Conclusions from the development and application of a revised Curriculum in the Department of Electronics of the Technological Educational Institution (TEI) of Athens.

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Abstract: - For the first time, at the Department of Electronics of the Technological Educational Institution (TEI) of Athens, a systematic and profound reformation of the course curriculum was realized. What is presented here is a short report of the design activities and of the parameters that have been taken into consideration. Evaluation issues are also addressed. Last, a number of activities are proposed, required for ensuring the maximum possible effectiveness of the curriculum in the learning process.

Key-Words: - curriculum development, electronic engineering education, curriculum evaluation.

1 Introduction

The design and building of a modern and properly structured curriculum present certain significant difficulties [1]. These difficulties accrue from the fact that a number of requirements and criteria have to be satisfied. Below are some typical requirements [2-5]:

1. A modern curriculum is supposed to offer -to the extent this is possible- a broad education and culture and should not be limited to a narrow and strict scientific-technological knowledge or professional qualification.
2. It should achieve an overall coverage of the subject areas of the discipline, provide the necessary specified knowledge and also focus on the particular subjects that correspond to the Department's orientation.
3. The curriculum has to ensure good balance between the major and minor fields.
4. Overlapping of the material between modules has to be avoided.
5. Undue priority to certain modules, at the expense of others has also to be avoided.
6. Provision has to be taken for optional modules, thus offering the students the necessary space to pick modules that fit their individual preferences and inclinations.
7. All modules have to be outlined in detail, thus facilitating the tracking of any overlapping, gaps or complications.
8. Each taught module must carry a number of credits and a certain amount of workload.
9. Progressive transition form core modules to specialized modules.
10. A modern and up-to-date study curriculum has to encourage the student to obtain research methodology and orientation.

Special consideration has been given to engineering education issues during the last years. However, the approach of the matter is quite complex and multifaceted and requires extraordinary execution plans [6,7]. Consequently, new approaches are needed. The way engineering education is conducted is important to the future of the engineering profession in the context of the growing gap between the need for well-trained engineers and the ability of universities to produce such human resources [8,9].

Electrical and Electronics Engineering is a vital part of the rapidly changing needs of modern technology and permeates virtually every engineering discipline. The field covers areas such as telecommunications, digital systems and computer design, control systems, electronics, fibre optics and solid-state devices. The Department's mission in the above speciality is to provide our electronic engineering students with the necessary tools and skills to understand and apply today's technologies and to play a leading role in the development of future technologies. An Electronic

Engineering programme should prepare the students to pursue successful careers in industry.
Taking all the above into consideration, the Department of Electronics of the Technological Educational Institution (TEI) of Athens undertook the project of the revision of its curriculum. The development of the new curriculum started in 1999 and was completed in 2001, while the new curriculum applied in 2002 for the first time. As it has been almost three years that it has been running, the first conclusions have been reached, and actions are suggested to accomplish the maximum efficiency possible.

2 The preparatory work for the drawing of the new study curriculum

During the preparatory phase of work towards the design of the new study curriculum, the input of four different groups involved was recorded. Namely, the input came from the academic staff, the students, the graduate students, as well as executives of companies of the Electronic sector. The aspects of all the above were recorded through the completion of four different types of questionnaires, which contained open or multiple-choice questions. The processing of the questionnaires produced the following feedback:

– The existing curriculum did not seem to provide adequate knowledge in the following subjects: Software Engineering, Digital Design Techniques, Computer Networks, Modern Control Systems, Modern Technologies and Telecommunications Services.
– The structure of the existing curriculum failed to provide the students with a good command of the taught subjects.
– The procedure of the undertaking of the dissertation needed significant review.
– The laboratory teaching often did not meet the expected standards and was not tuned with the lectures.
– The few optional modules that existed in the curriculum were not properly structured, and did not offer the student an overview of the subject.
– The teaching of the core modules, and mainly of Mathematics was not as much orientated towards its applications in Electronics, Telecommunications and Automation, as it should be, thus rendering low usefulness to the module.

Further to that, the ratio of the amount of knowledge assimilated to the amount of knowledge offered was judged to be low.

Last, the existing course curriculum was compared against the curricula of the Electronics Departments of several Universities, which are internationally highly regarded, aiming at approaching the current trends concerning the content and the attractiveness of modern curricula internationally [7].
The new trends in modern curricula were recorded, in connection with the percentage of various module groups included, such as: general background modules, specific background modules, specialization modules, as well as regarding subject areas of the whole discipline of Electronics, such as Analogue Electronics, Digital Electronics & Digital Design, Computer Science & Software Engineering, Telecommunications & Computer Networks, Automatic Control, etc.
Hence, the design and development of the new course curriculum started having in store a high amount of data that had been collected, processed and submitted in the form of reports.

3 The activities for the drawing of the new study curriculum

Initially, a three- member committee created a draft course curriculum, to be used as a pattern for discussion that would lead to the final output.
At the stage of design, the subjects were determined first, whereas the modules remained to be specified afterwards. Then, those subjects either constituted an entire module or, where the weekly time schedule per semester could not afford, the subjects split to more modules, e.g. the subject Analogue & Digital Electronics is covered by a module over three semesters. When the draft curriculum was published to the academic staff of the Department, various points were raised.
The finalization of the draft curriculum was reached shortly, following to discussion that took place in the Department. Then all members of staff submitted their remarks on the detailed outline of each module. After the processing of the views expressed, and taking into consideration the basic parameters described in the introduction of this paper, the three-member committee assigned to design and prepare the curriculum, presented the final layout. In the same time, the presentation of each separate module was made. This included the weekly teaching hours of the module, its credits according to ECTS, the aims and objectives of the module, its detailed syllabus, the proposed prerequisites, the workload, the mode of examination and the recommended bibliography supporting it.

Finally, the proper course of action was followed as provided by the internal regulation through the Department's Committees (Departmental Board, Boards of Subjects Areas) where the curriculum was ratified by the Board of Studies following to long and fruitful discussion. The curriculum has been applied since September 2002.

4 The features of the new course curriculum

The revised course curriculum comprises forty modules, which belong to four main groups.

- General Background (GB)
- Special Background (SB)
- Specialization (S)
- Management, Finance, Law (MFL)

Table 1 shows the number of modules in each group and Figure 1 presents the corresponding percentages.

Table 1. The number of Modules in each group.

MODULE GROUPS	NUMBER OF MODULES
General Background	7
Special Background	16
Specialization	15
Management, Finance, Law	2
TOTAL	40

One of the most difficult issues was the sequential distribution of the modules into the course semesters. The modules had to be allocated to the semesters in a way that would allow smooth attendance by the students, also ensuring the proper "building" of knowledge, starting from the foundation (basic knowledge in the discipline offered by the background modules) and ending at the specialization modules. An illustrating overview of the progressive transition from the background to the specialized modules is shown in Figure 2.

The new curriculum introduces the specialities. Two specialties are offered for each student to select. Namely: Telecom Electronics and Industry Electronics. Semester 1 to 5 are common and the students specialize in semesters 6 and 7 where 4 modules are common and 7 more different modules are offered for each speciality.

As far as the module credits are concerned, they range from 2 to 7. Figure 3 depicts the module distribution according to their credit weight.

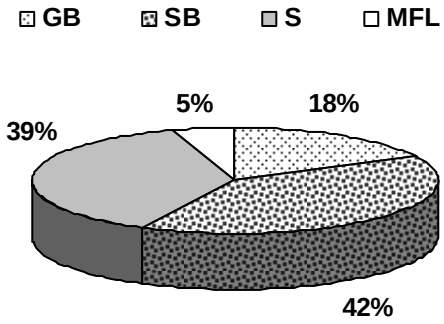

Fig. 1: The percentage of modules into the four modules groups of the curriculum.

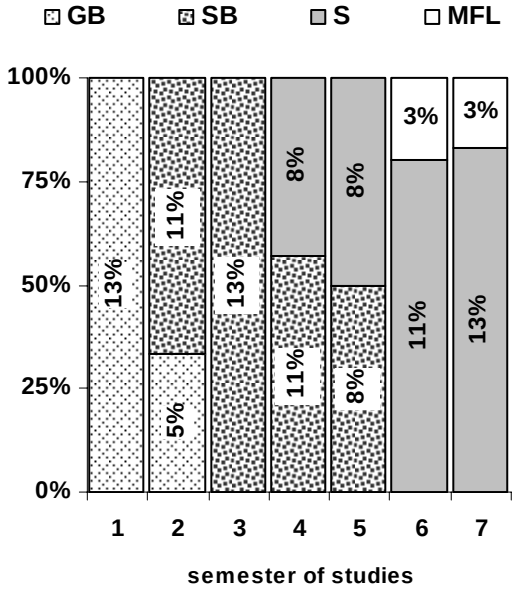

Fig. 2: The percentage of the four module groups into the course semesters.

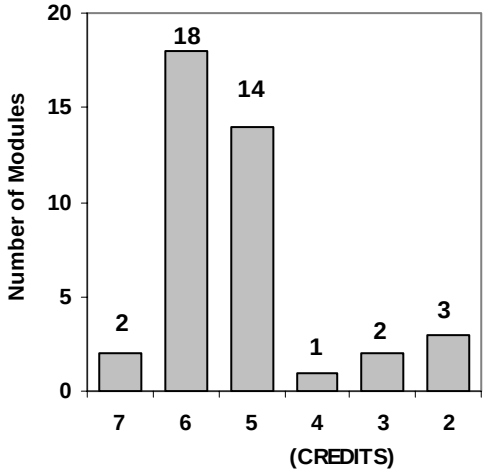

Fig. 3: The distribution of modules in terms of credit weight.

The workload of each module in the curriculum is also quite different, in a range of 6 to 10 hours per week. Figure 4 presents the workload distribution of the modules, in terms of occupation hours per week.

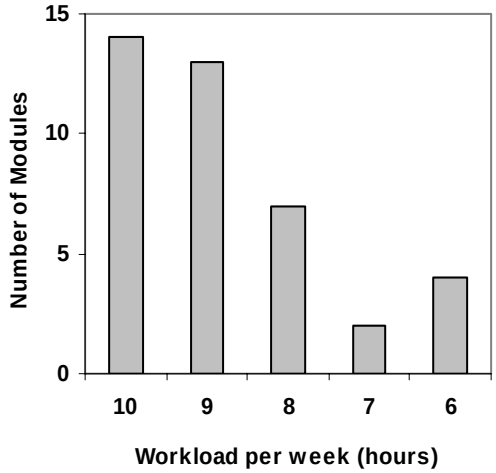

Fig. 4: The workload distribution of the modules, in terms of occupation hours per week.

5 The effectiveness of the revised curriculum

The critical points for considering the effectiveness of the revised curriculum that will qualify the Electronic Engineers of the following decade are:

5.1 Strict application of the programme

There should be no curtailments of the prescribed modules and their outlines. In particular, all subject areas related to the recent technological development and services need to be taught. This constitutes a necessity, since new technologies evolve so fast that education is inevitably always one step behind the new knowledge that is produced and developed [7, 10].

The responsibility for the straight and firm application of the new curriculum mainly lies with the academic staff. Each member of the staff will have to adapt his teaching mode and methods in compliance to the new and up-to-date status.

Today the Department of Electronics is equipped with all required means and know-how to support such efforts and introduce modern teaching patterns. To achieve the above, each academic should prepare a file for each module, which must include the following:

- Bibliography supporting the module.
- Interesting resources and links on the Internet.
- Module notes of the lectures delivered.
- Example questions, exercises and worked solutions assisting the student in understanding the essence of the module.
- A set of past exam papers.

All the above material may also be available in electronic format, either in CDs or on the Internet. A relevant educational portal that enables the students to access multiform study material has already been created [11]. In this way, the needs of the exceptional students are also satisfied, given that it constitutes a moral and pedagogical obligation to meet those students' requirements.

5.2 Update of the laboratory infrastructure and teaching

The laboratory equipment should be updated and enriched on a regular basis. The existing equipment may meet the current needs of practical training satisfactorily. This does not mean that after the lapse of three years the same standard of efficiency will be accomplished. The quick outdating of the equipment and the new technologies necessitate major purchases in the laboratory infrastructure. Hence, the Department of Electronics has to pursue resources, beyond those related with the regular funding. All possibilities of funding ensuring the necessary renewal and update of the Laboratory equipment have already been exploited. In most modules, the laboratory teaching needs to be modified to become more substantial and effective. Reduction of the students' workload is required and the offered practical knowledge should be useful and qualifying towards their future careers.

Computer and associated technologies should be used in all parts of the curriculum as tool to enhance and increase learning. The digital computer has offered new possibilities regarding the laboratory training, including simulation, automated data acquisition, remote control of instruments and rapid data analysis and presentation. Due to the above, the laboratory training has become quite interesting during the last years and has given an impulse to laboratory education [12,13]. At the Department of Electronics of the TEI of Athens, the mode of the laboratory training has to be investigated in detail, in the light of the next curriculum review. The aim is for the students to accomplish those technical skills accompanied with the required knowledge, so that they will be able to participate in a competitive global economy upon graduation.

5.3 Continuous evaluation of the educational work

The evaluation and assessment of the educational work is a major means towards the upgrading of the offered education and spotting in the same time existing weak points and faults, in order to address the required changes and reviews in the educational process. Furthermore, the curriculum was built in a way that allows minor modifications and amendments without causing any problems.

The establishment of a five-member Board of Studies to manage and introduce issues that have to do with the educational process and the methods for its upgrading, constitutes a significant help towards the accomplishment of the above goals.

6 The outcomes of the evaluation of the revised curriculum

Table 2 presents a short report of the first and indicative outcomes of the evaluation of the revised curriculum. Actually, what is assessed is the extent to which the ten criteria set in the introduction are satisfied. The score scale used ranged form 1 (poor) to 5 (high).

Table 2. The level of response of the curriculum to the basic requirements and criteria that a modern study curriculum should satisfy. (5- point scale)

CRITERIA-BASIC REQUIREMENTS	SCORE
Complete insight on the subject of the Department's discipline	3.8
Full coverage of the fields of the speciality	3.8
Good balance between major and minor fields	3.9
Avoidance of overlapping	4.0
Avoidance of excessive gravity to certain modules, against others	3.9
Provision for optional modules	4.1
Detailed syllabus for each module	4.1
Determination of the weight and workload of each module	4.4
Progressive transition from the core modules to the specialized modules	4.1
Emphasis on the development of research methodology	3.6

Initially, the evaluation was conducted by the leading members of the Board of Studies and mainly reflects their personal perception. At a second stage, the assessment of a three-member panel of external evaluators specialized in educational matters was recorded, along with that of a five-member panel consisting of scientists and managerial staff from the area of the Electronics Industry. The managerial staffs selected were active executives who graduated form the Department of Electronics of the TEI of Athens and implemented PG studies at foreign Universities. Table 2 depicts the average response to each criterion as given by each of the three above groups of assessors.

A first conclusion drawn by the above evaluation is that in the future, special attention should be paid to issues that concern the development of research methodology by the students, a question that requires reappraising the relation between theoretical education and Laboratory Engineering Education. Another process that should be established is the further assignment of individual or group projects to the students. Projects will aim at the solution of a problem or the development of an integrated circuit or setup, in addition to the final project that they realize at the completion of their studies.

Furthermore, special consideration should be given to the re-determination of the taught subjects of the General Background Modules, such as Mathematics and Physics. Electrochemistry and special topics on Nanotechnology [14,15] has also to be introduced.

7 Suggestions on the evaluation of the educational work

The already accumulated experience and the established attitude at TEI concerning the assessment and evaluation of educational process, lead us to the adoption of the procedures below, in order to achieve at least an unofficial implementation of a continuous evaluation of the educational process. Continuous activation of the Board of Studies that will suggest and deal with issues that have to do with the educational process and methods for its upgrading is needed. In particular, the Board will have to work out the following:

- Make reports about the level of the education offered for each module, reports which should be oriented to the direction of spotting the weaknesses and not just exercising strict criticism, thus assisting to the upgrading of the academic work.

These reports will be forwarded to each academic individually and will not be published broadly to the academic community.

- Drawing of general report on the quality of the offered education each semester.
- Drawing of proposals on the support of the laboratory instrumental and technical infrastructure in order for the education to satisfy the current and future needs.
- Drawing of proposals on the modification and partial review of the curriculum.
- Conduct of research through questionnaires, recording the views of the students, teaching staff and other parts involved as far as educational issues are concerned.
- The pursue of close contact and cooperation with other TEI or University Departments of similar disciplines.
- The organization of Meetings on a annual basis on the education offered at the Department of Electronics.

More specifically, each academic will have to address to the students through questionnaires asking them to evaluate the tutor and the lesson. Then the data should be processed and a relevant report will be made and submitted to the Board of Studies. The questionnaires for the evaluation of the lesson and the tutor could address some of the following questions: the tutor's ability to communicate knowledge, his consistency & professionalism, as well as the suitability of modules' handouts and the evaluation of the teaching methodology.

It is obvious that the students applicable to fill in the questionnaire should be those who have at least a 50% attendance in the classes. The evaluation feedback should be sorted by date, so that possible relative improvement can be recorded. Every member of the teaching staff has to realize the significance of the evaluation and join such a pilot project. As for the students of our Department, they should be motivated towards the practice of evaluation and encouraged to understand that they should state their views in a responsible and unbiased way.

8 Conclusions

A relatively successful review of the curriculum was carried out in the Department of Electronics of the TEI of Athens, something that was imperative by the power of technology, its pervasiveness, and its continual advances. The accomplishment of the goals of the new curriculum focuses on a number of procedures that should constitute issues of everyday practice, on a standard basis. The continuous evaluation of the educational work is a milestone that helps assess the performance of the educational process and check the response of the curriculum to the new technological challenges. The minor modifications and revisions of the curriculum every two years are imperative. The improvement of the mode of teaching and the use of applications such as computer-assisted design, engine analysis software, or network management software specifically for technological education courses are questions that should excite the academics' interest.

Acknowledgement:

The authors would like to thank Mrs. I. Leraki for her contribution to the recording and processing of the data during the various phases of the development and evaluation of the curriculum.

This work and its dissemination efforts have been funded by the Greek Operational Programme for Education and Initial Vocational Training (O. P. Education) under the action: 2.2.2.· "Reformation of Undergraduate Studies Programs".

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