The Reform and Practice Exploration of Teaching Method of Signals and Systems Course

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Abstract. The signals and systems are professional core curriculum of information science and electrical engineering, which are directly related to the teaching quality of the follow-up courses. At present, according to basic situation of teaching practice in the signals and systems in our university, and combined with the training objectives of professional excellence project, according to the teaching content and teaching methods of the signals and systems, we make the corresponding reform measures, take the course group as the teaching unit, combine theory with practice as teaching scheme, and understand the abstract concept of the physical. In addition, the network teaching section is added, which is complementary to the classroom teaching and improves the efficiency and flexibility of the study.

Introduction

The rapid development of electronic information science has become a catalyst to promote the development of other traditional industries. In recent years, with the development of networking and cloud computing technology, the electronic information technology has become a bridge between the physical world and the virtual world, and will greatly promote the development of social economy and improve the human living environment and quality of life. Electronic information technology is closely related to the contribution of innovative talents in its early age. In the modern Internet era, the demand for innovative talents is more and higher than ever before [1]. At present, our country's higher education has entered a connotation development stage of improving the quality. It is very important to accelerate the construction of excellent course resources to deepen the teaching reform and improve the quality of teaching [2].

The signals and systems are required course for undergraduate students in the fields of electronic information, communication engineering and automatic control. This course is based on the advanced mathematics, engineering mathematics and circuit analysis courses, and is the basis for subsequent courses such as digital signal processing, communication principle, automatic control principle and modern digital signal processing for graduate. It is a theoretical and practical course for a wide range of professional area. In recent years, a lot of teaching research and reform work in the signals and systems teaching area has been done in many universities, and practice teaching plays an important role in teaching, so it is the focus of teaching reform [3].

In this paper, combining with the characteristics of Shanghai University of Engineering Science, a lot of reform work has been done on the optimization of the practice teaching section and content, and make the implementation of the "curriculum group" reform. The research group also explores the practice of network teaching mode, and combines the network teaching with traditional classroom teaching, and learns from each other, in order to achieve better teaching effect.
1. Curriculum Group Reform

1.1 Disadvantages of Curriculum Arrangement

Authors believe that the construction of the curriculum group in our university has the following problems: (1) Putting too much emphasis on theory, making mathematical analysis too prominent, lacking of integrating theory with practice, and making the application unclear. A huge volume of textbook, a large number of mathematical formulas and their corresponding derivation processes, many key points needed to understand and master, all of these increases the difficulty of learning, and makes students form a psychological fear in learning and lose their interest and confidence in subsequent courses; (2) The selected reference [4] in our university, which contains the time domain analysis of discrete time systems, Z transform and discrete Fourier transform in the discrete part, repeats the first three chapters of the literature [5], and to implement teaching according to the teaching plan will make part of the contents repeated and result in a waste of time in limited class hours; (3) The design of digital filter is one of the core contents of digital signal processing course, but this part is missing in the signals and systems course; (4) There is no organic whole formed in the repeating part of the course with usually bad cooperation in the teaching process, which results in the repetition and the irrelevance in the teaching, and man-made obstacles for students to grasp the knowledge point.

Therefore, these problems exist in the arrangement of the curriculum, in a sense, which bring some difficulties for teachers to teach and for students to learn the course.

1.2 Integration of Related Courses in Curriculum Group

Three courses of the signals and systems course group have different emphases: signals and systems focuses on the description and analysis of system; digital signal processing focuses on the methods and techniques of the realization of digital signal processing; technology and application of DSP focuses on the development of software and hardware of DSP. When we form the course groups, in order to solve the contradiction between the class hours and teaching contents, it is necessary to optimize the integration of the three courses in the curriculum group, to form teaching mode under the concept of course groups: Taking the signal description as the basis, system analysis for the bridge, processing technology as a means, and design system as the purpose, and realize the combination of the principle, method and application, so that students can systematically master the content of the course.

The basic goal of the construction of signals and systems course group is to improve the quality of personnel training and the level of curriculum group construction, to realize the scale effect, and to improve the efficiency of the curriculum construction, so only the integration can remove duplicate content, and only the integration can organize the teaching resources in a unified coordination, and break the barriers of curriculum, experiment, faculty members, and so on. According to the training target, the connection and synthesis of the course are strengthened in the logic and structure, so that the teaching resources can realize the sharing and improve the whole running efficiency [6].

2. Curriculum Teaching Content Reform

Signals and systems course are professional basic course, which mainly research the transmission processing and analysis methods of the deterministic signal by invariant system, and are generally divided into two systems (continuous time system, discrete time system), two kinds of analysis method (input and output description method, state variable description), three transforms (Fourier transform, Laplace transform, Z transform). As a main course of engineering major, it focuses on case analysis, with communication and control engineering as the engineering application background [7].

At present, there are two main ways to arrange the signals and systems course in domestic and
foreign universities: one is firstly continuous time signals and systems and then discrete time signals and systems; the other is firstly time domain analysis, then frequency domain analysis (Fourier transform), and lastly Z transform, with continuous and discrete time teaching alternatively. The debate over the two teaching orders has been last for many years. According to the textbooks written by domestic and foreign authors, a variety of writing sequence for the signals and systems course materials will coexist for a long time. For example, Zheng Junli, wrote his textbook of the signals and systems in the first order, while Wu Dazheng wrote his using the second order. Both have their own advantages and it is very hard to prove which one is better in nature. However, taking into account the student’s way of thinking is easy to accept, teaching with alternating the continuous time signals and systems and discrete time signals and systems makes students easier to learn in comparison, and through the comparison of learning, deepens their understanding of the abstract theory of knowledge.

In recent years, due to the teaching reform of college curriculum, the reduction of class hours on basic theory, and the increasing of practice teaching hours, the theoretical class hours in the course of signals and systems are reduced from the original 64 hours to 48 hours. The reduction of hours presents a greater challenge for the reform of teaching content. In view of the problem of the reduction of class hours, the teachers adopt the engineering-oriented teaching method by replacing tedious mathematical formula derivation with actual engineering cases. This teaching reform shifts from abstract to reality and from theory to practice, which not only improves the quality of teaching, but also makes the students to change from the original boring passive learning into now active hands-on learning, with learning interest and efficiency greatly enhanced.

3. Reform of Teaching Ways and Methods

Traditional teaching methods of Signals and systems are injective and nanny-based, while too many theoretical contents and mathematical formula derivation make students fearful and weary. Therefore, how to improve the students’ learning interest, coordinate with the engineering practice and successfully complete the contents in the syllabus in reduced class hours is the key to the teaching reform of the course.

3.1 Combination of Traditional Teaching with Heuristic Teaching

Teachers not only use traditional teaching methods, but also highlight the concept of heuristic teaching with students as the center, by using the inspiring and cultivating ability as the basic principle, combining lectures with discussion method and experiment and practice to improve students’ ability of flexible using knowledge, analyzing and solving problems. Under the circumstance of reduced class hours, the teachers should arrange the contents correspondingly, with focus on the core contents, general explanation on general contents, and with the unimportant contents left for the students to self-study. Classroom teaching process focuses on the cultivation of students' thinking ability. With innovative thinking, students can not only easily self-study the contents which is not covered by teachers, but also be able to independently innovate new things [8].

3.2 Weaken the Mathematical Derivation, Strengthen the Physical Concept

The signals and systems course are applied course with quite a lot of complex mathematical formula derivations, so the teaching focus should be put on the physical connotation of theories and methods of the signals and systems reflected by mathematical models, mathematical formulas and mathematical representations, pay attention to correct and overcome students’ weakness staying in mathematical understanding. Although the contents of signals and systems are mature and complete, its theory and methods can be described and characterized by rigorous mathematical theory, it has a strong physical background and application. On the one hand, teachers should guide students to quickly grasp the essence of the theory of signals and systems and method by using mathematical tools. On the other hand, teachers should focus on explaining the physical concept and methods
reflected by mathematical abstraction. In this way, we can make students to understand the nature of the course content from the abstract to the specific, and to master the essence of the curriculum. For example, when they study the impulse response of linear time invariant system, in the case of stable system, the input is impulse signal, while the output is continuous attenuation signal. If many students feel difficult to understand and teachers can guide students to think of the problem into the actual circuit (the components of circuit system have a capacitive and inductive charging and discharging effect), it deepens students' understanding of the physical concept.

3.3 Combination of Traditional and Modern Teaching Methods

The traditional teaching mainly depends on teachers’ writing on the blackboard and students’ taking notes. Although the idea has advantages of detailed and rigorous derivation of the formula, this teaching method increases teachers’ labor intensity, at the same time, the dull atmosphere of the classroom also reduces the students’ interest in learning. Although there is "sound" and "color" in modern audio-visual teaching, too much sensor stimulation will make students tired. In addition, audio-visual method sends much more information to the students in the classroom teaching than the traditional teaching method. If students do not timely review after class, it will lead to a lively classroom, difficult homework after class and unsatisfactory final grades at last. Both the traditional teaching and modern audio-visual teaching have advantages and disadvantages and play different roles in the process of teaching. To improve the teaching effect, teachers should learn from each other and use different teaching methods flexibly. Therefore, in our teaching process, the author applies a variety of teaching methods flexibly based on the characteristics of the curriculum, such as the audio-visual teaching supplemented by traditional teaching mode, in order to improve the teaching efficiency and students’ learning interest.

Modern audio-visual teaching method can be divided into two modes: "multimedia teaching” and "network teaching". Multimedia teaching mainly refers to the use of multimedia in classroom teaching, which requires courseware preparation. Visual demonstration helps conveniently explain abstract concepts, and multimedia teaching can also increase the number of application examples to broaden the students' knowledge and improve students’ learning interest. But this kind of teaching method also has some shortcomings, such as too much visual impact will cause students visual fatigue. In order to make up for the limitation of the traditional teaching mode and the multimedia teaching method, we are actively building the network course of signals and systems. Course website creates conditions for students to self-study and provides help and guidance. Teachers will place the syllabus and requirements, courseware, exercises, simulation questions and experimental resources on the course website. Students can learn easily. The online communication module is convenient for teachers to guide students and answer questions, which strengthens the communication between teachers and students, and improves the students’ interest in learning. Of course, teachers should guide and supervise the students to visit the course website, actively use the rich learning resources. For example, teachers upload the traditional paper work online, and students are required to log in their accounts and complete regulated number of exercises. The system will score in real-time, and this part of study will be included in the final results. The network course can overcome the time and place limitation of the traditional teaching, and promote the improvement of the teaching quality.

4. Strengthening Practical Teaching

Signals and systems are basic courses which have a strong practicability and cover a wide range of professions. The course teaching puts a high demand on the theory and practice. How to apply the key concepts of the course, the basic theory and its application in all aspects of information technology in the modern society together and closely, to make students establish links between theory and practical application in the learning is the core requirements of the curriculum system. MATLAB has the ability of powerful numerical analysis and visualization of the results of the calculation, which
provides a strong support for the practice of the course. Its Simulink supports linear and nonlinear systems, continuous time systems, discrete-time systems, continuous and discrete hybrid systems, and the system can be multi process [9].

To learn with the help of MATLAB, solving can be simplified and rapid analyzed, understandable and vivid images and graphics will help focus on learning abstract concepts, focus on the principle of understanding and reduce the tedious derivation and unnecessary computations. Therefore, in the course of experiment teaching, the combination of hardware and software can be used. In the software experiments, by using MATLAB, students can not only modify the parameters, compare the experimental results, but also design their own system simulation, which strengthens the comprehensive design ability of students. In the hardware experiments, the practical ability and the ability to analyze problems of the students has been improved. The combination of software simulation and hardware experiment not just fully realize the intuitive, real-time, realistic, flexible operation characteristics of the software experiment, and compared with the previous experiments which only completed the actual circuit adjustment, it greatly improves the students’ experimental interest and plays a better teaching effect. Through the experiment mode of combining hardware and software, it not only improves the practical ability of students, deepens the understanding of theoretical knowledge, but also enables students to contact with advanced design tools, to mobilize their enthusiasm and initiative, and to stimulate their desire to learn.

Only practice teaching is not enough, usually we only have 8 hours experimental teaching, which cannot greatly improve the students’ practical ability, so we should try to use the students’ rest time and laboratory spare time, and organize the students into practices related to professional courses, and form interest groups to increase the students’ practice time. And we should open more experimental elective courses to increase students’ practice opportunities. Students’ engineering practice ability should start from the day-to-day management of the laboratory, simple equipment maintenance, as well as the connection and welding of the circuit wire. All these can let the students to try and participate.

Experimental assessment methods change from a single assessment of basic experimental requirements into three assessments, with the basic experiment now accounting for 40%, the experimental design accounting for 40%, and attending usually accounting for the rest 20%, which actively mobilize students’ initiative and participation, and better integrate the theoretical knowledge in practice, more focus on the flexible application of the basic principles and concepts, at the same time, improve students’ analyzing and problem-solving ability.

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References

