Electrical Engineering Education Systems in Finnish and Chinese Universities

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(*Invited Paper*)

Abstract— Electrical engineering education systems at the university level in Finland and China are introduced in part and compared in this paper according to the author's personal education experiences in these two countries. In addition, several simple yet effective in-class demonstrative experiments or tools for undergraduate students taking my fundamental electromagnetic course are introduced.

1. INTRODUCTION

Electrical engineering is certainly one popular major that most undergraduate students are willing to choose [1–3]. As a result, it is usually one of the largest departments in an overwhelming majority of universities all over the world [4]. However, educational systems for electrical engineering may vary from country to country. It might then be interesting to make comparisons between these systems. These comparisons will possibly be helpful for the administrative personnel in universities, when there are desires to reform current educational systems, and to draw lessons from experiences and strategies of foreign universities. In Section 2 of this paper, comparisons will be conducted between electrical engineering education systems in Finnish and Chinese universities. The focus will cover curriculum design for undergraduate students, eligibility examination (trail lectures to a group of experienced educators as the audience) for new lecturers, and lecturer evaluation system. Also, responses and suggested modifications to the current educational systems from Chinese undergraduate students will be presented briefly.

Nevertheless, the very first question a reader may raise is why you choose Finnish and Chinese universities specifically. My personally educational experiences and current profession would be the straightforward explanation. Born and bred in Harbin, I was cultivated in education systems of a Chinese style from eight to twenty-five when I was granted the master degree. A new chapter of my education began in Helsinki, Finland, where I lived and worked for six years and achieved my doctoral degree, conveniently. Therefore, I am familiar with the educational systems in Finnish universities. Presently, I am an associate professor in Harbin Institute of Technology (HIT), a top 10 university in China and the largest one in northeastern China. It would then be reasonable to consider myself part of the educational systems in Chinese universities, or at least in HIT. Those are the reasons I choose Finnish and Chinese universities as the topic.

In Section 3, a rather different yet relevant issue will be discussed. I will present several simple yet effective in-class demonstrative experiments/tools for undergraduate students taking my fundamental electromagnetic course.

2. EDUCATION SYSTEM COMPARISON BETWEEN FINNISH AND CHINESE UNIVERSITIES

Electrical engineering educational system covers a very broad range of topics and issues that would be impossible to discuss thoroughly in this paper. Only a few selected yet interesting topics will be discussed in this section.

2.1. Curriculum Design

There is not any obvious divergence between the Finnish curriculum and the Chinese counterpart. The main distinction can be properly summarized with one word, i.e., freedom. In Finland, college students have more freedom to customize their curriculum in order to accumulate credit points. Indeed, courses such as Mathematics are mandatory, but they still have freedom to choose a majority of their major and minor courses, according to their own interests and advices from supervisors and instructors. Backside of such a system could be that students may avoid intentionally those 'boring' but courses of fundamental importance. Such a decision won't prevent them achieving a degree but may have a long-term impact on their future career. On the contrary, Chinese college students do not have many choices. Academy committee in each school is responsible to design the four-year curriculum for their students. Students have to pass each course listed to complete their Bachelor degree, no matter whether they are interested or follow the specific course. It seems to me that Chinese college students resemble rare materials in a massive manufacturing factory, where they will undergo exactly the same processing. The question is how you can expect diversification from these 'products'.

2.2. Eligibility Examination for Lecturers

According to my best knowledge, such an eligibility examination for lecturers is a peculiar characteristic in Chinese universities. The rules of this exam are as follows. For a newly employed college lecturer, who plans to give a specific lecture, he has to complete and submit the detailed lecture notes of the whole course to the teaching committee of the university, which will undergo strict inspections by a group of experienced lectures. If your lecture notes meet their requirements, the committee will randomly choose a chapter from them as the contents of your eligibility examination. Only two days are given to prepare for this trail lecture, whose audience will then be the same group of professors examining your lecture notes. This examination will be held twice annually, and the passing rate is around 80%. As far as I am concerned, such a system would effectively urge the lecturers to thoroughly prepare his lectures in advance, since you can hardly give an excellent lecture on a topic you are not extremely familiar with after a two-day preparation.

2.3. Lecturer Evaluation System

Both Finnish and Chinese universities have such a system for undergraduate students to evaluate the corresponding lecturer at the end of an academic semester. Such a system reflects from the viewpoint of a student that whether the lecturer was familiar with the lecture contents, whether he managed to present the contents logically and fluently, whether he gave enough practical examples, whether his lecture was easy to follow, etc., and most importantly, what are the suggestion to this lecturer to improve his lecture? The results of this evaluation are very helpful for lectures which point out clearly the way he should work out to improve his lectures. In particular, three overall grades (A, B, and C) exist in the lecturer evaluation system in HIT. Also, a harsh regulation is that if a lecture who received an overall evaluation grade worse than B. He will automatically lose the eligibility to give a lecture in the coming semester until he passes the eligibility exam.

2.4. Response to Current Systems from Undergraduate Students

Unfortunately, I have not done any survey regarding this point to Finnish college students. However, a recent survey, conducted in School of Electronics and Information Engineering, HIT for the third-year undergraduates, shows that there is a non-negligible demand for the redesign of current curriculum. Students ask for more rights to choose at least their minor courses according to their personal interests instead of the experiences of the academy committee. In addition, some students hope the lecturers could upgrade the textbook or at least the lecture notes to introduce more cutting-edge developments related to the lectures. A majority of students anticipate that there will be more technical training courses in the curriculum, such as Matlab programming, and training courses of popular commercial full wave simulation software. According to student's responses, our school made the decision that each department should offer students relevant courses in the coming autumn semester in September, in order to improve their capability to manipulate useful computational software. It is believed that such a renovation in curriculum could better prepare students for their future academic or industrial careers.

3. IN-CLASS DEMONSTRATIVE EXPERIMENTS OR TOOLS

Fundamental electromagnetic courses always seem like a Himalayas to the students, both mathematically and physically. Mathematically speaking, students are not familiar with vector calculus, such as divergence and curl, leaving alone the cylindrical or the spherical coordinate systems. However, the mathematical complexities can be conquered by continuing practice [5]. The coherent difficulty of such courses for students lies in its abstract concepts and 'invisible' physical process to human eyes. In order to facilitate students' understanding, lecturers could take advantages of the triple E, i.e., examples, experimental demonstrations, and electromagnetic simulations. In this section, three simple yet effective in-class demonstrative experiments or tools for undergraduate students taking my fundamental electromagnetic course will be introduced.

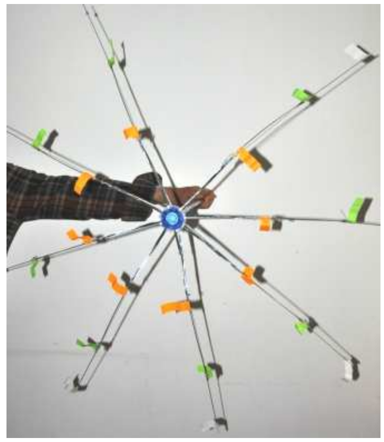


Figure 1: A foldable in-class demonstrative tool for divergence and curl.

3.1. Divergence and Curl

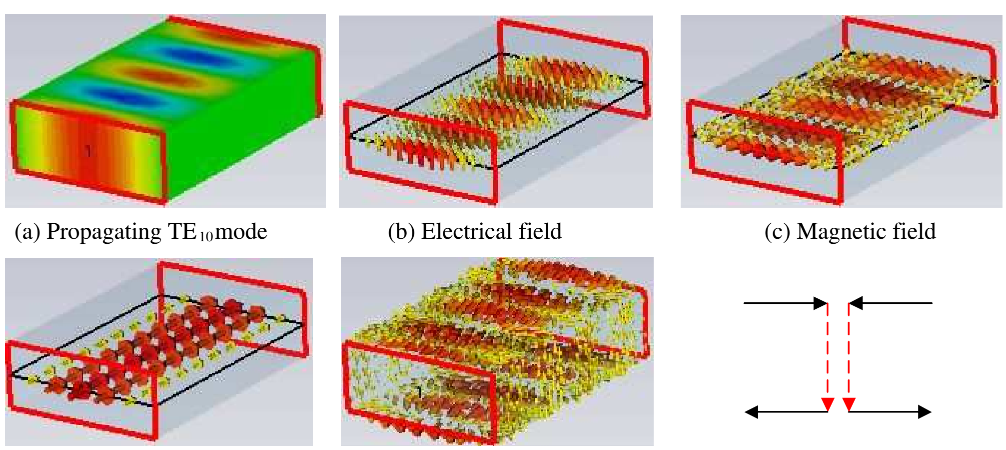
Divergence and Curl are mathematical operators of fundamental physical importance, as they are main operators or notations in Maxwell's Equations. Divergence of a given vector indicates the existence of a flux source or sink, while curl of a vector shows that of a rotational source. How can we impress students with the vector lines produced by different sources? A few pictures may be an easy choice, but they are still motionless and not straightforward examples. As shown in Fig. 1, a foldable in-class demonstrative tool with light weight that I constructed may solve this puzzle. It is made from a foldable broken umbrella. When held still, its shaft is the flux source and the ribs represent the vector lines. When I rotate the umbrella shaft, which is thus the rotational source, the motion of stickers of different colors will visualize the closed vector lines clearly.

3.2. Skin Depth

The skin depth is also an important concept, which quantifies the penetrable depth a wave can propagate into a lossy material including metal. By placing a cell phone in a concealed metal box, one can easily demonstrate this effect.

3.3. Modes in a Rectangular Waveguide

The mode in a rectangular waveguide is another abstract concept, and its propagation is also difficult for students to imagine. In this case, animations generated by commercial full wave computational packages could be a lifesaver. Let us take TE_{10} mode as an example. As shown in Fig. 2(a), the guided wave clearly travels along the waveguide, and forms a standing wave on the transverse plane. Figs. 2(b), 2(c), and 2(d) visualize the electrical field, the magnetic field, and the



(a) Propagating TE_{10} mode (b) Electrical field (c) Magnetic field

(d) Poynting vector (e) Surface currents (f) Displacement current

Figure 2: Simulated TE_{10} mode in a given rectangular waveguide. The conceived red-dashed displacement current (with black lines representing the surface currents) in (f) completes the physical process how a propagating TE_{10} mode is generated in the waveguide.

time averaged Poynting vector, respectively. The surface current distribution is shown in Fig. 2(e), which helps us to conceive the displacement current (red dashed lines) in Fig. 2(f). It will finally help students to understand the physical process how a propagating TE_{10} mode is generated in waveguide.

4. CONCLUSION

Electrical engineering education systems at the university level in Finland and China were introduced and compared in this paper according to the author's personal education experiences in these two countries. These comparisons would possibly be helpful for the administrative personnel in universities, when there are desires to reform current educational systems, and draw lessons from experiences and strategies of foreign universities. In addition, several simple yet effective in-class demonstrative experiments or tools for undergraduate students taking my fundamental electromagnetic course were introduced, which can facilitate the students' understanding of abstract concepts and 'invisible' physical process of electromagnetics.

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