

The Teaching Reform of "Automatic Control Theory" Course

Rui Yang^{1,2}

¹ School of Electronics and Electrical Engineering, Zhengzhou University of Science and Technology
Zhengzhou 450064 China
snowycry@qq.com

² Henan Intelligent Information processing and control engineering Technology Research Center
Zhengzhou 450064 China

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Abstract. Modern control theory course is a compulsory course for automation majors. It is based on automatic control theory course and plays an important role in teaching process. In view of the problems in the teaching of modern control theory, such as abstract content and weak mathematical foundation, this paper puts forward some reform suggestions from the aspects of teaching method, mathematical foundation, and the difference and connection with the course of automatic control theory, in order to improve students' learning interest and teaching quality. Based on the analysis of the teaching status of automatic control theory in School of Electronic and Electrical Engineering of Zhengzhou University of Science and Technology, combined with the reform needs of ideological and political needs, teaching methods, assessment and evaluation, this paper puts forward a multi-dimensional curriculum reform with "moral education as the center" and "case type" + "online and offline hybrid" + "ideological and political" Thinking. Some results have been obtained through practice.

Keywords: Automatic control theory, Weak mathematical foundation, Learning interest, Teaching quality.

1. Introduction

Modern control theory is a compulsory course for automation related majors in colleges and universities, and it is also an elective course for electrical engineering and automation majors. The basic course is automatic control theory, and the follow-up course is nonlinear system and optimal control, which plays an important role in connecting the previous and the next [1-3].

The main content of the automatic control theory course is the analysis and discussion of linear time-invariant continuous systems. That is, on the basis of analyzing the mathematical model of the system - differential equation and transfer function, the four properties of the system are analyzed from the three analysis methods of time domain analysis, root locus analysis and frequency domain analysis, that is, system stability, accuracy, rapidity and stationarity. According to the analysis, the system is calibrated to make the system's dynamic performance indicators such as overshoot and adjustment time meet the design requirements. The teaching content of modern control theory courses is relatively extensive, including the establishment of the mathematical model of the control system, the motion analysis of the linear control system, the judgment of the stability of the control system, the optimal control, etc." Therefore, in order to achieve the purpose of "teachers can teach well and students can learn well" in the daily teaching process [4-6], teachers and students are required to have solid mathematical basic knowledge such as advanced mathematics and linear algebra, but also have automatic control theory, signal and system, digital signal processing and other related professional knowledge.

Automatic control theory is the basis of learning modern control theory, so in the teaching process of modern control theory, teachers first help students review the relevant content of automatic control theory, on this basis, put forward new problems, and guide students to think about and solve new problems. Finally, the two methods and ideas to solve the problem are summarized and compared to deepen the understanding and grasp of the knowledge content.

The automatic control theory course is a very important basic course for automation-related majors such as electrical engineering and its automation, agricultural electrification, etc. It mainly studies the basic composition and performance index of automatic control system, which plays an important role. "Student-centered, output-oriented, (static stability, dynamic stability), types and characteristics of the control system, typical analysis methods of the system (time domain method, root locus method, frequency domain method) and system calibration, etc. With a wide range of knowledge, comprehensive, strong practice, strong methods and other characteristics, it is the foundation course of subsequent courses such as motion control system, modern control theory and other courses, and the Outcome Based Educa score of "continuous improvement" in the course learning of the entire

automation related majors [7-9]. With the continuous progress of engineering education certification, the original teaching content, teaching means, methods and technologies need to be improved to meet the requirements of application-oriented and composite talents training under the background of new engineering and engineering certification. The path and countermeasure of this literature reform and practice. OBE is a very important component of engineering education professional certification. Combining with the situation of College of Information, this paper discusses the course teaching of automatic control theory

Automatic control theory is also a course that pays attention to students' ideological and political education. Through the study of this course, students can not only gain professional knowledge, but also understand the social significance of scientific research and engineering practice, cultivate the spirit of daring to explore and dare to innovate, improve the understanding of human civilization, build a correct world outlook, outlook on life, values, and find the purpose of life. However, at present, the specialization of automatic control theory courses leads to the marginalization of ideological and political education. The teaching process focuses on specialty and practice, but ignores humanities and ethics. The teachers lack ideological and political education background, and it is difficult to extract ideological and political content. The teacher's language expression ability of thinking and politics is not strong, and there are difficulties in explaining the content of thinking and politics. And students only listen to "useful", in the process of ideological and political education listening enthusiasm is not high. Science and engineering students emphasize logic and results in the learning process. Science and engineering mainly cultivate applied talents, and there are certain difficulties in integrating ideological and political education." In order to cope with the new round of scientific and technological revolution, support scientific and technological innovation, and serve the "Made in China 2025", the Ministry of Education put forward the new engineering construction plan in 2017, and regarded the training of applied talents with strong engineering practice ability and innovative thinking ability as the basic requirements for the training of engineering students in colleges and universities in the new era. As one of the earliest majors to pass the engineering education certification in China, automation major of Zhengzhou University of Science and Technology attaches great importance to the construction of professional courses. As the core course of the major, automatic control theory should grasp the connotation of the training of engineering talents in the new era, run the course ideology and politics through the whole process of education, and actively carry out the reform of talent training education and teaching under the background of new engineering [10-13].

2. Present Situation of Modern Control Theory Teaching

2.1. Difficult to Teach

The course of automatic control theory includes classical control theory and modern control theory, which requires mathematical abstraction of the control system, that is, listing differential equations according to the working principle and then obtaining the transfer function of the system, and analyzing the characteristics of the transfer function mathematically. The course content is varied and abstract, involving many knowledge points, such as the solution of differential equations, matrix analysis, Laplace transform and other mathematical knowledge. College physics knowledge in mechanics, heat and other aspects also involves the content of electrical courses such as circuit theory, motor and drag foundation, analog electronic technology, etc., which requires students to comprehensively apply knowledge to solve practical problems and mathematical modeling ability." This course involves a large amount of knowledge points and a wide range, so it is difficult for students to systematically digest and absorb all the knowledge points they need to master effectively, and the learning effect is poor [14-16].

For automatic control theory and modern control theory, the content of the explanation is similar. Therefore, students cannot distinguish the specific difference between the two in the process of learning. Usually, classical control theory comes first and modern control theory comes second, so students believe that most control problems in reality can be solved by relevant content in classical cybernetics. The connection between modern cybernetics and practical control systems cannot be established, that is, the reason why we should study this course is not clear enough, so students pay little attention to it.

2.2. Teaching methods are backward

Most teachers still adopt the traditional teaching method of blackboard writing + courseware, and have a poor grasp of modern teaching information technology, such as animation, 3D software, simulation analysis and dynamic software. In the teaching process, there is a lack of case introduction and analysis, theoretical teaching and practical teaching are disconnected, the two have not reached effective unity, and no amount of guidance and inspiration can reflect the engineering of the course. In this teaching mode, students still do not know why to use the automatic control theory after learning the course. They can only do problems but cannot solve practical

applications. Students' ability has not achieved substantial improvement, and there is a big gap between them and social requirements [17-20].

The course concepts and methods of modern control theory are abstract and difficult to understand, and the relevant content is based on a relatively simple practical electrical system as an example, which is solved and analyzed by mathematical methods, which makes students often find the course content abstract and difficult to understand and master in the process of learning.

2.3. Student's Own Problem

The overall self-restraint of students is insufficient, the classroom concentration is poor, the self-learning ability is weak, and the learning effect is not satisfactory.

In the process of applying modern control theory courses to solve practical control problems, it is necessary to use a lot of advanced mathematics and linear algebra related mathematical knowledge, and students with insufficient mathematical foundation will often feel powerless in the learning process. Therefore, with the deepening of the course, students will lose their interest in learning. In order to improve the efficiency of lectures, teachers are required to help students review, review and supplement relevant mathematical knowledge in time.

3. The Reform of Course Teaching Mode of Automatic Control Theory

3.1. Case Teaching

Effective engineering cases can not only strengthen students' in-depth understanding and mastery of theoretical knowledge, but also cultivate students' sense of achievement in solving practical projects, so as to enhance their learning interest in this course. Through selected projects designed by local agricultural and industrial enterprises, industry College of Jinzhong Information College and discipline competitions, they are appropriately interspersed into the curriculum system. For example, the mathematical modeling introduces the water level control system of the water tank in the livestock workshop, the temperature control system of the agricultural greenhouse, and the constant temperature control system of the electric furnace; In the time domain analysis, constant pressure water supply system and automatic control system of feed transport vehicle are introduced in the new rural demonstration area. The operation control system of feed truck arm was introduced in root locus analysis. In the frequency characteristic method, a single closed loop speed control system with (no) static difference is introduced. In the system calibration, the control system of fruit and vegetable picking robot and the double closed-loop speed regulation system of speed current of transport car are introduced. Integrate engineering practice into theory teaching and put engineering first in the curriculum. Through case teaching, five projects related to automatic control theory were selected as provincial college students' innovation and entrepreneurship training projects.

3.2. Online and Offline Blended Teaching

The online and offline hybrid teaching of automatic control theory courses adopts a learning platform. By transferring part of the content to be explained online, students preview and study after class, and watch the knowledge point video content on the student side. In the classroom, the flipped teaching method is adopted, and the teacher is no longer the protagonist in the whole teaching process, and the goal is to obtain students' knowledge, which changes from passive indoctrination to active learning and application of knowledge.

3.3. Curriculum Ideology and Politics

Curriculum thought and politics is a very important link in the training of talents. In the teaching of professional courses, the integration of ideological and political points and the selection of appropriate ideological and political cases have a great impact on the teaching effect of the course. In the course of ideological and political construction, two main lines are adopted, namely "one light and one dark", which are organically integrated into the whole teaching process. On the bright line, the structure is designed strictly according to the professional knowledge points, and the dark line adopts the design around the professional knowledge points on the bright line to integrate the nodes, integrate the ideological and political elements timely and appropriately, and use the limited space and time to complete the implicit ideological and political teaching. The open line is the main, the dark line is the auxiliary, and the two lines promote each other."

Through a large number of actual cases and group discussions, while adhering to the scientific, logical and complete teaching content, the ideological and political fresh cases are effectively integrated into the classroom, so that students can personally feel the strength of the motherland, and the transfer of pure professional knowledge into an effective integration model of "professional + ideological and political".

3.4. Strengthen Practical Teaching

Reduce the proportion of confirmatory experiments, increase the design and comprehensive experiments. Appropriate introduction of cooperative enterprise projects and subject competitions for training. Project cooperation with enterprises can not only increase the efficiency of enterprises, but also improve the scientific research ability of teachers and students, and promote the real integration of schools and enterprises. Introduce discipline competitions into curriculum teaching, encourage students to actively participate in control related competitions, such as the five provinces of North China University Student Robot competition, National University Student Robot Competition, etc., so that students can flexibly apply their knowledge to practice and truly apply what they have learned. Our students won one national second prize and two third prizes in discipline competitions.

3.5. Further Refining Curriculum Ideological and Political Teaching

With teachers' organization and guidance as the supplement and students' emotional development as the main focus, it emphasizes both knowledge transfer and value guidance, integrates patriotism, team spirit and craftsman spirit into the teaching process, fully explores and deepens the ideological and political education function of professional courses, improves students' political awareness, overall situation awareness, core awareness and conformity awareness, and emphasizes training of scientific thinking methods and scientific ethics education. We will foster students' sense of responsibility and mission to explore the unknown, pursue truth, and reach scientific heights. We will focus on strengthening engineering ethics education, cultivate students' spirit of excellence as craftsmen of a great country, inspire students' feelings of serving the country with science and technology and sense of mission, and earnestly train builders and successors of the cause of socialism with Chinese characteristics.

3.6. Reconstruct Teaching Process

Based on STEM teaching concepts, explore more suitable curriculum ideological and political teaching processes, including theoretical teaching processes and practical teaching processes, apply information and communication technology to curriculum teaching more effectively, give full play to the advantages of synchronous language and asynchronous written communication activities, deeply explore the value of digital learning resources and active learning strategies, and let students fully participate in learning activities. On the basis of teaching basic theoretical knowledge, design practice links that conform to the characteristics of automation major of Zhengzhou University of Science and Technology and the characteristics of thermal power industry. Make full use of multiple co-built laboratories such as the Simulation experiment Center of Automation major of North China Electric Power University, virtual simulation experiment platform, Rockwell Lab, Emerson Digital Lab, etc., and combine the theoretical knowledge taught in class with practice. Deepen students' understanding of theoretical knowledge and enhance students' ability to apply theory to practice. At the same time, the scientific research projects of the actual power plant operation site are brought into the course teaching, and the new technology and new methods are combined to reflect the cutting-edge professional technology of the discipline. In the teaching process, the theoretical knowledge that students should know should be integrated into specific projects, the project implementation results and theoretical knowledge are linked, exercise students' ability to solve practical problems, enhance students' interest in learning and self-confidence, and make them obtain a sense of achievement in solving practical problems.

3.7. Enhancing Teachers' Ideological and Political Teaching Ability

The key to the implementation of curriculum ideological and political construction lies in enhancing teachers' awareness of curriculum ideological and political construction and enhancing teachers' ability of curriculum ideological and political construction. The teaching team actively carries out teaching and research activities around curriculum ideology and politics, learns the spirit of national curriculum ideology and politics related policies and documents such as the Guidelines for the Construction of Curriculum Ideology and Politics in Colleges and Universities, and forms a scientific and correct view of education and teachers and students from the perspective of concept and consciousness; Organize the study of relevant theoretical materials, dig deep ideological and political materials in the professional field, build the course ideological and political teaching system, revise the course syllabus and teaching plan, and fully integrate into the ideological and political teaching design; Participate in the training of promoting curriculum ideological and political deepening collaborative education, participate in the training of college teachers' ideological and political teaching ability sponsored by the National Network Training Center for College Teachers of the Ministry of Education; Refine the ideological and political elements in teachers' scientific research, combine them with curriculum teaching, and pay attention to the combination of

theory and practice to strengthen students' awareness of applying what they have learned and serving the country. Understand students' daily life and thoughts, conduct comprehensive and in-depth communication with students, infect students with noble personality, win students, and improve their education ability and effectiveness in a targeted way [21-25].

4. Main Characteristics of Ideological and Political Teaching of Automatic Control Theory Course

1. Ideological and political integration, moistening things silently. Centering on the five ideological and political modules, five work links and five combined thoughts, the ideological and political elements are integrated into the teaching content, which stimulates students' patriotic enthusiasm and reflects the goal and characteristics of professional education. The five ideological and political modules are "Four self-confidence", individual and State, artisan spirit, innovative development, and scientific ethics. The five work links are the basic link - platform, key link-participation, key link-guidance, difficult link -evaluation, core link-integration. The basic links include online platforms such as classroom, learning Channel and offline platforms such as classroom, study room and laboratory. The key link is that students participate in the whole teaching process. The key link is to change the "infusion" teaching and adopt teacher-assisted and student-oriented guided and heuristic teaching; the difficult link is to change the single performance-based curriculum evaluation method and establish a diversified ideological and political evaluation method; the core link is to integrate ideological and political elements into curriculum teaching comprehensively and naturally. The five combinations are the combination of in-class and after-class, online and offline, theory and research, assessment and evaluation, and individual and team. The teaching team actively combines the content related to socialist core values with the course teaching in the whole teaching, highlighting the moral education of the course.
2. Carry out ideological and political teaching with students as the main body. In the course teaching, respect students' main position, in order to constantly stimulate students' learning motivation, cultivate students' self-learning ability, and build more learning scaffolding for students from their existing experience. For example, in the teaching process, students are encouraged to communicate with teachers and tell teachers about their learning plans and needs, so that teachers can teach students according to the different needs of each student; Encourage students to actively collect ideological and political content related to automatic control theory in class and share it with other students; Based on the classroom teaching, students are allowed to evaluate ideological and political teaching after class, and teachers constantly adjust the teaching mode according to the evaluation, so as to meet the actual learning needs of students.
3. Use network resources to support ideological and political teaching. By using online teaching platforms such as Classroom School and Super Star Learning Channel, we will establish a rich curriculum ideological and political resource bank and question bank for students to study by themselves, and encourage students to find more relevant curriculum ideological and political learning resources on this basis, upload them to the shared resource bank, and continuously enrich online curriculum ideological and political learning resources. These curriculum ideological and political learning resources include not only the learning of knowledge and skills, but also the completion of various projects and tasks. Teachers record micro-videos related to lecture content in advance, assign pre-class tasks to students, let them watch and learn in advance before class, guide students to explore and practice, and stimulate students' thirst for knowledge. Students complete the corresponding tasks through independent learning, and teachers can give individualized guidance offline according to the completion of students, so that students can experience the sense of accomplishment of completing tasks independently.

5. Conclusion

Based on the analysis of the problems existing in the teaching process of modern control theory, this paper puts forward some suggestions on the reform of teaching methods. Both modern control theory and automatic control theory, as far as they are concerned, are abstract and difficult in content and are closely combined with mathematics. In order to learn the two courses well, teachers should not only change the teaching methods in real time according to students' knowledge content, but also emphasize the differences and connections between the two courses and help students to compare and learn the two control theories. This will achieve the purpose of understanding and mastering, and lay a foundation for the study of subsequent courses.

6. Conflict of Interest

The authors declare that there are no conflict of interests, we do not have any possible conflicts of interest.

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Biography

Rui Yang is with the School of Electronics and Electrical Engineering, Zhengzhou University of Science and Technology. Research direction is Automatic control, computer application and AI.