Discussion on the Teaching Reform of the Automatic Control Theory

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Abstract. As the specialized basic course of automation, the subject of Automatic Control Theory is a significant part of the professional knowledge system, having negligible effect on students in their engineering practice and innovative ability. However, either teachers or students face the difficulties in the teaching practice of this subject, so as to encumber the improvement of teaching quality and the realization of teaching purpose. Therefore, it is definitely necessary to promote the positive teaching reform for the course of the theory of automatic control. First of all, this article introduces the characteristics of the subject; secondly, it analyzes the present problems about the teaching practice, and fatherly it discusses effective strategies for reforming the teaching of this course.

The Characteristics of Automatic Control Theory Course

The characteristics of this subject mainly include：first，it is related to many relevant specialized subjects. Automatic control theory is the specialized basic course of majors such as automation, electrical engineering and automation, mechanical engineering and automation. Meanwhile, it is also the elementary course of subjects including energy and power, machinery, electrical information, instrumentation and other disciplines; besides of these, it is a very important lesson to many engineering majors. Second, the course of automatic control theory is the basis for subsequent courses. It is the specialized basic discipline of the subjects or majors and is established during the period of transition time from basic course to specialized course, so the teaching design, content organization and teaching quality directly affects student's reflection for subsequent courses and their full understanding of the whole specialized knowledge. Third, it is especially difficult to learn the course. The course covers a variety of subjects, such as mathematics, electronics, physics, mechanical, electrical, etc., and is closely related to the actual engineering control system. It is rich in content, wide in the knowledge, profound in theory and fast in update, which sets up more difficulties to students in learning. If teachers too much emphasize theories and mathematical derivations, the teaching process will inevitably become boring, which not only arouses student's hostile emotion, but also prevent them from improving in many abilities.

The Present Problems of Automatic Control Theory in Teaching

Many Courses and Little Periods.

The automatic control theory course contains abundant contents, broad knowledge involving multi disciplinary. However, the planned periods of the course are not enough to meet the actual requirement of the teaching content. In this case, the teacher has no choices but to consistently expand information, because of this, students can have sufficient time to accept and understand new knowledge, resulting in that knowledge is not absolutely grasped and the effectiveness of class is seriously influenced. In addition, some teachers only explain the importance of teaching materials, without the introduction of current advanced research achievements in engineering control technology, making the students cannot understand the current situation of industrial automation.

The Conservative Teaching Mode

When teaching the content of automatic control theory, teachers still take the indoctrination mode and focus on the explanation for conceptual, abstract theoretical knowledge, increasing the difficulty of learning and reducing the students' interest. Meanwhile, only teachers speaks while students just listen to them during the whole class in order to finish the teaching task, such kind of teaching mode

does not spare students so sufficient time to think that they cannot play a main role in the teaching process.

The Gap between Theory and Practice

In the specific teaching practice, the teachers don't connect theory with practice so that students lack intuitive and emotional awareness of the control system, which not merely increases the difficulty of students' understanding of theoretical knowledge, but also negatively effects on the students 'cultivation of engineering practice and innovative ability. Moreover, in practice, teachers commonly use confirmatory experiment, so such single method is hard to arouse students' enthusiasm to participate in experimental activities.

The Unscientific Assessment Methods

As to the assessment of automatic control theory course, the traditional methods often contain two modes: closed book or open book exam to be the only form. Depending on a piece of paper to assess the students' comprehension to knowledge and skills is clearly not enough scientific. Under this single exam system, some students had a negative attitude, do not pay attention to the learning accumulation in usual time, nor actively participate in a variety of practical activities, but just recite knowledge by rote when reviewing in order to reach the borderline in the final exam.

Strategies of Teaching Reform of Automatic Control Theory

Optimization of Content and Improvement of Learning Efficiency

Both teachers and students have been faced with difficulties in the course of automatic control theory. To enhance teaching effectiveness, the optimization of the teaching structure should be firstly considered, in another word, it means arrangements for teaching content to ensure the closely connection between theory and practice. First, teacher should be aware of the teaching key points and strengthen explanation of rudimentary knowledge. Being subjected to rigorous, systematic and completed content, teachers can appropriately adjust the teaching, selecting the important principles of teaching outline provisions, focusing on content and highlighting methods, such as the transfer function of the strike, Rolls criterion, frequency domain analysis method. On the understand content prescribed in syllabus, teachers can mention or not as little as possible, in order to improve teaching effectiveness within the limited hours. Secondly, teachers should dilute mathematical proof and stress practical application. Teachers should strike out the mathematical proof from teaching content; reduce the burden on students to avoid bringing students upset emotion for learning caused by the boring content. Teachers can adopt the way of explaining the idea of proving to dilute mathematical proof process, highlight the conclusions and refer to content with restricted conditions when explaining, and then consolidate knowledge through exercises. Third, teachers should update course content to ensure its advanced nature. Combining with the contemporary development of industrial automation, teacher should enrich the course contents with advanced engineering research achievements, such as sub-PID control, fuzzy PID, optimal control, robust control and other control theories. Besides, teachers can introduce how to select parameters under engineering examples, which can increase students' knowledge of automatic control.

The Improvements of Teaching Methods and Efficiency

The application of heuristic

Teachers should transfer from the traditional "indoctrination" teaching methods emphasizing on theory to heuristic method of cultivating students' sense of innovation and creativity, which can fully play the main role of them, active their thinking and stimulate their interest. Teachers should encourage students to express their views in the classes, making them take questions into learning, constantly improving their abilities of analyzing and solving problems.

The application of engineering case pedagogy

The Course of Automatic Control Theory is so theoretical and practical that teachers shall adopt this method to assist teaching which attach great importance to the cultivation of students' habits of thinking, to help students understand and master the theoretical knowledge, and improve the ability of engineering practice. For example, when the teaching responses to the principles, teachers can

combine the working principle of air-condition temperature-control system in daily life, and guide students using the knowledge of control theory to analyze examples, thus mobilizing the enthusiasm of students. In addition, due to the knowledge of this course updates faster, teachers should introduce cutting-edge technologies related to the field of automation in teaching. For example, the Hubble space telescope pointing system can gather the horizons on a coin from a distance of 644km, which can correct the space telescope deviation massively. This is what teachers can employ in teaching for that this engineering case can help students establish the mathematical model according to the Hubble Space Telescope pointing system to analyze some related systems. After this, teachers may raise questions from higher levels for students to think: If introduced a series connection PI controller in the control structure, can it play a role of optimizing system performance? Teaching by examples cannot only stimulate students' strong interest in learning, but also deepen the students' understanding of the practical application of automatic control theory.

The application of multimedia pedagogy

Teachers can utilize multimedia pedagogy to produce the courseware which including sound, graphics, and text. In this way, abstract concepts can be visualized and materialized to show students, thus enhancing their understanding of the learning content improving their learning efficiency. Besides, teachers also can apply the distance learning teaching method to upload teaching courseware to the school website to facilitate student learning automatic control theory courses at anytime, and to break space and time limitations of classroom teaching to meet students' needs of diversity and individualized learning .

Reformation of experimental teaching and cultivation of students' practical ability

Increasing comprehensive experiments and designed experiments

The experimental teaching is an important part of Automatic control theory teaching for training students' capabilities of thinking, creation, comprehensive application, and preliminary engineering practice. Teachers should combine the essential points and difficult points of teaching on the basis of original experiments, and increase comprehensive experiments and designed experiments appropriately to help students having a sound mastery of curriculum knowledge and skills of the automatic control theory. During the fundamental experimental teaching, students' understanding of speculative knowledge shall be enhanced so that students can link the system mentioned above with the actual control system by experiments and enhance their perceptual knowledge of the actual system. While in the comprehensive experimental teaching, teachers should select typical control systems as the objects of experimental study to guide students to analyze the system architecture, establish the relevant mathematical models, and observe and record characteristics of the systems, thus helping students mastering the learned knowledge and improving the knowledge and comprehensive skills. In the designed experimental teaching, teachers can list propositions for students to design and implement experimental programs independently and require students to have a comprehensive usage of the learned control elements, automatic control theory, analog circuit, digital circuit, sensors, computers, simulation methods and other relevant knowledge, so as to train students' ability to solve practical engineering problems.

Strengthening the practicalness of experiments

In the experimental teaching, teachers can use the following three experimental teaching methods to gradually improve students' practical application of the automatic control theory. Firstly, the application of MATLAB software in simulation experiments enables students to see the results intuitively, validate the learned theoretical knowledge, thus enhancing their understanding and memory of the theoretical knowledge. Secondly, the automatic control theory chamber can be used in the experiments. For example, when doing the frequency characteristics experiments, students are required to use analog circuit units of the test boxes to build a good analog circuit through connection, and then use the virtual oscilloscope and signal generator functions provided by the host computer to complete the open-loop frequency characteristic measurement of the first-order and second-order system. Through these experiments, students' ability to operate can be effectively improved. Thirdly, build a simulated industrial field which allows students to debug and control experimental device in a real operating environment, so that students can accumulate practical experience for working in this

field after they graduated. For example, to enable students to debug level object, understand the impact of the controller parameters on system performance, and through the contact with DCS control system, to enhance students' ability to apply the automatical control theory knowledge in practice.

Innovation of assessment methods to promote changes in the style of study

Nowadays, schools should take a comprehensive reform of automatic control theory course assessment methods to establish a scientific and rational curriculum assessment system. The past means of deciding scores that relying on only one examination shall be changed to make the assessment results can accurately reflect students' mastery of the knowledge, as well as the application of skills, so as to lay the foundation of training high quality talents. Meanwhile, schools should also take full advantage of the incentive impacts of assessment to mobilize students' initiative, correct their attitudes towards learning, and promote the formation of a good style of study. Specific reform of assessment methods are as following: to divide the total scores into the usual scores, test scores, and practical scores; usual scores comes from a student's learning attitude, class participation, appraisal preview, attendance, assignments, application of the professional knowledge and other aspects, which occupies 10% of the total scores; test scores can be divided into the closed-book exams which occupies 50% of the total scores and the open-book exam which occupies 20% of the total scores; teachers make out the closed-book exam papers and invigilate strictly to ensure the authenticity of the results; the open-book exam may take the form of written exam, listing students the topics and leading them to use the library resources, networks, etc. to find solutions to problems; practical scores comes from a student's attitude, attendance, innovation ability, manipulative ability, lab reports and other aspects, which occupies 20% of the total scores. The way of reforming assessment methods of automatic control theory course, can make students understand that the preparation for the final exam is not enough. They must pay attention to the usual learning, work hard and participate in the experiment teaching activities, so as to obtain better scores.

Conclusion

All in all, automatic control theory course is a curriculum with significance of both theory and practice, which plays an important role in training students' capability of engineering practice, innovative thinking, and operation. To this end, schools shall take a teaching reform and innovation of the automatic control theory course, to improve the teaching quality and raise the learning efficiency by optimizing the teaching content, improving the teaching methods, reforming the experimental teaching, innovating the assessment methods and other ways, thus laying a good foundation for students subsequent professional courses and making students highly qualified talents.

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