

# *Practical Exploration of the Course Control Engineering Fundamentals for Mechanical Engineering*

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**Keywords:** Industrial Production, Control Engineering, Virtual Simulation Technology, Teaching Reform

**Abstract:** In the new era, the advanced education and teaching concepts such as the cultivation of excellent engineering talents has been deepened, and new engineering disciplines are reforming. As a core compulsory course for the education of mechanical undergraduate majors, the course ‘control engineering fundamentals for mechanical engineering’ has a direct impact on the teaching effectiveness and cultivation quality. However, the existing control engineering fundamentals for mechanical engineering course is now facing the problems of backward teaching concept and detaching from industrial production, which needs urgent reform and exploration. In this paper, we explore the multi-dimensional reform of the course from the aspects of project-based teaching engineering practice, virtual simulation technology application, and dynamic teaching evaluation mechanism. This aims to break through the traditional practical teaching methods, combine virtual simulation technology and case study teaching, exercise students' hands-on thinking ability and comprehensive application ability. Through this to realize the unification of abstract theory and embodied analysis.

## 1. Introduction

As a core compulsory course in undergraduate education of mechanical major, the main learning content of the course control engineering fundamentals for mechanical engineering involves construction, analysis and performance improvement of control systems. Through the study of this course, the undergraduates can have a solid foundation to comprehensively apply their engineering expertise to design, manufacture and control complex engineering problems in mechanical field. Besides, it is also an important bridge-course between various pre-requisite basic courses and professional courses [1]. With the deepening of education and teaching concepts, such as the cultivation of excellent engineering talents in the new era and the reform of new engineering disciplines, the existing course of fundamentals of mechanical engineering control has some problems in teaching concepts and teaching modes [2]. In order to better adapt to the education situation in the new era, the combination of professional knowledge and engineering practice should be fully considered. This paper takes the course of control engineering fundamentals for mechanical

engineering as an example to enhance and improve the combination of industrial production and virtual simulation technology in the course teaching.

## 2. The Status and Main Problems in Course Teaching

### 2.1. Detaching from Industrial Production

Control engineering fundamentals for mechanical engineering is a comprehensive and practical course. As the main body of teaching, in-classroom teaching mode is still based on teachers' lectures and students' listening and watching, which focuses just on students' understanding of key concepts and theories. This is detached from the actual engineering practice in industry. Thus, there is an urgent need to strengthen this course to cultivate ability of students and to carry out comprehensive design, analysis and control of complex mechatronic systems [3].

### 2.2. Abstracted Theoretical Knowledge

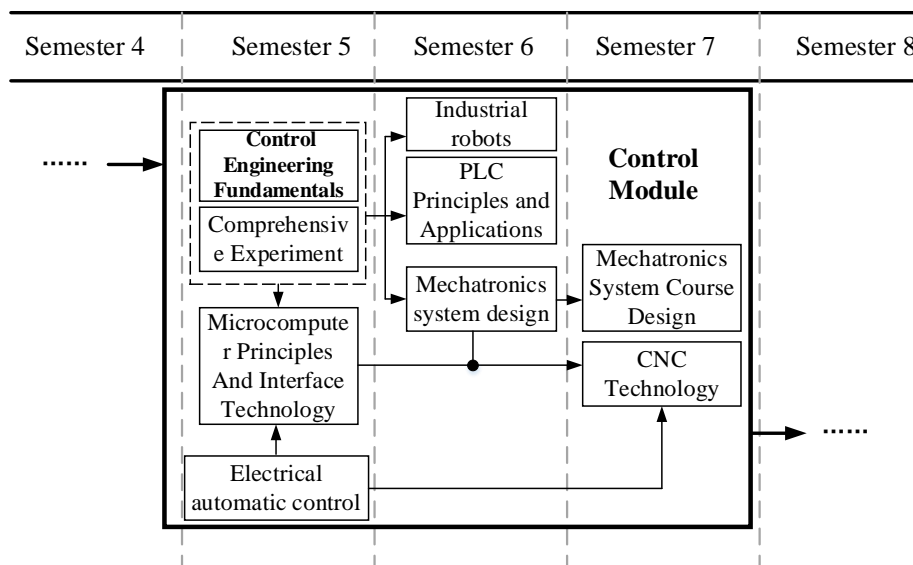


Figure 1: Relationship between “Control Engineering Fundamentals for Mechanical Engineering” and courses of “Control Module”

This course requires students to be able to use multiple kinds of pre-foundation and professional course knowledge. As presented in Fig.1, the course Control Engineering Fundamentals is one of the core courses in Control Module for mechanical engineering major students Training Program. The associated courses include electrical automatic control, industrial robots, PLC principles and applications, mechatronics system design and so on. Besides, there are a lot of mathematical knowledge and analysis of graphical drawing involved in experimental verification, such as solving differential equations of advanced mathematical. The abstract theoretical knowledge is difficult for undergraduates to understand. The lack of experimental class time makes it more difficult to support the figurative requirements of students [4]. It is urgent to break through the traditional practical teaching methods, combined with virtual simulation technology and case teaching, hands-on ability exercise for students, to enhance the thinking ability and comprehensive application ability and achieve the unity of abstract theory and embodied analysis.

### 3. Teaching Reform Methods

#### 3.1. Implementation of Project-Based Teaching Methods

In order to expand the depth of curriculum and improve the quality of professional engineer training comprehensively, universities should rely on the good cooperative relationship with various enterprises in the industry. This will satisfy the needs of the students for the latest development trend of the industry. Besides, breaking of the barriers between students, teachers and enterprises multi-subjects will actively explore and promote the deep integration of industry-education personnel training mechanism. This will help to construct a collaborative education model with organizational structure and distinctive teaching characteristics, and provide theoretical and practical references for the cultivation of high-quality engineering and technology talents.

Implementation of the project-based teaching method in control engineering fundamentals for mechanical engineering course should follow the following principles:

Firstly, students participate in the scientific research projects carried out by teachers, which will promote the cultivation of innovation and entrepreneurship competitions. The demands of industries and enterprises will also be introduced, and the actual project topics are utilized as the application background for course knowledge. Thus, students major in mechanical engineering can integrate professional theoretical knowledge and engineering practice under the premise of complying with the learning syllabus. This will provide an effective solution for the phenomenon of disconnection between teaching contents and enterprise practice, and enhance the ability of students in engineering practice and solving complex engineering problems.

Besides, in project-based teaching, the teaching team is made up of school teachers and enterprises experts. Both of them will participate in the student cultivation. Engineers from enterprises teach practical courses in the extending classroom of enterprise workshop. Besides, school teachers participate in the technical research of enterprises to realize faculty training in industry practical application. This new mode can complement and improve the teacher training resource by all-round sharing.

#### 3.2. Combination of Virtual Simulation Technology to Facilitate Figurative Analysis

With the development of computer technology, virtual simulation technology has been widely used, taking the advantages of vivid visualization, low cost, small safety risk and strong practicality. As a core course for mechanical engineering major students, the teaching content of control engineering fundamentals for mechanical engineering involves various formulas and graphical analysis, and the whole is abstract. However, the traditional multimedia courseware display effect is insufficient, and the experimental teaching hours are limited. To break through the traditional means of practical teaching, course reformation by combination of virtual simulation technology can realize the unification of abstract theory and embodied analysis [5]. Specifically, Matlab platform can be utilized in this course, which can provide various control algorithms and graphical functions, and data processing capabilities for virtual simulation. Thus, transformation of the abstract theoretical learning content of the course into simulation programs can be practically operated. This will not only help to facilitate understand of the course content, but also stimulate active learning enthusiasm of students and their creativity with the diversified teaching models.

Firstly, the foundation and learning ability variance between students makes their learning needs different in this course. Thus, in course design combining virtual simulation technology, multi-objective models should be provided, to meet the learning needs of students at different levels, stimulate their initiative to explore and protect enthusiasm for course learning.

Then, in order to give full play to the powerful visualization function of virtual simulation

technology in course teaching, the same type of experiments should have a variety of analysis results, to give students a concrete display from multiple perspectives, and to ensure the accuracy of virtual simulation teaching content at the same time.

#### 4. Dynamic Teaching Evaluation Mechanism

The formulation of a dynamic, open and sustainable teaching feedback evaluation mechanism is important for continuously improvement of course teaching. To be specific, by analysing the characteristics and making quantitative assessment standards of the course, regular and professional teaching activities can be carried out. Then, the problems arising in teaching can be solved.

Firstly, making a qualitative evaluation for the course fundamentals of mechanical engineering control, helping students establish correct concept of value-added learning and promote their comprehensive quality.

Then, constructing a teaching quality monitoring mechanism, enhancing the responsibility and teaching ability of the teachers to realize a continuous promotion.

Thirdly, building an open teaching quality evaluation mechanism, and enhancing students' ability to analyse and process mechanical control processes through information synthesis.

#### 5. Conclusions

With the deepening of the advanced education and teaching concepts such as the cultivation of excellent engineering talents in the new era, the reform of new engineering disciplines applied in the course fundamentals of mechanical engineering control is urgent. As a core compulsory course in the education of mechanical undergraduate majors, practical exploration of this course will lay a solid foundation for students to carry out the design, manufacture and control of complex engineering problems in the mechanical field with their comprehensive engineering expertise. Besides, it is also an important bridge between various pre-foundation basic courses and professional courses. This paper provides a practical solution for the exploration of multi-dimensional teaching reform of the course fundamentals of mechanical engineering control in terms of project-based teaching engineering practice, application of virtual simulation technology, and dynamic teaching evaluation mechanism, which helps to promote the teaching effect of the course comprehensively.

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