RECOMMENDED FOUNDATIONAL KNOWLEDGE IN THEORETICAL ELECTRICAL ENGINEERING FOR MOST UNIVERSITY STUDENTS

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Abstract: *The continuing changes during the last 10-15 years in the Physic syllabus of Bulgarian ordinary high schools and in the Theoretical Electrical Engineering (TEE) syllabus of the Technical University – Sofia lead to cut off some meaningful parts of the teaching content. Thus the continuity between high-school and university education has been seriously disrupted. Apart from that the number of teaching hours for these subjects concerning both types of educational institutions mentioned above has been dramatically reduced. This reality has been hampering university students from understanding the complex TEE content. Their more effective integration in the TEE teaching process demands the adding of a number of preliminary lessons and labs before TU students start studying the discipline TEE.*

Keywords: *education, electrical engineering, syllabus, ordinary high schools, professional high schools.*

1. INTRODUCTION

The initial knowledge about the basics of „Electricity“ and „Electromagnetism“ Bulgarian students acquire in the 7th grade as a part of the school subject „Physics and Astronomy“. The topics discussed are: electric current, electric circuits, electric power and magnetic influence of the electric current. Ohm's and Joule-Lentz's laws are studied in the same grade [1].

The same topics are taught more profoundly and in a greater detail in the 9th grade. The volume and the extent to which this educational content is studied depend on the type of the particular high-school. In the language and ordinary high-schools the themes mentioned above are studied as a part of the Physics syllabus [1].

The situation is very different at the professional high-schools (PHSs) like „John Atanasov“ PHS, the Telecommunications College or the Technological School "Electronic Systems" (TU-ES) associated with the TU-Sofia. Apart from the standard Physics syllabus students in the 9th grade of these PHSs study the subject "Electrical Engineering" with quite an extended syllabus [2]. This discipline is aimed at building an adequate basis for teaching the technical subjects which follow "Electrical Engineering" at PHSs. It also builds the initial knowledge "Theoretical Electrical Engineering" (TEE) syllabuses in Technical Universities count on.

This paper aims at determining the particular levels of knowledge of students coming from different types of Bulgarian high-schools and at spotting the areas where an initial knowledge deficiency is observed from the university TEE point of view.

2. THE ELECTRICAL THEMES IN THE PHYSICS SYLLABUS FOR BULGARIAN ORDINARY HIGH SCHOOLS

Most students entering the TU-Sofia in the last years have been graduated from ordinary high-schools (OHSs) or mathematics and language high-schools where electrical engineering topics make a small part of the Physics syllabus studied in the only 8 out of the 72 Physics teaching hours (t.h.) in the 9^{th} or the 10^{th} grade [1].

The basic quantities taught are: electric current, voltage, power, resistance and capacitance. Students are introduced to the basic electrical elements: resistors, capacitors, coils and transformers theoretically only and also to the Ohm's law (look at Table 1).

Table 1

Teaching hours	*Lesson subject*
1	Capacitors
1	Ohm's law
1	Resistance and electric current
1	Serial and parallel connection of resistors
1	DC electrical source
1	Electrical power
1	Problem solving
1	AC components: coils and transformers

Until 2005 the syllabus for OHSs included additional t.h. for labs during which the class was divided into two groups of not more than 15 students so that individual involvement was possible. In the last 10 years the lack of practice leads to increasing the number of students who study without understanding. This tendency may also be due to the growing lack of demonstration equipment at OHSs. Only 2 out of the 72 Physics t.h. are intended for practicing or demonstrations. The electrical components are not shown physically the students, they are only presented by the teachers in a theoretical manner, as an illustration to the physics laws and formulae [3]. Their function in electrical appliances is not discussed at all.

The knowledge about electrical quantities and components obtained by the students during these 8 t.h. plus the optional 2 hours for demonstration/practice included in the current Physics syllabus for the 9^{th} grade obviously forms an insufficient theoretical base for studying the TEE by students of Technical Universities.

Moreover there is at least a four-year gap between the 9^{th} school grade and the second year at the TU-Sofia when the subject TEE is studied.

3. THE SUBJECT ”ELECTRICAL ENGINEERING” AT BULGARIAN PROFESSIONAL HIGH SCHOOLS

The students of the PHSs study „Electrical Engineering” as a separate discipline with 54 to 126 t.h. in the 9th grade depending on their specialty [2]. The students of the Technological School “Electronic Systems” associated with the TU-Sofia study two disciplines in the 9th grade namely:

- „Electrical Engineering and Electrical Measurement” with 72 t.h.;
- „Electric Circuits“ with 72 t.h.

In the course of study capacitors are not only introduced and their structure explained, but also circuits of capacitors connected in series and in parallel are taught. Equivalent capacitances as well as voltages across the circuit elements are calculated. The electrical quantities: current, voltage, power and resistance are not only introduced and calculated, but also measured by the students during the labs in the 10th grade.

The ways of connecting resistors in DC circuits as well as Ohm‘s and Kirchhoff‘s laws are taught, then students calculate the electrical currents, voltages and powers in simple DC circuits and after that they measure these quantities during the labs. This complex process of introducing theoretical knowledge and having practice with electrical measuring tools in the lab helps students understand the processes in the electric circuits in depth and teaches them to visually distinguish the elements of the electric circuits and the measuring instruments they use during the labs.

Simple AC circuits with resistors, capacitors and coils are also studied and their performance is visualized by graphs. Currents and voltages are calculated using the common high-school level of mathematics avoiding the symbolic method with complex numbers. The students are acquainted with the resonance phenomenon in serial and parallel R-L-C circuits. The labs are incorporated in the theoretical course at „John Atanasov“ professional high school or they form a separate discipline in the 10th grade at TU-ES following the two disciplines studied in the 9th grade.

4. WHERE DOES THE KNOWLEDGE GAP COME FROM?

As a conclusion from the facts stated above, the students in TU-Sofia come with very different levels of knowledge about the electric components, circuits and some or more often none practical experience. In fact the largest number of students comes from OHSs having not even seen how the electric components look like and having no idea about the ways of connecting these components and how to measure electric resistance, currents and voltages.

In [4] the authors have explored in depth a number of factors influencing TEE students’ performance and the reasons why their results have been worsening in the last 10 years after the TEE tutorials in TU-Sofia were reduced by 30 % although the topics taught remained almost the same.

In order to be adequately integrated in the TEE studying process these students need a number of preliminary lessons and labs to acquire the knowledge and experi-

ence which students from PHSs already have. In this way they will have the chance to see the electric elements, to connect them in different kinds of circuits, to calculate the expected values of the currents and voltages and finally to measure these values themselves, thus gaining priceless practical experience and understanding.

Such a preliminary module of TEE has to teach the laws and methods for investigating DC resistor circuits and show students how to calculate the equivalent capacitance of connected capacitors and the DC voltage on each of them. It is very important for students coming from ordinary high schools to acquire practical experience with handling measuring tools, switching among their different modes of measuring and connecting these tools to the electric circuits.

This can help breaking the barriers most of students come with and eliminate the fear of being inadequate in comparison with the students coming from PHSs.

5. CONCLUSION

As mentioned, in [4] the problems students encounter during their transition from high-school to university level of education are discussed. Even the students coming from PHSs who have studied additional subjects like „Electrical engineering" and „Electric Circuits" have difficulties in understanding the complex TEE teaching content in the second TU year. It's not hard to imagine how the students coming from OHSs feel having studied only 8 t.h. electrical engineering teaching content incorporated in their 9^{th} grade Physics syllabus.

The lack of a solid and profound basis due to the very few teaching hours and the scarce teaching content leads to a dramatically hard adjustment of these students to the complexity of the academic discipline TEE. The transition from the elementary level of studying of the themes mentioned above at the high-school level to the academic demands of the university level is additionally hampered by the students' insufficient level of mathematics knowledge.

That is why the authors propose the introduction of a preliminary teaching module aiming at smoothing the transition of students from high-school to university level and filling the knowledge gap most of them come with.

References

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