Reform of Teaching for Calculation Method in Mechanical Engineering

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Abstract: The course of calculation methods in mechanical engineering often faces problems such as strong mathematical abstraction, numerous knowledge points involved, excessive emphasis on theoretical teaching, and neglect of engineering applications. This article proposes a reform model that combines classroom teaching with practical teaching. Taking mechanical engineering problems as the background, students are taught how to apply the basic principles and algorithms of computational methods to practical production, thus clarifying the problem orientation of this course. Specifically, continuous improvement should be made in teaching content, teaching methods, assessment methods and evaluation standards, and practical aspects to enhance students' comprehensive ability to solve engineering problems in the field of machinery, promote the achievement of course objectives, and have important significance in achieving professional training goals and graduation requirements.

Keywords: integrating theory with practice, mechanical engineering, teaching mode reform, examination reform

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Introduction

The course of computational methods is a fundamental course in mechanical engineering with theoretical and systematic characteristics, and is oriented towards engineering applications. The research content is various numerical calculations and related theories for solving mathematical problems, and the teaching process needs to integrate the characteristics and application background of the profession. Through the study of this course, students can not only master the theoretical knowledge of numerical calculation and have a preliminary understanding of the construction of commonly used algorithms, but also model and solve practical mechanical engineering problems, analyze the results, and propose improvement measures[1][2]. The calculation method can lay a mathematical foundation for the future professional courses, scientific research, and engineering design of mechanical engineering students.

The calculation methods course in mechanical engineering aims to apply numerical calculation theory to solve mechanical engineering problems. The teaching content mainly includes solving linear algebraic equation systems, interpolation and approximation modeling, numerical calculus calculation, differential equation solving, etc. Due to the numerous theoretical formulas related to algorithms and the complex derivation process involved in the teaching content, the original teaching methods emphasized too much on theoretical explanations and neglected the cultivation of thinking and engineering practical abilities, resulting in a lack of close connection between the teaching content and the engineering background, leading to problems such as low learning enthusiasm of students and unsatisfactory achievement of course objectives[3]. The existing examples in calculation methods courses mainly focus on solving numerical problems, with a more mathematical perspective, and rarely involve actual mechanical engineering cases. Students do not understand the connection between the methods they have learned and their majors, and it is difficult to use the calculation tools taught in calculation methods courses when encountering professional problems.

In addition, the lack of expansion of related basic knowledge leads to difficulties in understanding for students. The course on computational methods has fewer class hours but more content. Therefore, many instructors mainly explain the calculation process of algorithms in the limited course hours, and have less introduction to the basic knowledge of courses such as high numbers and linear algebra involved. However, most students do not have a solid grasp of knowledge in courses such as advanced mathematics and linear algebra, which to a large extent leads to difficulties in understanding the algorithms proposed by most mechanical engineering students and unclear connections with their reserve knowledge[4]. Therefore, it is necessary for teachers to thoroughly explain the

algorithmic ideas related to the course during the teaching process, and to mention the basic knowledge involved in the algorithms, so as to facilitate students in identifying and filling in gaps during or after class, and improve their learning enthusiasm and efficiency[5].

Based on the principle of integrating theory with practice, this article proposes a teaching model for the entire process of mechanical engineering problems mathematical modeling calculation. Firstly, mathematical modeling knowledge serves as a bridge connecting mechanical engineering problems with computational methods. Secondly, this course strengthens the connection with basic courses and provides direct links to key knowledge points. Finally, detailed evaluation criteria were developed for each course objective, combining process assessment with final assessment to enhance the credibility of assessment results and stimulate students' learning enthusiasm. Teaching reform helps students truly master the knowledge of computational methods and the ability to solve mechanical engineering professional problems, which can lay a good foundation for future learning and work. The structure of this article is as follows:

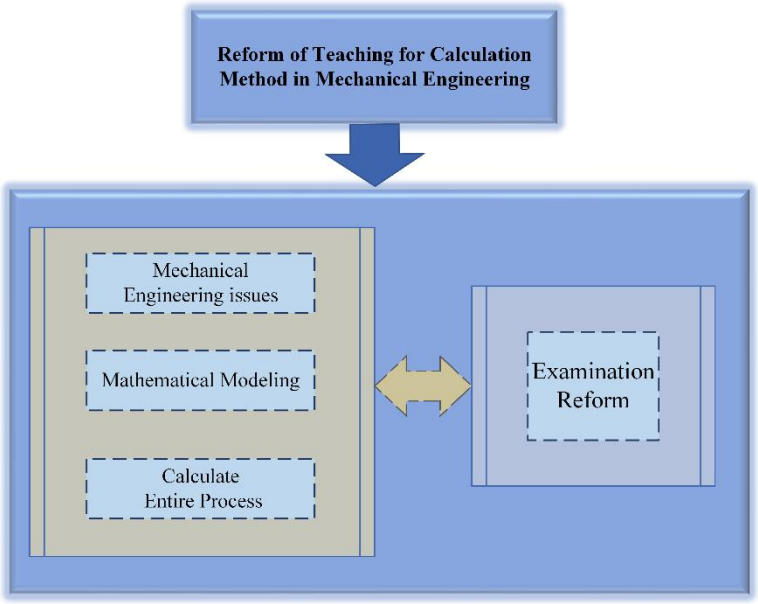

Figure 1 Structural diagram of teaching reform in Mechanical Engineering

1. Reform of teaching mode for computational methods

The reform of teaching methods can help mechanical engineering students successfully combine different types of typical practical engineering application problems with corresponding algorithm types. It is necessary to clearly represent the connection between the ideas of the learned algorithms and basic knowledge, making it easy for students majoring in mechanical engineering to learn. Students use algorithmic tools in computational methods to obtain numerical solutions to practical engineering problems.

1.1 Introduction of mechanical engineering problems

At present, the most direct demand for undergraduate students majoring in mechanical engineering is to address the practical needs in the field of mechanical engineering. Therefore, starting from mechanical engineering problems, it is required to establish simple mathematical models such as linear or nonlinear differential equations, and solve the mathematical models through computational methods. Finally, it is necessary to make a judgment on the numerical solution sought. If the numerical solution is reasonable, output the numerical solution. If the numerical solution is unreasonable, return to the actual problem of mechanical engineering and establish a more accurate mathematical model. Generally, before teaching the course content, students should start from mechanical engineering problems such as complex structural analysis, aircraft safety design, and multi-body dynamics, so that they can truly feel the problems that the taught algorithms need to solve.

1.2 Specification for mathematical modeling of engineering problems

Establishing analytical mathematical problems with general significance through approximations, assumptions, or modeling analysis software for practical mechanical engineering problems needs to conform to the application scope of the learned algorithms. In the modeling process, emphasis should be placed on modeling ideas, and model accuracy can be appropriately ignored or relaxed. Because during undergraduate teaching, students mainly focus on the general process from mechanical practical problems to mathematical models, rather than specific issues that may involve the modeling accuracy or efficiency of complex scientific research tools. When using the learned calculation methods based on mathematical models for solving, it is important to pay attention to the relationship and rationality between the calculated solution and the actual requirements of mechanical engineering problems, that is, to observe the degree of ill condition in the iterative calculation process and the rationality of the actual physical meaning represented by the obtained solution in mechanical engineering. If it is unreasonable, it indicates that some key issues or influencing factors may not have been considered during the modeling process, and it is necessary to return to the mechanical engineering problem and construct a new mathematical model. If it is reasonable, output numerical solutions and apply the obtained results to practical engineering problems.

1.3 Solving mathematical models for engineering problems

The purpose of solving the constructed model through computational methods is to obtain numerical solutions such as equation solutions and optimal solutions, and to apply them to mechanical engineering problems for judgment and feedback evaluation, in order to determine whether to retain numerical solutions. Taking complex structural analysis problems as an example, since the model is a numerical model, it is necessary to first establish a functional relationship between key output parameters (maximum stress, strain, mass, etc.) and input parameters (load, size parameters, etc.). It is obvious that the modeling knowledge of interpolation and approximation from the "computational methods" course needs to be adopted. Then, after establishing a more accurate mathematical model, it is necessary to establish a nonlinear equation system for solving, and the nonlinear equation system solving algorithm in the computational methods course will be adopted. Finally, the obtained numerical solution is substituted into the original problem for discrimination. If it matches, the numerical solution is output. If it does not match, corrections are made from two aspects: mathematical model establishment and algorithm selection. In the end, a satisfactory understanding is obtained.

2. Examination reform

The assessment method that combines regular grades and final grades aims to comprehensively evaluate the achievement of learning outcomes, enhance the credibility of assessment results, and stimulate students' learning enthusiasm. Daily grades mainly reflect students' classroom performance and level of acceptance of knowledge points, and the evaluation is mainly based on the homework situation in class. Through classroom questioning, students can grasp their understanding of the application of the course content in the field of mechanical engineering, and exercise their engineering thinking ability. The final assessment is a comprehensive assessment of a student's learning situation, completed through a large assignment. This major assignment includes two parts: a final classroom test and a complete course report completed after class. Through the large homework system, students are assessed for their understanding of the basic principles and methods of various calculation methods they have learned, as well as their ability to flexibly solve practical mathematical problems in mechanical engineering. This assessment downplays the memory of conclusions and emphasizes practical effects.

3. Conclusion

This article proposes a teaching reform model that combines theory with practice to address the problems of limited connection between mechanical engineering problems and limited expansion of related basic knowledge in the teaching of computational methods courses. The main steps of teaching reform are as follows: establishing a

complete process model of mechanical engineering problems, mathematical modeling, and computational solving, which has good reference value for the ability cultivation of mechanical engineering students and the promotion of engineering education professional certification and training goals. The new teaching model provides a way and strategy for the construction of new engineering disciplines and the cultivation of intelligent manufacturing professionals.

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