

# Reform Research of Deepening of the Theory Course of Mechanical & Electrical Transmission Control by Experimental Teaching

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**Abstract:** In order to improve the students' learning autonomy and enthusiasm, for the problems of unreasonable on curriculum sets, teaching mode and assessment method of "Mechanical & electrical Transmission Control" course in our school of mechanical design and manufacturing and its automation major. Put forward to deepening the research on theory of curriculum reform in experiment teaching, and improve the curriculum, the introduction of advanced teaching patterns and pay attention to students study way of examination reform process optimization, in order to improve the students master the theoretical knowledge in a short time and flexible application ability, problem analysis and solving ability, practical engineering application ability, develop pragmatic talents to meet the needs of society in the new century.

**Keywords:** mechanical & electrical transmission control; educational reform; experimental teaching

## 1. Introduction

The course of "Mechanical & electrical Transmission Control" is the core course of the major of mechanical design, Manufacturing and automation in our university. The main contents of the course include: the dynamic foundation of electromechanical transmission system, DC motor, AC motor, control motor's structure and principle, relay-to-contactor control, programmable logic controller and motor control, etc. [1]. Its purpose is to cultivate the students' mastery of motor drive control technology (including the start-stop motor, speed control and brake control), master the practical engineering application ability, master the mechanical and electrical drive control system is analyzed with system's point of view, and have the ability of analysis, design, mechanical and electrical transmission control system, the right ability to apply the theory to solve practical problems, to develop the ability to solve practical problems in industrial electrical control.

Because this course is to cultivate applied talents, so the link of the experimental teaching is very important in the whole course. It is part of deepening and

complementing the mechanical and electrical drive control theory, and through the experimental teaching, it can make the students fully understand and digest the principle of theoretical part, improve the students' autonomous learning ability and the ability to solve practical problems, thus reflect the quality of personnel training and professional development level [2,3]. However, this course involves many knowledge points of other courses with strong practicality, many teaching difficulties and little consistency in the content. It is an application-oriented course integrating mechanics and electronics, so students are not very active and enthusiastic in the learning process [4-6]. So as the Internet + and Education mode based on the learning Outcomes (Outcomes - based Education, OBE) development, teaching reform is also the focus of teaching research in all universities at present. Teaching researchers have also carried out reform research on electromechanical Transmission control from all aspects. For example, through flipped classroom teaching model [7-9], independent learning and classroom discussion interaction are strengthened to deepen the solidification of theoretical knowledge. In addition, the course experiment was reformed to be student-led, and the participation of students was improved through experimental preview and experimental random lottery model [10,11].

No matter which method is adopted, its core purpose is to improve students' theoretical knowledge mastery and application ability. In this paper, according to the shortcomings of the course of Electromechanical Transmission and Control in major of mechanical design, manufacturing and automation at our school, some reform measures are put forward so that students can better understand the theoretical knowledge and improve their ability to analyze and solve problems.

## 2. Problems in the Teaching Process

### 2.1. The Curriculum is not Reasonable

Due to the adjustment of the talent training program of mechanical Design, Manufacturing and automation major

in our school, the total teaching hours of this course are 32 hours, including 28 theoretical hours and 4 experimental hours. And course content involves many other courses, and some of them are comprehensive content, some concepts are abstract, the 28 theory hours are obviously inadequate, thus lead to students can't in-depth analysis in the process of teaching content of the chapters. And due to the theoretical foundation of the students in our school is generally poor, the knowledge of some basic courses involved in electromechanical transmission control theory is not enough, especially the courses of electricity, which leads to various problems and difficulties that students will encounter in the learning process. In addition, there is a separate chapter on PLC control in this course, while a programmable logic controller technology is introduced in the same semester, so there are overlaps in content. In view of the experimental section, four classes hours of experiments are obviously too few to cover all the theoretical content. However, in the actual experimental teaching process, students' participation in the experiment is relatively strong, and there will be an obvious independent learning process in the operation, so it is necessary to increase the experimental class hours, so that students have a deeper understanding and understanding of the theoretical content.

2.2. The Teaching Model is not Reasonable

Due to the shrinking of the scheduling, in order to complete the content required by the curriculum, teaching model generally adopts teachers' teaching and students listening usually called "force-feeding" model. In the whole teaching process, it is more difficult to carry out some interactive activities with full participation due to the large number of students attending classes together, which leads to insufficient interaction between teachers and students. Therefore, the class is relatively boring, and quite a few students will play mobile phones, listen to music and be in a daze. Mechanical and electrical drive control course is much theoretical for students, in addition, there are many analytical contents involving the influence of formula and parameter changes on performance, which are difficult to understand. Only a part of students can keep up with the pace of teaching, which will lead to the decline of students' learning enthusiasm, gradually lose their interest in learning and even develop feelings of disgust.

2.3. The Assessment Method is Unreasonable

According to the requirements of the current syllabus, the current assessment method is the closed-book test as the main method, and the total score is composed of 70% of the test score and 30% of the regular score. In the actual teaching process, it is found that a large number of people only pursue the final exam scores, so they usually do not study at all but take cramming exams in the early part of the final semester. This obviously violates the original intention of teaching, and they will soon forget after the exam. As for the usual performance, it is mainly reflected in the attendance rate of class, completion of

homework and completion of experimental report. Such usual performance assessment method cannot guarantee students' learning situation in class, and there is also serious plagiarism phenomenon in homework and experimental report.

3. Teaching Reform Measures

In order to effectively improve the teaching quality of electromechanical Transmission Control course and improve students' autonomous ability and learning enthusiasm in the course learning process and aiming at the existing unreasonable phenomena in the teaching progress, the content of experiments should be increased to deepen students' theoretical knowledge of this course. The teaching philosophy of OBE is also followed in the course setting, which attaches importance to students' process teaching and presents students' performance and progress in knowledge, ability and quality, as well as their degree of achieving goals.

3.1. Reform and Optimization of Curriculum Provision

In order to solve the problem of less class hours in the current training program, a new class hour is added in the new training program, and the theoretical class hour and the experimental class hour of the course are set separately, which are divided into 32 class hours for the theoretical course of Electromechanical Transmission Control and 16 class hours for the Experiment of Transmission and Control Method. At the same time, the overlap part of the course content was deleted, the basic knowledge of PLC was only quickly reviewed, the key content was put on how to apply to the control of the motor by PLC, and the method of motor's start and stop control, speed regulation and braking control was designed. The adjusted theoretical teaching schedule is shown in Figure 1.

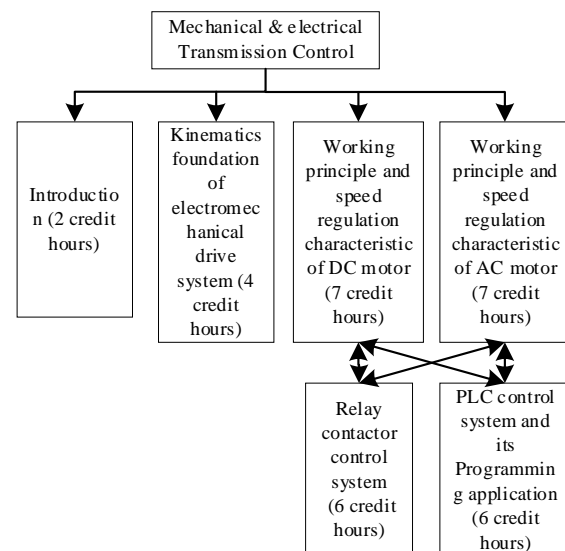


Figure 1. Theoretical teaching schedule

The corresponding part of the experiment is mainly to train students in the electromechanical transmission control system involved in the motor characteristics analysis and control method research. Through the

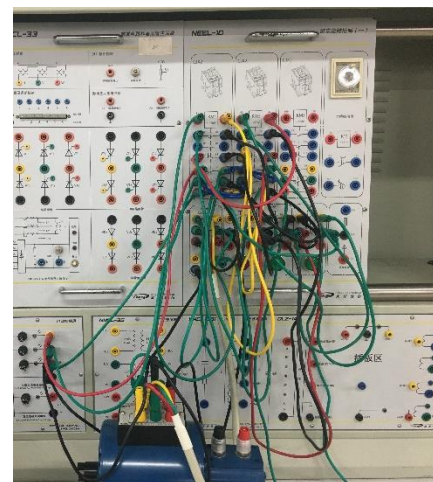
experiment of this course, students are trained to acquire the characteristics of DC motor and AC motor and draw the characteristic curve. Students are trained to build a control model and analyze the performance of the control loop according to the control methods and characteristics of the motor, so as to further master the content of the theoretical course. The experimental teaching of this

course advocates students' active learning and active practice as the core. Under the carefully organized teaching arrangement, it pays attention to the cultivation of students' innovative spirit and team consciousness. Students will actively think and explore in the process of completing the course. The specific Experimental teaching contents are shown in Table 1.

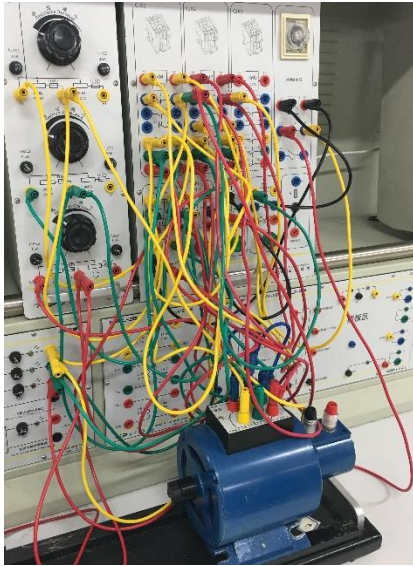
**Table 1.** Experimental teaching content.

	Project Name	Purpose and Content Summary
1	DC motor recognition experiment	Be familiar with the wiring, starting, direction changing and speed regulating methods of separately excited DC motor
2	Experimental characteristic test of separately excited DC motor	Master the working and mechanical characteristics of separately excited DC motor measured by experimental method
3	Speed regulation characteristic test of separately excited DC motor	Master the speed regulation method of separately excited DC motor
4	Operation characteristics of three - phase squirrel cage induction motor	Measure the parameters of three - phase cage induction motor
5	Three - phase asynchronous motor mechanical characteristics mapping	Mapping the torque - slip curve of the induction motor
6	Positive and negative rotation control of three - phase asynchronous motor	Master the working principle, wiring and operation method of positive and negative rotation control circuit of three-phase asynchronous motor
7	Step-down starting control of three-phase squirrel-cage asynchronous electromechanical motor	Master the working principle and wiring method of star-to-triangle step-down starting control circuit of three-phase squirrel-cage induction motor
8	Three-phase asynchronous electromechanical motor energy consumption brake circuit	Master the wiring and operation method of energy consumption brake of three-phase asynchronous motor

Through this method of increasing the amount of experimental class hours, students can deepen the mastery and application of theoretical knowledge through different experiments, and can analyze and apply knowledge of different courses in the actual operation process, so as to truly apply what they have learned. Figure 2 and Figure 3 show the positive and negative rotation control experiment of the three-phase asynchronous motor carried out by students in the laboratory and the step-down starting control circuit diagram of the three-phase squirrel-cage asynchronous electromechanical motor. Through the experiment, it is obvious that students have a deeper understanding of the theoretical knowledge of this part, and they can also find and ask questions during the experiment, thus truly achieving the purpose of autonomous learning.



**Figure 2.** Positive and negative rotation control of three - phase asynchronous motor



**Figure 3.** Step-down starting control of three-phase squirrel-cage asynchronous electromechanical motor

### 3.2. Reform and Optimization of Teaching Mode

For theory teaching, in view of the large class teaching in teachers' teaching and students listening usually called "force-feeding" model into with the task of teaching and teaching of driving form of enlightening questions combination mode in small class, and establish a set of multimedia courseware, add some video teaching link for students to understand the structure and working principle of the motor. Besides lecturing some key principles and main formulas, the influence of parameters such as resistance, external voltage and magnetic flux in the characteristic equation of DC motor on the characteristic curve is discussed in groups. And in the discussing process guide students to understand the inherent characteristics of formula and derived man-made mechanical characteristics of the formula, in the meanwhile according to the difference between artificial mechanical properties and intrinsic mechanical properties figure to analyze which parameter in formula influence the change in human characteristic curve. At the end of the discussion, a representative of each group was assigned to explain principle of formula in groups, and the influence of different parameters on mechanical characteristics and their advantages and disadvantages were compared. Finally, the teacher made a summary.

Through such teaching model, students can get more and a deeper knowledge in the process of teaching, also can strengthen students' mastery of knowledge, improve the students' autonomous learning ability, can also drive the bad grades the students' ability of comprehensive analysis, thus improve the whole class's and grade's logical thinking ability, summarizing ability and autonomous learning ability.

Meanwhile, in the teaching process, based on the OBE concept, "curriculum thinking and politics" is introduced, which is mainly reflected in the following aspects: 1. Relationship between electromechanical transmission control courses and the major; 2. Guide students to clarify their personal social responsibility and professional ethics;

3. Guide students to be honest. For example, classroom attendance and homework should be completed consciously and conscientiously in accordance with classroom requirements. 4. Initiative, struggle and enterprising spirit.

As for experimental teaching, since the previous 4 class hours have been increased to 16 class hours, the process of experimental teaching is particularly important, which is also a teaching approach to improve theoretical knowledge by applying experimental teaching in this paper. Through the design of the above experimental content, it can be found that the different experimental content distribution different chapters that are closely combined with the electromechanical transmission control theory part. In the implementation of the experimental section, in order to get better teaching effect, teachers are no longer elaborate the experiment process and introduce the concrete operation, but three students as a group to introduce and analyze the experiment content and principle. And the experimental requirements are set on the basis of providing the corresponding experimental equipment. The experimental scheme is designed by students independently and then reviewed by teachers. When there are problems in the process, the team members will take turns to check the mistakes, the teacher will only play a guiding role, and finally the students will analyze the reasons for the mistakes and seek solutions. This deepens the students' systematic learning of theoretical knowledge and strengthens the internalization of theoretical knowledge.

This teaching mode is expected to achieve the degree of students' participation in the whole process of theoretical teaching and experimental teaching, improve students' learning enthusiasm, and arouse students' desire to explore problems through this mode, so as to improve students' hands-on ability and problem analysis ability.

### 3.3. Reform and Optimization of Assessment Methods

In order to highlight the students in the usual learning process of the situation, increased the peacetime assessment. As theory teaching, each student's final assessment score is assessed by a score of 40% for the usual performance and 60% for the final exam. The usual performance is mainly reflected in the aspects of 50% class discussion, 20% class answer questions, 20% homework and 10% attendance. From the arrangement of proportion, it can be seen that students' participation degree in the classroom learning process is mainly examined.

In the case of experimental teaching, the evaluation basis is mainly divided into three parts: the experimental process 40%, the assessment criterion is the combination of theory and practice in experimental process, the problem-solving ability of the experimental process; Experimental results and analysis 30%, the assessment criteria for the experimental results of analysis and effectiveness; The experimental report 30%, the criterion of evaluation is the conclusion of each experimental theory and the experimental process.

In this way, students can be assessed from all aspects of the learning progress and mastering situation, increasing the degree of student learning participation, improving the enthusiasm and initiative of students, improving the practice of learning innovation and initiative.

#### 4. Conclusions

Aiming at the problems existing in the course of Mechanical & electrical Transmission Control, this paper puts forward the reform research of deepening the theoretical course of Mechanical & electrical Transmission Control by experimental teaching. Separately from three aspects of the curriculum sets, teaching mode and the inspection way to carry out the reform and optimization. The key point is to strengthen the class hours of the experiment and examining students the process learning. Through this curriculum reform, it can improve the students' participation ability and interactive ability in the teaching process. In addition, students can actively combine theoretical knowledge to realize the understanding of the experimental process, Put forward the relevant problems left in the theoretical course, and solve the operational problems in the experimental process through discussion in the experimental group.

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