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Communication Engineering Curriculum (Past, Present and the Future)

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Abstract**—**At present time, competition, unpredictable fluctuations have made communication engineering education in the global sphere really difficult. Confront with new situation in the engineering education sector. Communication engineering education has to be reformed and ready to use more advanced technologies. We realized that one of the general problems of student`s education is that after graduating from their universities, they are not prepared to face the real life challenges and full skilled to work in industry. They are prepared only to think like engineers and professionals but they also need to possess some others non-technical skills. In today's environment, technical competence alone is not sufficient for career success. Employers want employees (graduate engineers) who have good oral and written communication (soft) skills. It does require for team work, business awareness, organization, management skills, responsibility, initiative, problem solving and IT competency. This proposed curriculum brings interactive, creative, interesting, effective learning methods, which includes online education, virtual labs, practical work, problem-based learning (PBL), and lectures given by industry experts. Giving short assignments, presentations, reports, research papers and projects students can significantly improve their non-technical skills. Also, we noticed the importance of using ICT technologies in engineering education which used by students and teachers, and included that into proposed teaching and learning methods. We added collaborative learning between students through team work which builds theirs skills besides course materials. The prospective on this research that we intent to update communication engineering curriculum in order to get fully constructed engineer students to ready for real industry work.

Keywords**—**communication engineering, curriculum education, ICT, industry

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I. Introduction

COMUNICATION is about transporting your messages to other people in comprehensible way. In another words communication allows people to exchange their ideas and thoughts one to another. It gets the desired effect when both sides understand the same point of view. It is also known that the area of engineering is related to the development and operation of communications including technology, telecommunications and computer programming. The key here is engineers are not just responsible managing projects, designing network and maintained of fixed equipment but also to have ability to facilitate communication among different interest groups in international locations. Every field of studying has specific needs with relation to rapidly improving technology. Therefore, our goal to examine different samples of curriculum design from different universities and point out missing part(s) and inserted into new and improved curriculum structure. Our aim also is to improve quality of communication engineering education by refreshing curriculum and bringing new stable, updated curriculum form to engineering departments and colleges. In this research we make a possibility to see variant ways of writing curriculum approaches and to take useful one among them. Eventually we offer in depth analyzed modern version of curriculum to every single university. Related research works are presented in the following section. In section 3 full discussions about methods, techniques, includes online education, virtual labs, practical work, problem-based learning (PBL), and lectures given by industry experts. As well as short assignments, presentations, reports, research papers and projects students can significantly improve their non-technical skills. ICT technologies in engineering education have been discussed. Section 4, the proposed new curriculum for communication engineering has been full explained and new and improved structure form introduced. Conclusion is presented in the last section.

II. Related Research Work

A. Communication Engineering Course

There are many communication engineering proposals for education reform in order to have effective education. We will have a brief overview of what has been done so far. We will present their proposals as possible solutions for improvement of engineering curriculum. Many researches of higher education has realised that there are serious problems in the teaching methods.

Some of the proposed solutions are: teaching system should be adaptive to the development of communication science, include Computer Aided Analysis and Design, include some assignment and homework, support self-learning, online self-teaching, give some experiments for better understanding of theory, build a virtual network simulation experiment, teach students how to cooperate and share information with others, train teachers to update their existing knowledge, set seminar courses, and research methods[1], [7]. Internships are also important because of giving the students chance to see and understand how it all works in the industry. All solutions should be flexible and adjustable to changes [2]. Another aspect is that communication engineering courses are mostly abstract and rely on mathematical models. In these cases, there are some suggestions for using software like Software defined radio (SDR). Using these classroom demonstrations students get more familiar with signals in time or frequency domain, modulation, linear systems and filters, all of these things that were abstract for them [3]. In article [4], it is proposed to include new departments for Technical communication, or special courses like Engineering Design and Communication course. Outside the engineering classroom there are communication centers and writing centers that can also support efforts to integrate written and oral communication instruction within engineering curriculum. In article [5] propose new The National Innovative Communication Engineering (NICE) Education Program**.** Major tasks that should be organizing course planning and teaching material production, websites and databases, regional shared teaching laboratories, shared software center, seed lecturers training, exchange and collaboration between universities and industries, internationalization. Problem-Based Learning should be included in curriculum [6]. Instead of traditionally thought courses, students should get problems to solve.

B. Online Communication Engineering

Online education gives students the opportunity to access higher education, anywhere, anytime, which otherwise, would not be able to attend. Online education courses offer the flexibility, convenience and connection with the resources necessary to get education. There are many research papers which discuss about this kind of alternative learning. In [8] has been sad that online education offers not just distance learning from anywhere, but also play important role in bringing together the work of colleges and universities all around the world. This means that anyone anywhere can secure the education of their choice from any institution. Only condition for virtual labs is that they should provide results as close to real situations as possible. [9] In paper [10] is proposed several ways using online ICT for education, such as podcasting, usage of collaborative platforms, e-learning, web access to courses, online exams, serious gaming as pedagogical tool. As well as network of universities sharing common best practice, e-resources, e-skills oriented programs, e-governance of universities.

C. Communication Engineering in Industry

Communications engineers work within a number of industries, including internet and computing technologies, radio, networking and telecommunications. Good communication serves for development of the individual organization, society, nation, country. Taking into account all this, it is worrying the fact that many students have problems with effective communication. This is the reason why a lot of recent papers discuss about this issue. They offer a solution for integrating communication skills in engineering curriculum because communication skills are a regular feature of an engineer's job in industry. One of the solutions is that, during the students study. They should write different types of engineering documents, including design proposals, project management plans, status reports, instructions and other types of science writing. Assignments are more frequent, but shorter and more focused on specific writing and technical skills. This will provide them the oral and written communication skills required for their success in industry [11], [15], [16]. Many students lack the information and communication technology (ICT) literacy skills, while their employers want them to have these skills. It is necessary to integrate information literacy into the curriculum [12], [18]. Another solution for improving communication skills is using CollPad, a face-to-face computer-supported collaborative learning (CSCL) approach. Students are divided into groups where they can participate in group discussions, express their opinions, collaborate and develop critical thinking. Group-based pedagogies described in [14] provide group collaboration, communication, learning to learn, starting reflection, problem solving, management, communication, self-directed lifelong learning, self-awareness, ethics, creativity, critical thinking. In [17] is suggested new course, which has an aim to link the theoretical aspects with the professional practice. Using instrumentation, measurement procedures and strategies can integrate previous knowledge learned skills in real situations and evaluation purposes.

D. IT and Communication Engineering

Many universities have recognized the benefits of using information and communication technologies for teaching and learning. Information and communication technologies facilitate the process of education and improve the quality of education. Using ICT in education should be as a medium for learning, discovering, sharing and creating knowledge. It improves student's competencies such as critical thinking, decision-making, handling of dynamic situations, working as a member of a team, communicating together [20].

Because of the adaptation of wireless communication networks in factory automation, there is a demand for universities to prepare students to be up-to-date with wireless networks and devices, so that they can apply and configure the system, understand how the real system works and understand security and design issues under wireless environment. To meet this requirement, universities should include courses related to wireless networks in their curriculums, as a part of their curriculum improvement plan [21].

Evaluation in network technologies enabled users to share information easily using www. Developed technologies such as SMDS, Frame Relay, DQDB, ATM and ISDN, as well as communications protocols such as RTP, RTCP and IP Multicast have been well established giving ground for interactive real-time telemetric applications. The primary motivation for using ICT in education is the belief that they will support superior forms of Learning. Applicable resources with the ICT include: text, documents, textbook and essays in PDF format, picture and voice, email messenger and chat and other technologies like shared application programs, video conference, simulation and data stations [22][26].

In Germany is developed new virtual laboratories whose aim is to improve use and development of multimedia in academic education and training. Using software lots of animation have been added to static slides and lecture notes. In virtual lab are developed simulations of radio transmission system, using DSP boards, oscilloscopes and spectrum analyzers [23][25]. Using SMS, email or online forum combined with Internet communication media, it can be significantly increase student extrinsic motivation without causing higher pressure [24].

E. Curriculum Communication Engineering

Improvement of education has always been a primary goal of all university. Having the good curriculum is the key of successful education. Universities have to be very careful while preparing their curriculum programs. Because practical work is basis of understanding communication engineering, there has to be a balance between theory and laboratory exercises. While engineering programs became more theoretical, industry continued to require individuals who possessed more practical skills. To provide these practically trained individuals, laboratories are used to give students the "look and feel" of physical systems or to develop a "feel for engineering. There are different types of laboratories. Beside real experiments, computers can be used in laboratory to control experiments, acquire data, and analyze, correlate, and present results. Also, simulations are useful for experimental studies of systems that are too large, too expensive, or too dangerous for physical measurements by undergraduate students. For distance learning, there are programs for remote student's laboratory kits they could use at home to perform the course experiments. Instead of simply creating a laboratory exercise, researchers should be expected to identify their specific objectives and then demonstrate that those objectives have been achieved [26].

Good curriculum should include usage of ICT in teaching methods and also pay attention on improving communication skills of students during their study, which is already mentioned previously.

III. Discussion

We live in a time of great change, challenges and contradictions, fast development of information and technology, and overall changes in social and economic areas.

Since communication engineering plays huge role in society, to help manage the changes that society is facing, communication engineers need to have the knowledge about communication technology, communication systems and communication networks, the ability to research, design, and operate in the communications field, apply communications technology and equipment in each department of economy and industry. To respond these challenges, there is a need of improvement in the way engineering education is structured. Modern education must adapt to today's needs and follow very rapid development. Education must focus not on the past, but current and future technologies. Universities are obliged to bring new engineers prepared to cope with the changes in modern world. Eexperience has shown that there is much omission when it comes to the education of young engineers. Therefore, this problem has become a center of interest and many researches. Optimization of the curriculum is the most effective way of improving education in communication engineering. Reviewing the existing work related with education in communication engineering, we identified the current problems in education. Many solutions are creative and well designed and contribute to a better education. However, we noticed that all suggestions are based on a specific solution in a certain direction. Focus of their research is solving just one particular problem. For example, a lot of papers are written to offer improvements in communication skills as a response to industry requirements. Others offer the introduction of new teaching methods, including usage of ICT infrastructure. Online education is also taken as a new trend in education which provides a flexible learning. Even if all these proposals bring improvements, the problem of young engineers who are starting to work in the industry is still present. Employers noticed that graduated students are still not completely ready to work in industry. This objective has been our main motivation to make a step forward in education. While others apply only one method for improving teaching, our idea is to put together all methods and therefore to respond to all possible weakness in higher education. Idea is to propose one universal curriculum, which integrates all solutions in one, and satisfies all requirements. Unlike existing curriculums, which are based on solving one problem, like making the balance between theory and practice, or enhancing teaching methods, or improving student's communication skills, our curriculum implement all this good strategies, and is not focused just on one or two. We can say it is universal, simple, valuable, and applicable in almost every engineering course. Following this curriculum all requests for good high education are fulfilled.

IV. Proposed Curriculum

A. Old Style of Curriculum

The past and current curriculums is used for engineering courses can be criticized for being too narrow, in the sense that they include only traditional teaching format in which students are provided with information which will help them pass a test, but not necessarily with information which they can use.

Exchange between students and teachers are less encouraged, and the facilitation of class discussion is also not a part of the curriculum. There is no environment for developing critical thinking or communication skills. Only exams and assignments are used to measure accomplishment and progress in course. These traditional methods are not very well accepted in practice.

B. New Proposed Style of Curriculum

Successful engineers needs to have an appropriate engineering curriculum so that s/he can gain the knowledge and credentials necessary to secure a good job after graduation. It is important to consider a number of factors for having a good engineering curriculum as illustrated in Table (2).

Comparing new and old curriculum significant improvements can be noticed at the beginning. Some of the most important course aims should be developing of *communication skills*. This development can be achieved giving presentations, writing technical and professional reports, and encouraging discussion. Good *technical knowledge* ensures good understanding of different aspects of job and helps young engineer to give solution in the shortest possible time. *Critical thinking* skills are developed through responding on given problems. During the education students should do some practical work in industry. *Practical work* can be done in factories where students have an opportunity to see real time systems and processes and eventually to apply theoretical knowledge.

Course should support usage of new *ICT software packages*. New software packages should be used in the student's educational process, so after completition of this process student is qualified and ready to continue working in the industry. Traditional learning and teaching methods include lectures and homework. Since this practice is present in high school education it is not applicable in universities. Reason for this is that students should be encouraged and well prepared for facing with the new challenges. New proposed methods include *problem-based learning (PBL)*. This way of learning represents one way of linking theory and practice. Student is given one problem from practice and they should solve the problem using all material and lecture's help. In this way they develop critical thinking, and cooperation. PBL requires more time spent for solving the problems than traditionally thought methods, but students are opting for this method of learning.

Discussions in classes based on the lesson topics. Some discussions are strictly social; others concentrate on questions about the material, course and technology. Every student has an equal opportunity to share thoughts and opinions and give some meaningful comments. Students can help each other to learn. Students get as creative and social as they want. *Student Presentations* gives opportunity for students to present, organize, and share their work with other students. Students are more motivated to produce better projects knowing it will be presented to others.

This is shown as very good method because student has very quick feedback for his work, and after successful completion of task can increase self-confidence. Using *online teaching* teacher can give from any place a lecture to the students which give flexibility to students and teacher. Offering online courses students prevented from attending classes can have an access to lectures and easily overcome this problem. All information of given courses such as syllabus, lectures, lessons, homeworks and grades should be available on the web site. Experience has shown that students find it more practical when they have access to all course resources on the internet. *Team work* enables collaborative learning while improving student's writing and communication skills. Equal participation increases collaboration and diversity of ideas while building student confidence. Dividing students in groups can substantially affect their communication skills; give new approach in learning process. It builds a set of skills outside of course material that ensures graduates will be able to apply lessons to organizations of today and tomorrow.

Research environment enables active researchers to include the outcomes of their research into the curriculum; and encouraged the students to learn in research-like ways, solving complex problems with a growing level of autonomy; students may work in an environment and culture that clearly values research. Writing research paper requires that student can notice important and relevant information, develop critical thinking and improve writing skills enrich knowledge. *Visiting the companies* suggests that students should have not only a deep understanding of the wider significance of that which they are studying, but those they are likely to be able to participate effectively and see how it all works. *Lectures given by experts from industry* can play important role in education process of young engineer. Sharing relevant knowledge of real time processes students can be introduced with a work in the industry. This method of education provides a direct link between their theoretical knowledge and application of that knowledge in practice. *Laboratory work* can be accomplished using virtual or shared labs. Sharing labs between universities and some research centres can be very practical, especially when we know that some high sophisticated equipment is very expensive. This practice is already present in some universities. Also, virtual labs can be very useful. Using virtual labs the student has the possibility to perform experiments online via web-interface in order to learn the course's main purposes in a much more practical way. A virtual laboratory is in a way that gives the student the opportunity to do the same practical exercises via web browser that he could have done locally at our institute. *Surveys* offered at the start and end of each course have a purpose to measure how students attitudes towards development are changing through the semester.

TABLE I
NEW AND IMPROVED PROPOSED CURRICULUM

Digital Communications Syllabus	
Course aims:	After completition of this course, students will develop: 1) Oral and written communication skills 2) Technical knowledge 3) Critical thinking 4) Practical work 5) Team work and discussion 6) Usage of new ICT software
Teaching and Learning Methods:	Teaching and learning methods should include: a) Problem Based Learning (PBL) b) Science writing (seminars, projects, research papers) c) Presentations d) Student teaching e) Online teaching f) Teaching by discussion g) Visiting relevant companies h) Lectures given by experts from industry i) Laboratory work

V. CONCLUSION

Engineers are responsible for developing new products that meet a certain need. To accomplish this, we come up with the new and improved curriculum for communication engineering. The main aim of our proposal is to bring new, improved and updated curriculum, which follows current trends and need. Our idea is to use advantages of all existing methods and propose new one which will integrate successful solutions. Following the curriculum all requests for good education should be accomplished. Curriculum is simple, contemporary, intelligent, and solve all recognized problems in communication engineering education process. It is universal and applicable to all communication engineering courses. It is improves student's qualities through developing student's communication, decision making, critical thinking, collaborative and technical skills. All students who will be trained by this system will be well constructed and rounded. They will have diverse set of skills in complex international environments and therefore much more opportunities to develop their professional carriers. We hope that our new design of improved curriculum will affect quality improvement in whole communication engineering education.

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