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Reform and Exploration of the Curriculum of Control System of Electric Drives in the Local Applied University

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Abstract: *This article begins by examining the characteristics of the "Electric Drive Automatic Control Systems" course within the Electrical Engineering and Automation major at Yulin University, a local applied university, identifying the existing issues in the current teaching and providing a detailed analysis. Secondly, with the goal of serving local enterprises in Yulin, the curriculum was revised in collaboration with these businesses. Active discussions were held with local engineers on course construction, and reforms were implemented in several areas, including adjusting teaching hours, modifying practical teaching content, introducing simulation software for inquiry-based learning, implementing discussion-based teaching methods, and expanding the teaching content. Finally, the learning management system SuperStarLearn was utilized as an auxiliary tool to reform the process assessment in three aspects: attendance assessment, in-class quizzes, and homework assessment. Through this series of reforms, the persistent issues with the course were overcome, stimulating students' enthusiasm for learning and providing them with a greater sense of achievement and satisfaction in their professional studies.*

Keywords: *Local applied university; Teaching reform; Process-oriented assessment*

1. Introduction

As one of the first institutions in Shaanxi Province to transition into an applied university and a hub for nurturing talent in energy and chemical engineering, Yulin University (hereinafter referred to as the University) is dedicated to its mission: "Rooting in Yulin, Researching in Yulin, Serving Yulin, and Contributing to Yulin." Capitalizing on regional resources and the characteristics of industrial development, the University has cultivated a suite of disciplines and specialties that directly meet the needs of the industry. Within this context, the Electrical Engineering and Automation major underscores the holistic development of students. The "Automatic Control System for Electric Drive" course plays a pivotal role as an integrative professional course, demanding a comprehensive understanding of power electronics, automatic control principles, and motor theory [1-5].

Known for its extensive content, broad scope, frequent updates in knowledge, and tight interweaving of theory with practice, this course is challenging for both teaching and learning. The main reason for the above problems is that the authors believe that there are three reasons: firstly, the teaching content of the course "Automatic Control System for Electric Drive" involves the mathematical model and dynamic process analysis of the DC speed control system with double closed-loop control of rotational speed and current, as well as the steady-state model and dynamic models of asynchronous motors, which have the characteristics of strong theoretical nature, many concepts, and combining with the engineering practice and other close features; Secondly, due to the need for proficiency in the pre course, students generally do not have a good grasp of the pre course due to the following two issues. (1) The course "Power Electronics Technology" was finished one year before the course started, which led to a lot of difficulties when analyzing the control circuits; (2) Although the course "Principles of Automatic Control" was finished in the last semester of the course, the course did not combine the design of some typical links

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with the electric motor system, and therefore the students would not model the electric motor system with the contents they had already learned. The students will not be able to use what they have learned to model the motor system. Therefore, teachers need to spend a lot of time reviewing the contents of the above two courses when teaching this course. Finally, the teaching concepts of some teachers need to be updated and the teaching methods are old-fashioned, which makes the course of "Electric Power Drive Automatic Control System" as a century-old antique in the eyes of the students, which is unattractive to speak of. Only through scientific and vital teaching reform activities can we improve the quality of teaching and realize the goal of cultivating high-quality talents. The teaching reform of the course of "Electric Power Drive Automatic Control System" has been the most concerned problem of the relevant lecturers, therefore, this paper conducts research on this from the perspectives of teaching outline, teaching content, teaching form, experimental methods, and process assessment methods. Moreover, in response to the demands of local service industries, it is very urgent to reform and explore this course.

2. Aligning with Enterprises to Revise Syllabus as Necessary

Engaging with local enterprises to grasp the needs of their front-line workers and drawing insights from the experiences of comparable institutions, we have updated the course's training scheme.

2.1. Adjustment of teaching hours

After thorough research and an analysis of student employment trends over the past three years, a significant demand for motor control expertise has been identified in Yulin's local industries, particularly in coal mines and chemical plants which require professionals adept in motor speed regulation and inverter operation. To address these needs, we have enlisted front-line engineers from these enterprises as corporate mentors to provide guidance during practical sessions. Thanks to Tencent Meeting, these mentors can demonstrate motor operation, maintenance, and inspection, as well as the supervision of mine hoists and routine checks on other motor load conditions, all within the framework of safe production practices. This hands-on approach immerses students in the practical application of motors in real-life settings, offering a more concrete and engaging learning experience.:

2.2. Adjustment of Practical Teaching Content

After thorough research and an analysis of student employment trends over the past three years, a significant demand for motor control expertise has been identified in Yulin's local industries, particularly in coal mines and chemical plants which require professionals adept in motor speed regulation and inverter operation. To address these needs, we have enlisted front-line engineers from these enterprises as corporate mentors to provide guidance during practical sessions. Thanks to Tencent Meeting, these mentors can demonstrate motor operation, maintenance, and inspection, as well as the supervision of mine hoists and routine checks on other motor load conditions, all within the framework of safe production practices. This hands-on approach immerses students in the practical application of motors in real-life settings, offering a more concrete and engaging learning experience.

On this basis, we have also improved the experimental part, the previous experiments are mainly verification experiments, the new experimental syllabus has increased the proportion of design and comprehensive experiments, and rewritten the experimental guidebook. Before the reform, six or eight students were grouped together, but now they are changed to four students per group, allowing every student to participate actively. This time, the duration has been adjusted to a dynamic schedule; if the 2-hour session is not enough, students can apply to the teacher for an additional 2 to 4 hours. This ensures that each group of students can complete the experimental tasks. There are four modified experiments as follows: Experiment 1, Determination of the Parameters and Characteristics of the Thyristor DC Speed Regulation System (Basic type); Experiment 2, Open-loop and Single Closed-loop PWM DC Speed Regulation System Experiment (Design type); Experiment 3, Double Closed-loop Control of Speed and Current DC Speed Regulation System Experiment (Design type); Experiment 4, Digital Control DC Speed Regulation System Based on Engineering Design Methods (Comprehensive type).In addition to the above experimental content, we have also added a dedicated practical week for the course design of "Electric Drive Automatic Control Systems". The purpose is to deepen students' understanding of the basic theories and calculation methods of AC and DC speed regulation, to learn the engineering design methods of DC double closed-loop speed regulation systems and the design methods of AC speed regulation, and to cultivate the ability to use theory to analyze and solve practical problems. At the same time, it strengthens the cultivation of students' independent thinking ability, innovation ability, expression ability, and teamwork ability, and improves students' employability and lifelong learning and active

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learning abilities. Students can choose to work on DC or AC based on their interests. For students, completing the tasks of this dedicated week requires them to actively apply knowledge to solve problems through their own thinking, increasing their enthusiasm and initiative, thus forming an atmosphere of learning, exploration, and research activities.

2.3. Introducing simulation software for exploratory learning

In order to better facilitate inquiry-based learning, Matlab/Simulink is introduced into the course teaching of "Electric Drive Automatic Control Systems". Matlab/Simulink, with its simple programming, ease of use, and visualizable results, can stimulate students' interest in learning and enhance their abilities to analyze and solve problems. For instance, after the third chapter is concluded, a simulation of the speed closed-loop controlled DC speed regulation system will be arranged. The specifications provided for the DC motor include the motor model, rated voltage, rated current, rated speed, back electromotive force coefficient, amplification factor, and time constant. Students will use these parameters given to establish a DC speed regulation simulation system with Matlab/Simulink, and adjust it based on the theoretically calculated parameters, continuously tweaking until the system stabilizes. Finally, the simulation results will be compared with the theoretical calculations and the actual operational parameters of the regulator. This teaching design approach can be widely applied in the course of "Electric Drive Automatic Control Systems". For example, in the section on DC motors, parameters for electric vehicles can be provided, allowing students to calculate the highest speed of the electric vehicle under different voltages. With the help of simulation software, students can learn the related content in an "interesting" way.

2.4. Implementation of discussion-based teaching methods

The unified teaching method is the teacher-centered instillation teaching. It should be an interactive process of "teaching" and "learning", but the result is that learning interest and motivation are often stifled, creativity is extinguished, and there is no way to cultivate students' ability to analyze and solve practical problems. Even in the practice of inquiry-based learning, heuristic learning to do some teaching design, but in view of the difficulty of the course and students' interest in learning, the implementation of the effect is not good. Later, we changed our thinking, the class let the students speak first, the teacher discussed. For example, for a certain part of the teaching content, let the students use their own language, the content of this part of the restatement of the teaching. The teacher or other students can ask questions, in effect, forcing students to study independently before class. We call this kind of teaching method that students speak, teachers ask, teachers and students ask and answer each other "discussion" teaching. Practice has proved that as long as students can be quiet, "power drag automatic control system" course in the vast majority of the content, is able to understand and tell. The teacher will correct, supplement and expand the content of the student narrative. Through the promotion of the above teaching methods, students' learning enthusiasm will be mobilized, and they will no longer feel that the course is boring, and the teaching effect will be significantly improved.

2.5. Expand theoretical teaching content

The history of electrical engineering is nearly 200 years old, but it is still developing and evolving. The construction of research universities and double first-class universities also requires undergraduate teaching to reflect the latest advances in the frontiers of science. In this regard, in the DC motor section, we have designed a topic on the simulation and calculation of the maximum speed of electric vehicles. In addition, in order to change the course from "useful" to "interesting", we prepared electric car toys for students to modify their circuits to realize motor speed control and organized the whole class to participate in a competition. Although the competition only took up 10 minutes of class time, the students were highly motivated and would spend a day or even a weekend preparing for it after class. Through these teaching arrangements, the teaching content can be closer to the frontier of the discipline, promote the connection with the subsequent courses, reflect the connotation of the profession, and subconsciously improve the students' innovative consciousness.

3. Utilizing Online Tools to Optimize Process-Oriented Assessment Methods

In the final grading scheme, process-oriented assessments contribute 40% to the overall score, while written examinations make up 60%. This process-oriented assessment includes attendance, homework, in-class quizzes, and group discussion reports. Attendance accounts for 10%, homework for 40%, and in-class activities for 30%.

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3.1. Adjustment of Practical Teaching Content

The assessment of attendance is a two-step process: (1) Considering the fixed number of seats in the classroom. For example, there are 62 students in the class of "Level 21 of Electrical Engineering and Automation", the classrooms for classes this semester have 70 seats, with 10 seats in each row. It is my requirement that only two students occupy the last row, consequently, a brief visual inspection of the classroom before each lecture is sufficient to identify any cases of absenteeism; (2) If the number of attendees matches expectations, there is no need for a roll call. Otherwise, a check-in on the learning platform SuperStarLearn is implemented, which swiftly identifies those who are absent. Students who are absent without legitimate reasons three times will forfeit their right to take the final exam and will have to retake the course in the following year.

3.2. In-Class Quizzes

During each lecture, a brief period of 5-10 minutes is allocated to administer practice questions that pertain to the material covered in that session. Students are required to finish the exercises in class and submit their answers to SuperStarLearn without delay. The instructor evaluates and grades the submissions after class, providing feedback in the subsequent session. This method promotes the timely review and reinforcement of knowledge, underscores the importance of gradual learning, and deters procrastination and last-minute studying before final exams.

3.3. Homework Assessment

In-class quizzes provide insights into students' understanding of the material. Students who display weaknesses in comprehension have their homework corrected through personal interaction. During these sessions, they are invited to justify their responses. Failure to do so can lead to the deduction of marks at the teacher's discretion. Immediate answers are furnished by the instructor, enhancing student comprehension and markedly diminishing the likelihood of plagiarism.

4. Conclusions

Following three years of implementation, the restructured "Automatic Control System for Electric Drive" course has garnered positive outcomes. Employers have noted that graduates are able to swiftly adjust to the workplace, competently manage motor systems, and quickly integrate new information and skills. The feedback has been overwhelmingly positive. Nevertheless, in order to further improve teaching effectiveness and the quality of talent development, ongoing efforts are necessary to bolster students' practical engineering experiences and their innovative abilities.

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