

Teaching Reform and Practice for the Course of "Signal and System"

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Abstract. With reform of teaching of Signal and System as the starting point, it mainly discussed the following four aspects: The first is optimization of the theoretical teaching content; the second is exploration and practice of new teaching methods and measures; the third is reform of the experiment and practice teaching; and the fourth is reform of the course assessment system. Practice shows that the students' interest in learning is increased, they are changed from passive learning to initiative exploring, their abilities of problem solving and innovation are significantly enhanced and their academic performance increased remarkably.

Introduction

Signal and System course is a basic backbone specialized course of electronic information type with strong theoretical and practical properties, which carries out time domain and transform domain analysis to deterministic signals with higher mathematics, linear algebra, complex variables functions and principles of circuits. As a key course that leads students from the knowledge field of circuit analysis to the field of signal processing and transmission, it plays the role of connecting link for subsequent specialized courses such as principle of automatic control, principle of communication and digital signal processing [1-2]. In recent years, Signal and System course has been changing and the theory and practice research has been continuously developing [3-4]. On the one hand, various analytical methods is constantly updated and the object of application is expanding. On the other hand, the teaching forms of virtual simulation and MOOC have become a development trend of this course. In order to let students deeply understand and master this course and improve teaching quality, the Signal and System research group carried out in-depth investigation, earnestly summarized and explored teaching methods and modes for Signal and System.

Optimization of Teaching Content

Rational Organization of Teaching Content. The Signal and System course mainly discusses time domain of deterministic signals, description and characteristics of LTI as well as time domain analysis and transform domain analysis of invariant system when signals pass linearity. This course mainly studies basic concept, basic theory and basic analysis methods of deterministic signals and linear time invariant system (LTI), the content mainly includes time-domain analysis of continuous system and discrete system, frequency-domain analysis of continuous system, plural frequency domain analysis of continuous system and z-domain analysis of discrete system as well as interrelation and detailed application of these analysis methods. The knowledge is arranged as continuous before discrete, firstly concentrate on studying continuous signals and system analysis, and then understand the concepts of discrete signals and system analysis by analogy, thus establishing complete concept of Signal and System. The content of Signal and System course is shown as Fig. 1.

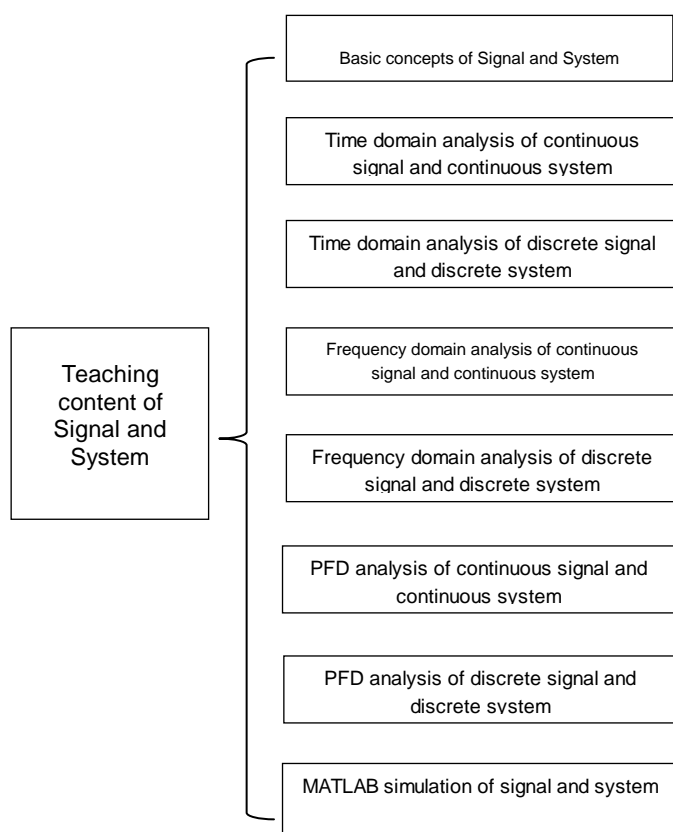


Figure 1. Content signal and system teaching

Emphasize Individualized Teaching and Hierarchical Teaching to Meet Requirements of Students at Different Level. As students vary from their accumulation of knowledge, personal interests, employment intention, so it shall pay special attention to implementing hierarchical teaching. According to the actual situation of students of a class, they are divided into three levels: Students with sound basic knowledge, strong acceptability and intention of sitting in postgraduate entrance examination; employment-oriented students; and students with poor basic knowledge. Thus, it not only focus on common development and improvement of all students, but also pay attention to breakthrough of some students. In addition to master basic requirements, students at the first level should study course content system deeper, master question solving skills of Signal and System, try best to pass the postgraduate entrance exam of this course; students at the second level should master basic requirements for laying basis for studying specialized course; students at the third level should be helped to master basic requirements of this course and try to pass exams of this course. Therefore, in the classroom teaching process, the teaching content is organized according to three levels, teach according to the highest levels, but carry out strict classified guidance, make clear which content should be mastered or understood by which level, and exam according to the minimum requirement of syllabus.

Reform of Teaching Methods and Teaching Measures

Introducing "45341" University Efficient Classroom Teaching Mode. we introduced Harbin Normal University's "45341" university efficiency classroom teaching mode that was awarded national teaching achievement prize in 2014[5]. The first "4" refers to "four-dimensional objective" of classroom teaching, that are four main training objectives of knowledge, abilities, moral qualities and innovative quality; "5" refers to that each lesson should determine five points i.e. importance, difficulty, blank point and innovative point of such lesson in teaching design according to "four-dimensional objectives" and detailed teaching content, teachers shall "giving classes with such five points in mind";

"3" refers to "three-explanation", i.e. teachers shall explain content of three aspects in the class: Basic knowledge structure; the forefront questions and development trend of content of this lesson; the second "4" refers to "four-have" that is each class must have at least a scientific and systematical design, deep and appropriate questions, discussion and dialogue and suited cases; the last "1" refers to "one guide" that is to guide students in learning method and homework.

Physical Significance Based Discussion of Signal and System Teaching Methods. Many of the concepts of Signal and System are derived from mathematical theory, and then obtained by modeling[6]. However, this course cannot be taught as mathematics, but emphasize on physical significance of the results. when signal multiplexing is taught, it can educe GSM mobile phones that discriminate signals of different users with different time slot multiplexing as well as CDMA mobile phones that discriminate signals of different users with different orthogonal spreading codes; and when signal filtering of filter is taught, it can be analyzed and explained with practical application voice and image de-noising and FHS extraction. With these practical engineering, students can deeply experience the application of the knowledge they learnt.

Interactive and Communicative Teaching. There are large amount of repetition between the course of Signal and System and relevant courses[7]. The course of "Circuit Theory" of our university is provided in the third semester, while the courses of Signal and System and "Automatic Control Principle" are provided in the fourth semester, which lays basis for reform of interactive and communicative teaching. Since this course is highly theoretical and involves more mathematical knowledge, chapters with relevant content in "Circuit Principle" and "Automatic Control Principle" that students have learnt before is selected in teaching of Signal and System for carrying out reform of interactive and communicative teaching. Result survey of interactive and communicative teaching is shown in Table 1.

Table 1 Result survey table of interactive and communicative teaching

Knowledge point mastery of the courses of Circuit Principle and Automatic Control Principle before studying Signal and System				Knowledge point mastery of the courses of Circuit Principle and Automatic Control Principle after studying Signal and System			
Deeply understand	Generally understand	Remember	Completely forget	Deeply understand	Generally understand	Remember some relevant knowledge point	Still do not understand
10%	25%	50%	15%	45%	40%	10%	5%
Overall satisfaction of interactive and communicative teaching				Whether interactive and communicative teaching worth to be popularized			
Very satisfactory	Relatively satisfied	Generally satisfactory	Not satisfactory	Very worth	Relatively worth	Generally worth	Not worth
56%	39%	5%	0%	55%	41%	4%	0%
Mobilize initiative of study				Strengthen team spirit			
Quite favorable	Favorable	Normal	Not favorable	Quite favorable	Favorable	Normal	Not favorable
55%	40%	5%	0%	55%	45%	10%	0%

Reform of Experimental and Practical Teaching

Hardware Test Is Integrated with Software Simulation. There are two common ways for experiment teaching: Signal and system experimental kit based hardware experiment teaching and

MATLAB based simulated experiment teaching[8-9]. it cannot achieve favorable experiment teaching result by a single platform, so the research group discussed a kind of "software + hardware combined" dual-platform experiment teaching mode, the teaching with hardware platform is done in lab and the experiment with the software platform can be done by students in extracurricular time. The students have to write program and finish simulated test before carrying out hardware experiment, and then compare the hardware experiment result with that of simulated experiment. By taking this kind of dual-platform teaching method, on the one hand it deepens the understanding to experiment knowledge points and realize favorable experiment effects, on the other hand it cultivates students' abilities of problem solving and analyzing.

Network Experiment Course. In reform of this time, experimental course is added into teaching content, but the total class hour shall not take up classroom time. Therefore, the experiment course is carried out online. Release the subject, objective, content, step and data of the experiment to be carried out, set time for submitting test report and simulation program, meanwhile teachers can carry out guidance and exchange within appointed time. By utilizing network platform, the problem of tight class hour is solved and students have more freedom for independent arranging their study, which is helpful for students to learn self-management and self-discipline and improve study efficiency.

Reform of Assessment System

Course examination and scoring are crucial components of the whole teaching process[10]. Examination and scoring methods play the role of guiding in study of students and teaching of teachers, especially have powerful guiding function to students' striving direction and fostering of study method. Therefore, establishing course examination and scoring methods that match to the objectives of the course is a non-negligible link of teaching reform.

Integrating Open-book and Close-Book Examination, Bring the Educational Function of Examination into Play. Paper examination includes both open-book examination and close-book examination. The final examination adopts close-book examination that focuses on realizing management function of examination. Open-book examination is selected for quiz organized in the course implementation process, which focus on instructing teaching activities, solving problems in teaching process, help teachers and students to timely adjust and perfect teaching activities in order to supplement insufficiency of final examination on bring the functions of education into play. Open-book quiz is periodical tests which are usually carried out when students feel difficult to understand or after the chapters that are closely associated with application.

Integrate Independence and Cooperation and Cultivate Teamwork Spirit. In course training, the condition that students collaboratively finish task driven by project or interest will be assessed. This course training firstly cultivates students' abilities of independently obtaining and utilizing knowledge since the knowledge or skill required for finishing tasks have to be mastered by self-study; secondly it cultivates students' teamwork spirit and management abilities such as planning, organizing and coordinating; thirdly, it integrates theoretical knowledge and multi-media technology to promote modernization and functionization of teaching content; fourthly, it arouses the students' interest in studying this course.

Integrating Results and Process and Promoting Overall Development of Students. Course study is a dynamic process, so the limitation of original course assessment can be improved by incorporating main teaching activities in the process of course implementation into course assessment items[15]. Process assessment items include: daily homework scores (including reading reports, summarizing), scores of teaching activities participation (such as students commenting homework, curricular and extracurricular questioning and communication) and open book quiz scores. Comparing to static assessment, the process assessment is open on space, the time span across the whole course implementation process, and the assessment content focuses on usual study behaviors and pays attention to quality training. Process assessment items include: the first is cultivating the scientific

attitude of being practical and realistic and establishing good style of study. The second is improving written and oral expression skills. The third is cultivating independent studying ability.

Conclusion

Over the years, the research group has been paying attention to teaching and guiding construction of this course with advanced teaching philosophy. Continuously carry out teaching content optimization and knowledge system reform, and continuously strengthen this course's position of basic specialized course. Students better and better master and understand basic theories of Signal and System, they pay more and more attention to this course, changed from passive study to initiative exploration, their problem solving ability and innovative ability are enhanced and the assessment results are promoted year by year. From 2014 to 2015, the research group visited some enterprises, and our university's graduates highly appreciated the teaching results of Signal and System course, degree of integration with practical production and, its help to and knowledge reserve for subsequent study and work.

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