

Signal and System Experimental Research under the Background of Engineering Education Certification

Xiaojuan Wei
School of Electrical Engineering
Northwest Minzu University
Lanzhou, China
weixiaojuan@impcas.ac.cn

Abstract—In recent years, higher engineering education has widely implemented engineering accreditation. In the accreditation of higher education engineering in China, experiment teaching is an important basis for certified experts to consider whether students can meet the requirements of graduation. Signals and Systems is an important professional basic course in science and engineering universities. This course has the characteristics of abstract concept, strong theoretical and practicality. After learning, students generally reflect that it is boring and difficult to understand, and they cannot translate the theoretical knowledge learned in the classroom into practical application. Combined with the requirements of engineering applied talents training under the background of engineering education accreditation, this paper puts forward experiment teaching strategy change as well as evaluation system and other reforms, takes ability and practical training as the core, focuses on improving students' initiative and learning interests and emphasizes on the cultivation of practical ability and innovation ability so that students can consolidate their theoretical knowledge through experiments and solve the practical problems of engineering, thus achieving the related indexes in educational engineering accreditation.

Keywords—*Signals and Systems; Engineering accreditation; Research and practice*

I. INTRODUCTION

Engineering education accreditation (hereinafter referred to as “engineering accreditation”) is a significant work faced by domestic higher engineering education in recent years, which aims at performing the specialized accreditation for each major of higher engineering education through national or international professional associations, professional societies as well as educational experts and enterprise experts in the related fields, so as to provide the quality guarantee of preliminary education for related engineering technology talents to obtain employment in the industrial circle. Engineering accreditation is an international quality assurance system of engineering education, which has great significance for the realization of international mutual recognition of engineering education and engineer qualifications[1].

The core of engineering accreditation is to confirm whether

This work is supported by Gansu Province Science Foundation for Youths (17JR5RA281), Fundamental Research Funds for the Central Universities of Northwest Minzu University of China (31920180039, 31920180120) and by the Teaching Reform Project of Northwest Minzu University of China.

the graduates of engineering majors meet the quality standards recognized by the industry, emphasize that higher engineering education should take training objectives and the requirements of graduation export as the guidance, and require the establishment of specialized course system as well as course teaching, teaching staff, allocation of school running conditions and so on all revolve around the core task of cultivating students' graduation ability. In this context, facing the requirements of engineering accreditation, strengthening the training of students' ability by specialized course education has become the main task and objective of specialty course construction and teaching in higher engineering education[2].

“Signals and Systems” is a core course of electronic information majors such as communication engineering, electronic information engineering, automation and so on. At the same time, it is also one of the entrance examination courses for most master and doctoral students majoring in electronic information. The contents of this course include signal analysis, time and frequency-domain analysis of continuous time system and discrete-time system, Fourier transform, Laplace transformation and Z transformation, etc[3]. The concept is more abstract, and the mathematical operation is more tedious. Moreover, the analysis results lack the visual presentation. It is difficult for students to understand the practical application of the results in signal processing. Therefore, under the background of engineering accreditation, how to solve the problem of the experiment content and the cultivation of students' engineering application ability in the experiment teaching of “Signals and Systems” is a major problem that must be studied and solved, which has great significance to the cultivation of academic consciousness and the improvement of comprehensive ability for students majoring in electronic information.

II. TRAINING OBJECTIVES UNDER THE BACKGROUND OF ENGINEERING ACCREDITATION

Each university has its own school-running characteristics and theories on school management, and has its own clear personnel training mode and objective according to its self-positioning. The ideas of talent training are reflected directly in the teaching link. At present, domestic universities can be divided into academic ability training and engineering ability

training in the aspect of talent training according to the different levels of running school. Academic ability training mainly faces students who continue to study for master degree or enter scientific research institutions. For this kind of students, the teaching process should emphasize the integrity of the theoretical system and the ability training of algorithm design, so as to make the students have a solid ability of signal processing and system analysis, and lay a good foundation for the future research work. The engineering ability is the talent training objective of many local universities. The engineering ability training mainly serves the employment of the industry, and the training link strengthens the engineering literacy of students and the ability to solve the practical problems in the engineering. In this process, the teachers should focus on the practical links and set up some systematic and design experiments from the shallower to the deeper through teasing out basic theoretical knowledge, so as to stimulate learning interest of students and clarify the learning objectives.

As a key course to guide students from circuit analysis to the field of information processing and transmission, "Signals and Systems" also plays a pivotal role in the subsequent majors and professional basic courses. The teaching connotation of the course is the signal representation and system description. Through the study of this course, students gradually learn the description method of the signal in time domain and frequency domain, and can deeply understand the mechanism of signal on the system as well as the internal relations between them. The basic theories and methods of Signals and Systems are widely used in the fields of control engineering, communication, digital speech processing, digital image processing, signal detection and so on. According to the requirements of engineering education accreditation standard and combined with the characteristics of Signals and Systems, the experiment of "Signals and Systems" is determined[4]. Through the implementation of teaching activities, the following five specific objectives should be achieved (Ability index points).

1) Be able to apply the knowledge of engineering mathematics and natural science to deal with the modeling and solution of general circuit problem; Understand the concepts of signals and systems and their embodiment in the field of engineering, and express the experimental results in the form of diagrams and tables.

2) According to the working principle of signals and systems, the signals and systems can be analyzed in terms of time domain, frequency domain and plural frequency domain by using proper mathematical method, and applied to solve the general engineering problems to obtain effective conclusions.

3) Be able to carry on parameter design for specific part of information system and deal with input signal according to the requirements of technical index so as to make the output signal meet the requirements.

4) Be able to conduct an experiment, record data and make analysis according to designed experiment content and steps on the basis of theory course learning. The experimental results can be analyzed and explained, and the model parameters can be verified or fitted so as to obtain effective conclusions. Try to analyze the solution of complex engineering problem.

5) The MATLAB software can be used to carry on simulated analysis. The signals and systems which meet certain requirements are built model and programmed in the computer to realize simulation, prediction and evaluation. Understand the principle and limitation of analog calculation.

The new teaching objective is guided by graduation requirements and emphasizes the ability to transform understanding into knowledge and then put it into practice. It is emphasized to guide the students to analyze the simple practical application system, solve the engineering application problems and cultivate the thinking mode and consciousness to solve the complex practical engineering problems through the study of book learning.

Taking fully into account the characteristics of minority students and poor mathematical foundations in our school, as well as the characteristics and training objectives of the course provision which are important for the undergraduate students majoring in electronic information, this paper puts forward the talent training model of "solidifying foundation, emphasizing practice, strengthening ability, and improving quality".

III. EXPERIMENT TEACHING CONTENT UNDER THE BACKGROUND OF ENGINEERING ACCREDITATION

Take the study achievement as the guidance, and make the meticulous design for the experiment teaching content. In the process of engineering accreditation, certified experts should carry on investigation and reached degree evaluation for course system and teaching programme (including experiment programme) based on professional training objectives. The core of the teaching programme is the teaching content. The teaching content should be designed based on the course objectives. According to the above-mentioned experiment teaching objectives, it is considered that the signals and systems experiment takes the application software MATLAB&SIMULINK and LabVIEW as the experimental tools. With the help of its powerful simulation function, the students can use MATLAB and LabVIEW to carry on visual and intuitionistic computer simulation and emulation to realize key points, difficulties and some practices in the theoretical course, thus deepening the understanding of the basic principles, methods and applications of signals and systems. The experiment teaching of signal and system by using MATLAB and LabVIEW simulation software is the best experimental tool under the current teaching resources. For the specific arrangement of experiment, the progressive principle is mainly used to gradually deepen the experiment content. Pay attention to the insertion and repetition of pre-and post-experiment, and strengthen the application of basic concepts and basic principles[5]. Increase the engineering application examples and cultivate the consciousness of students to apply theoretical knowledge to engineering practice, which is also beneficial to clarify the physical concepts. For example, in the frequency domain analysis of the experimental signal, students are required to master the frequency domain analysis of the aperiodic continuous signal in the experiment programme, and the frequency domain analysis of the acoustical signal can be added in the experiment.

1) The collected men and women signals are carried on frequency-domain analysis. The experiment helps students

understand why the man voice sounds deep and the woman voice sounds sharp, thus being able to qualitatively explain and quantitatively describe the voice characteristics of men and women in terms of frequency domain, which clarifies their physical concepts.

2) The time-domain and frequency-domain analysis of the sound signal with high-frequency noise are carried out. It can clearly see that it is difficult to distinguish the signal from the noise in the time-domain, but the signal in the frequency-domain is obviously separated from the noise, so the noise can be removed by means of smoothing.

IV. EXPERIMENT TEACHING METHOD UNDER THE BACKGROUND OF ENGINEERING ACCREDITATION

The experimental teaching method has an important influence on the experimental teaching effect. The experimental teaching method with strong flexibility, visualization and interestingness, has great advantages to strengthen students' subjective initiative, arouse people's curiosity, cultivate interest in experiments, and promote students' thinking, and thus cultivating students' autonomous learning ability. The former experiment teaching is led by teachers' teaching, and the teachers' teaching methods are conservative and fixed. The learning contents and experiment steps remain the same. The students operate step by step according to the teacher's instruction, and do not need to know the operating principle. The dynamic role of students is not brought into play and the flexibility of the experiment is not enough, which causes some students to have no idea of the basic requirements and basic steps before the experiment. In the course of the implementation, they do not understand the performance and principle of the instrument, and are unable to use. It is often necessary to take a large amount of time to debug the instrument, so that the experiment can't be completed successfully. The students have lost interest in the experiment, and the learning effect is not good.

In order to solve these contradictions, the teaching scheme has been revised: First of all, the explanation is carried out in combination of theory course and experiment. Secondly, some interesting small experiments can be added. Thirdly, the laboratory opening project can be set up, such as design of sound signal frequency analyzer, portable data acquisition analyzer, etc. Students are asked to be divided into groups and complete the design and production of the product in the process of taking this course as well as write the conclusive report. The implementation of research and exploratory learning around engineering projects is an extroverted extension of teaching in the class and an important auxiliary means to guide students to face engineering practice and strengthen engineering training.

V. DIVERSIFIED EVALUATION SYSTEM UNDER THE BACKGROUND OF ENGINEERING ACCREDITATION

The core of the engineering accreditation education concept is ability-oriented, and the emphasis of students to grasp the knowledge point is to understand rather than memorize, which requires that students must have the ability to solve open problems, not only the ability to solve problems with fixed answers. In the process of completing challenging tasks,

students constantly summarize the methods of solving practical engineering problems, and then complete the design of complex engineering problems. In order to facilitate the improvement of students' comprehensive ability, the course teaching group has carried on the bold reform to the course assessment mode, and changed the simple written test and computer test to the "overall process and all-round" diversified assessment system. The assessment system includes two dimensions: progressive evaluation and summative evaluation, and several evaluation indexes are set up in each dimension. The assessment system not only pays attention to students' knowledge and skills, emotional attitude and values, but also evaluates their engineering practice ability, innovation consciousness, ability to analyze and solve problems, coordinate ability and cooperative spirit of group, etc. The course evaluation can guide and cultivate students' ability of thinking, research, questioning, determination and presentation in an all-round way. For the evaluator, in addition to the teacher, the student is also the main body of the evaluation.

The process of professional accreditation requires teachers as the subject of liability to fulfill the course objectives, and realize the ability elements through the evaluation of students' learning results in the teaching process. Students' performance is closely related to the results of course assessment, and the rationality of assessment mechanism is an important premise. In the past, it is difficult to evaluate the students' experimental teaching results objectively because the experiment assessment is carried out from two aspects: the attendance of the experiment and the experiment report. In the process of professional accreditation in many schools, most experts think that the evaluation criteria in the process of experimental teaching are not clear, and the judgment of performance is not uniform. There is no basis for judging the results of the experiment report. Based on the basic ideas of engineering education accreditation, which are "result-oriented", "student-centered" and "continuous improvement", the evaluation method of experimental achievement is modified as the evaluation of the experiment process, the evaluation of experimental report, and the experiment test. The experiment performance is given comprehensively and the proportion of evaluation in the experiment process is increased. In order to avoid the problem of inconsistent evaluation criteria for experimental results due to subjective reasons, an experimental process rating scale and an experimental report rating scale are formulated.

VI. CONCLUSIONS

Engineering education accreditation provides a good development opportunity and effective carrier for electronic information specialty. Under the background of professional accreditation, the research on the course construction of Signals and Systems is representative in electronic information specialty. Its knowledge system and abilities are very important and key abilities in the training and employment of talents. It can be used for reference in the construction of other relevant courses. It can guide us to radiate the benefits and promotion of construction into the teaching construction and reform of the whole specialty.

ACKNOWLEDGMENT

This work is supported by Gansu Province Science Foundation for Youths (17JR5RA281), the National Natural Science Foundation of P. R. China (61463046), Fundamental Research Funds for the Central Universities of Northwest Minzu University of China(31920180039, 31920180120) and by the Teaching Reform Project of Northwest Minzu University of China.

REFERENCES

- [1] T. Dan, C. Houjin, L. Ying, H. Linlin, M. Qinglong, Z. Wenshan, C. Meie, Y. Jingjing, "Engineering Education Accreditation Based Construction and Practice on Electronic Science and Technology Specialty," *Education Teaching Forum*, vol. 16, pp. 134-135, April 2018.
- [2] T. Dan, H. Jian, Linlin, C. Houjin., "Reform and Practice on Electronic Information Course Based on OBE Mode –Take "Signals and Systems" as An Example," *Education Teaching Forum*, vol. 30, pp. 81-82, July 2018.
- [3] S.S. Haykin, B. Van Veen, *Signals and Systems*, 2nd., Electronic Industry Press, 2002.
- [4] A. V. Oppenheim, *Signals and Systems*, 2nd., Tsinghua University Press, 1998.
- [5] E.W. Kamen, B.S. Heck, *Fundamentals of Signals and Systems Using the Web and Matlab*, Science Press, 2002.