Research on the Big Curriculum Construction of Circuit Signal and System under the Background of Emerging Engineering

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Abstract. Guided by the trilogy of emerging engineering construction, a novel teaching concept of student-centered, outcome-based has been updated and established. The knowledge fusions of three levels are achieved from interior of single course, among three courses and the interdisciplinary perspective for the three courses including *Circuit Theory Foundation*, *Signal and System* and *Digital Signal Processing*. So, a big curriculum knowledge system has been established. The practice has proved that the proposed knowledge system of the big curriculum has improved effectively students' learning efficiency, learning ability, engineering awareness and innovative awareness.

1. Research Background

The year of 2017 is the first year of emerging engineering construction (EEC) in China. *Fudan University Consensus* [1], *Tianjin University Movement* [2] and *Beijing Guidance* [3] are the trilogy of EEC, which put forward new requirements for talent training from different angles. The *Fudan University Consensus* points out that comprehensive colleges and universities should promote the organic integration of science education and humanities education. The *Tianjin University Movement* points out that a new paradigm for engineering development should be explored and established actively. The latest developments of industry and technology and the latest requirements of industry for personnel training should be introduced into teaching, and the teaching contents and curriculum system should be updated. The *Beijing Guidance* presents that it is necessary to pay more attention to the leading of concept and establish the concept of innovative engineering education.

At the same time, there are still some problems in our current teaching and learning. Current college students, called *digital native generation* or *network generation* [4], are very different from the previous ones because they have strong dependence on the network. The courses of C*ircuit Theory Foundation* (*CTF*), S*ignal and System* (*S&S*) and *Digital Signal Processing* (*DSP*) are the professional basic courses of electronic information science and technology and communication engineering in many colleges and universities, which play an irreplaceable role in the majors for cultivating students' abilities of thinking mode, innovation consciousness, methodology and system theory. However, there are some issues in the actual teaching, such as self-centered, lack of connection and coordination among these courses, repeated contents between the before and after course, and disconnected for some knowledge among these courses, which are not conducive to the overall study of students and do not meet the requirements of EEC.

Facing the new era, new background and new requirements, it is necessary and urgent to explore and cultivate engineering students with innovative consciousness and engineering practice ability.

2. Updating the concept of curriculum construction

In view of the current problems in students and teaching, colleges and universities should combine closely their respective talent orientation, school orientation and training objectives, as well as new requirements for EEC. The basic concepts should be established, which are student-centered, outcome-based, concern for students' learning effectiveness, continuous feedback and continuous improvement. The fusion innovation should be considered as the entry point to achieve supply-side relationship reform based on output stakeholders.

In accordance with the requirements of the Washington Agreement [5], which China joined in June 2016, it is necessary to design reversely the contents of the course based on outcomes, to track and pay attention to students' learning outcomes. And all of these should be considered as the main teaching evaluation and feedback on teaching methods to promote the continuous improvement of teaching methods so as to complete the teaching contents, achieve the final teaching objectives and an operable whole process of improving the quality of teaching.

3. Establishing a knowledge system of *big curriculum*

Regarding the 2017 undergraduate teaching evaluation as an opportunity, taking the EEC as the background, taking the Outcome-based Education (OBE) [6] concept as the guideline, combining the professional certification common standard graduation requirements and related professional training programs, the corresponding relationship matrix between the three courses and the graduation requirement target was confirmed. The curriculum knowledge system was reconstructed with target-oriented, and the leap is achieved from the original *self* to *non-self* to *big self*. The knowledge fusions of three levels are carried out from interior of single course, among three courses, and from interdisciplinary perspectives, and a *big curriculum* knowledge system is established, which not only enable students to understand systematically the three courses, but also adapt to the demands of EEC.

3.1 Knowledge fusion within single course

Based on strengthening engineering application and highlighting key points and characteristics of course, the engineering concept is infiltrated, the modularized and systematized contents of the course are reconstructed, and the new knowledge system of engineering oriented and practice oriented is formed. Based on keeping the integrity of the knowledge system of each course as much as possible, the course itself is slimmed down properly and it is expanded appropriately at the same time. On the one hand, the slimming attempts are achieved by strengthening the concept and foundation, simplifying some mathematical deductions and optimizing the combination of knowledge points. On the other hand, the expansions are carried out from three aspects, namely paying more attention to the generation and application of new science and technologies and integrating the professional frontier into the curriculum, paying more attention to the use of advanced hardware platforms and software tools and reserving good exports of engineering oriented and application oriented for students to supply full preparation for their future developments.

According to the actual situation of students, some specific contents of the selected teaching materials [7] of CTF are adjusted in order to enable students to establish firmly some basic concepts, familiarize themselves with the characteristics and applications of basic circuit components, master circuit theorems and laws, know the basic analysis methods of circuits, cultivate students' scientific thinking ability, and establish a correct engineering perspective. For example, Chapters 1 and 5 of the textbook are adjusted to a unit to discuss Kirchhoff's law and circuit components systematically. Chapters 6, 7 and 9 are adjusted to a unit to analyze sinusoidal steady-state circuits systematically. Some learning hours are reduced including the time domain analysis of the steady-state process of linear dynamic circuits in Chapter 10 and the complex frequency domain analysis of the transient processes of linear dynamic circuit in Chapter 11. Some learning hours are increased appropriately including circuit theorem in Chapter 3, network diagram, network matrix and network equations in Chapter 13 and two-port network in Chapter 14. The new plan architecture has realized the integration

between theory and practice, between classics and modernity, which not only ensures the connection with the follow-up courses, but also enhances the teaching practicality.

In order to enable students to solve practical problems using mathematical tools, establish several important ideas such as system, decomposition and transformation, and improve students' ability to analyze and solve problems, the selected textbook [8] of S&S has been adjusted. The adjustments include simplifying some mathematical derivation processes, emphasizing physical concepts and meanings, and adjusting the contents of some chapters. The learning hours of time-domain analysis of continuous-time system in Chapter 2 and discrete-time systems in Chapter 7 are compressed. Both Laplace transform and s-domain analysis of continuous-time systems in Chapter 4, and z-transformation, z-domain analysis of discrete-time systems in Chapter 8 are highlighted. The Fourier transform in Chapter 3 and the application of Fourier transform in Chapter 5 are combined into a whole unit and so on. The new plan not only makes the whole course more focused, the system structure more distinct and systematic, but also lays a necessary foundation for the subsequent courses of communication principles, DSP, automatic control principles and so on.

Likewise, the teaching contents of DSP are adjusted in actual teaching. Some learning hours of base of digital signal processing and z-transform of discrete-time signals are reduced. However, the contents of Fourier analysis of signals and the design of the digital filter are highlighted, and some latest applications and developments of signal processing technology are added. All of these will lay the necessary foundation for students to further study and master the professional courses in digital communication and information processing technology. And all of these will enable students to master the basic theory of discrete signals and systems, basic analysis methods, basic digital signal processing techniques of discrete Fourier transform, digital filter and so on, understand the development process of digital signal processing technology in design and application, and train students' abilities to use the software tools of DSP.

3.2 Knowledge fusion among courses

Integrating the concepts of big engineering and big curriculum into the overall design and transformation of the curriculum system, a knowledge system of big curriculum is established for CTF, S&S and DSP. The relevant knowledge among three courses are fused not only avoiding unnecessary duplication but also making necessary connections, so that students' understanding of three courses is more systematic, which are more suitable for the needs of EEC.

For the overlapped contents of time domain analysis of dynamic circuits, the spectrum of signals, Fourier transform, Laplace transform, system function, etc. in the courses of CTF, S&S, the strategy of teaching slightly in CTF and teaching in detail in S&S has been taken. The strategy of a detailed explanation in the former and only a brief review in the later is taken for the overlapped contents of the basic concept of signal and system, z-transform, sampling and so on in S&S and DSP. This will help to focus on Fourier transform analysis, especially Discrete Fourier analysis, and design strategy of digital filters in DSP. For the section of state variable analysis, the course of S&S is only responsible for making the necessary preparations, and the details will be explained in the course of *Automatic Control Principles*. In this way, the three courses not only have their own emphasis and characteristics, but also have achieved overall optimization, coordination and unity, which will help students to grasp systematically the *big curriculum* and will conducive to cultivate the students' abilities of innovative consciousness, creativity and engineering practice.

3.3 Interdisciplinary knowledge fusion

With the development of scientific, it is necessary to span multiple disciplines and generate new ideas and new theories for achieving creative breakthroughs. The specialty of electronic information of three courses is a combination of modern electronics, information, communication and other technologies, involving electronic technology, computer, communication and control, etc. Its distinctive feature is the intersection and integration of disciplines. Therefore, we broaden our horizons and integrate the three courses into a larger interdisciplinary environment. Firstly, we pay

attention to the interdisciplinary relevance, integration and complementarity, absorb the thinking patterns of different disciplines and the collision results of knowledge and methods between disciplines, and condense a number of classic cases from different disciplines for teaching and practice. For example, the case of the digital transmission of voice signals originates from the disciplines of communication and signal processing, and the case of location accompanied system is from machinery, control, signal processing and other disciplines. Secondly, for multi-disciplinary background, the caliber is expanded in the teaching of knowledge, so that students not only can base on the professional, but also can dabble professional knowledge in communication engineering or electronic information, computer technology, automation, measurement and control technology and others. The better professional adaptability and broader perspective of thinking will help students to develop composite innovative talents and can meet the growing needs of employers.

4. Conclusion

As a new thing, emerging engineering construction is a complex system engineering, which is being carried out in colleges and universities in China. There is no fixed model to follow, and it is necessary to innovate continuously in all aspects of education and teaching. Under the background of emerging engineering construction, combining the college-level key projects, the authors update the concept of courses construction and establish a big curriculum system based on Circuit Theory Foundation, Signal and System and Digital Signal Processing. Practice has proved that the proposed knowledge system of the big curriculum has improved students' systematic understanding and grasp of three courses. The students' professional knowledge becomes more systematic, furthermore, students' enthusiasm for learning, engineering consciousness and innovation consciousness have been improved greatly.

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