or as alternative routes but the type of professional to be educated will be determined by the outcomes, in terms of knowledge, skills and competencies.

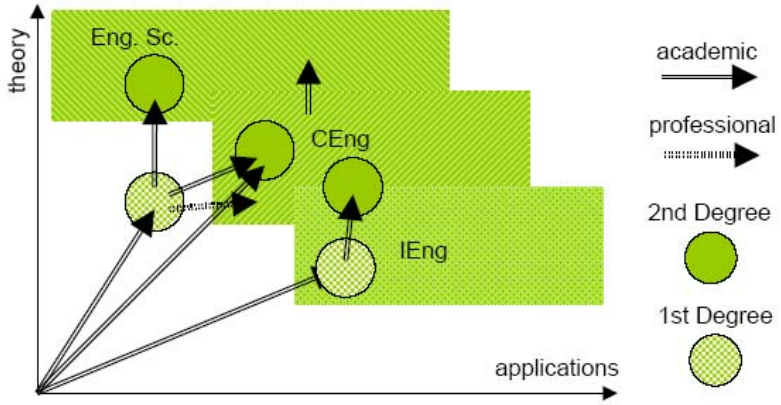

Fig. 1.

3. THE COORDINATED STRUCTURE FOR A 3 YEARS BACHELOR DEGREE

A coordinated structure for a Curriculum for a 3 years Bachelor degree in Electrical and Information Engineering was elaborated in the frame of THEIERE project [1], [4], [5].

The proposed coordinated structure has the objective to prepare professionals who will be able to analyze, specify, design, industrialize, commercialize and use products and services in Electricity, Electronics and Information Technology.

The common structure has the following components and relative weights measured in European Credits Transfer System (ECTS).

- Basics of Engineering – 54 ECTS,
- Basics of Electrical Engineering – 48 ECTS,
- Specialization Courses – 48 ECTS,
- Project – 12 ECTS,
- General Courses or non-technical skills – 18 ECTS.

The following specialization areas were taken into consideration:

- Telecommunications,
- Electronics,
- Power Systems,
- Automation and Control.

The main characteristic of the proposal is the strong common basis in the fundamentals in Electrical Engineering and only the Specialization courses (48 ECTS) are different from one area to another.

4. EUR-ACE STANDARDS AND PROCEDURES FOR THE ACCREDITATION OF ENGINEERING PROGRAMMES

The accreditation of professional engineering education programmes is a key function for the practice.

It is intended that if, in a particular country, established accreditation standards cover fully the

Requirements proposed in this framework, and then the award of the European label will be automatic.

The standards [6] propose the following outcomes for Bachelor and Master Degree:

Table1. Academic Programme Outcomes

		First Cycle Graduate	Second Cycle Graduate
1.	**Knowledge of Engineering Sciences**	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to engineering procedures, processes, systems or methodologies.	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the conceptualization of engineering models.
2	**Problem Analysis**	Identify, formulate, research literature and solve *intermediate* engineering problems reaching substantiated conclusions using analytical tools appropriate to their discipline or area of specialization.	Identify, formulate, research literature and solve *complex* engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
3	**Design/ development of solutions**	Design solutions for *intermediate* engineering problems and *contribute to*t he design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Design solutions for *complex* engineering problems and *design* systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4	**Investigation**	Conduct investigations of *intermediate* problems; locate, search and select relevant data from codes, data bases and literature; design and conduct experiments to provide valid conclusions.	Conduct investigations of *complex* problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

5	**Modern Tool Usage**	Select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modeling, to *Intermediate* engineering activities, with an understanding of the limitations.	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modeling, to *complex* engineering activities, with an understanding of the limitations.

Table 2. Personal Programme Outcomes

		First Cycle graduate	**Second Cycle Graduate**
1.	**Individual and Team work**	Function effectively as an individual, and as a member or leader in diverse engineering teams.	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
2.	**Communication**	Communicate effectively on *intermediate* engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	Communicate effectively on *complex* engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
3.	**The Engineer and Society**	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
4.	**Ethics**	Understand and commit to professional ethics and responsibilities and norms of engineering practice.	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
5.	**Environment and Sustainability**	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
6.	**Project Management and Finance**	Demonstrate an awareness and understanding of management and business practices, such as risk and change management, and understand their limitations.	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
7.	**Intercultural Competencies**	Work in an international environment with appropriate consideration or differences in culture, language, and social and economic factors.	Work in an international environment with appropriate consideration or differences in culture, language, and social and economic factors.
8.	**Life long learning**	Recognize the need for, and have the ability to engage in independent and life-long learning.	Recognize the need for, and have the ability to engage in independent and life-long learning.

5. PROPOSED STRUCTURE FOR A CURRICULUM FOR A 4 YEARS BACHELOR DEGREE IN ELECTRONICS ENGINEERING

The proposed Curriculum was elaborated for the specialization *Applied Electronics and Information Technology* which is going to start on the 1-st of October 2005 at the German section of the Faculty of Engineering in Foreign Languages from the POLITEHNICA University Bucharest.

By the Legislation in Romania the first degree (Bachelor) education for the technical universities should require 240 credit points (4 years full time). Having in view the proposed specialty, the elaborated programme is mainly scientifically oriented with a broad education in Electronics and Computer Communication facilitating the mobility of the students. We agreed to do this Curriculum as close as possible to the proposed Coordinated Curriculum presented in Chapter III, but some differences occurred in our proposal in the spirit of diversity.

A strong idea of the Curricula is to form an engineer by being able to cope with the labor market and be competitive with his skills, competencies and creativity.

In order to obtain the necessary practical skills and to stimulate the creativity of the students, each semester there are scheduled practical works in labors and team work based project activities. To outline the importance given to this activity, the

laboratories are organized in a logical sequence and complexity degree; these are independent and have their own credit points and evaluation.

Having the same final objectives, the project activity will stimulate creativity by well chosen topics and proportionate working hours. The Curricula propose 6 such independent projects, with their own credit points and evaluation. The final Bachelor Thesis is planned to be an integrated one, whereas the system requires solutions from different disciplines. The students will have as advisors a team of specialists who will evaluate their project. The students have in the last two semesters, 4 hours per week dedicated to this activity.

In order to assure the necessary knowledge and competencies in economics we introduced for each semester a discipline from this subject area. It is very important for our students to have good communication skills in foreign languages; therefore we have foreseen special training disciplines for each semester.

Special attention was paid for the presence of courses from the subject area of European Integration, Quality management, Project Management and Legislation.

6. OUTCOMES OF THE PROPOSED CURRICULA

The curricula pay a special attention to the outcomes of educational process in order to assure to the students a good start position on the labor market and at the same time to assure the accreditation of the proposed Engineering Education Programme according to the EUR – ACE accreditation standards.

The basics of Engineering and Electrical Engineering (Mathematics, Physics, Electrotechnique and Information Technique, Communication Technique, Electronics) give the knowledge that together with the specialization disciplines help the student to identify and formulate the problem, to use analytical tools necessary to give a solution for the tasks of intermediate difficulty.

The projects activity will offer the skills to elaborate projects of an intermediate degree of difficulty. The ability to investigate the literature will be also stimulated.

The laboratory activity assures the necessary skills to carry out an experiment and to acquire and process the data, to install and exploit specific devices, to check and repair the installations from graduate's activity area.

The engineer will master the use of modern investigation methods and tools for the benefit of his practical activity.

The estimated outcomes of proposed curriculum have to be proved by the first graduates. The comparison with the outcomes from Table 1 gives a good chance of success. A drawback of the curriculum at this level us can remark a rather low interest to the social and environmental problems. The explanation could be the lack of such an interest at the university level.

The University is aware of the fact that our graduates have to be integrated in the social life and they have to have abilities for human and technical communication, basic knowledge of economics and team work. This is why the general, non-technical education is good represented in the proposed curricula by disciplines like: Human

and technical communication (4 cp), Foreign languages (4 cp), Project management, elements of economical sciences, etc.

At this level of personal programmes outcomes our curriculum is not more so close to the outcomes of Table 2. Unfortunately our university cannot assure the necessary frame for an education in the field of Ethics, intercultural competencies and life long learning. The Romanian society and the Romanian high schools have no tradition in this direction. Some personal examples are not enough to assure quantifiable measures of skills and attitudes in this regard.

It is important to outline that even under these circumstances the proposed curriculum does its best to assure the communication abilities, the ability for team work and Project management.

7. CONCLUSION

Today it is hard to say where the borders of the electrical and Information Engineering area are because the electricity and the information technology "invaded" the technical and the non – technical sciences.

Last year the American and the European scientific community made a hard effort to solve this crisis of identity because the technical education needs some guidelines to build curricula according to the general criteria of utility on labor market.

Fortunately the European Association for Education in Electrical and Information Engineering (EAEEIE) offered by the THEIERE project a definition of our area of interest and by EUR – ACE standards a unified method to evaluate the curricula.

It is very important to outline this effort and its results. Our work was focused on the idea to implement the basic principles of EAEEIE in the proposed curriculum. We hope that in this way we contribute to the creation of the European Higher Education Area.

8. REFERENCES

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