Course Construction and Practice of Computational Electromagnetics

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Abstract: Computational electromagnetics is a professional course for graduate students majoring in Electronic Science and technology. It is a method course that combines electromagnetic field theory and numerical calculation methods into engineering practice. It is a follow-up course of electromagnetic field theory course, so that students can understand several common numerical analysis methods in electromagnetic field engineering and understand their application and limitations. The course puts forward higher requirements for students' professional foundation and practical ability. Therefore, in the process of curriculum implementation, an important and continuous concern is how to improve students' mastery and practical ability. The purpose of this project is to modularize the teaching content according to the thematic teaching, start from the basic knowledge, carry out numerical experiments by topics, discuss phenomena and results, prepare the teaching materials of computational electromagnetics and highlight the innovation and application of basic theoretical analysis methods and related technologies. At the same time, relevant software is introduced for algorithm practice to guide students to learn and master how to combine this kind of software with practical engineering problems, and establish a teaching system combining teaching and practice.

1. Introduction

Computational electromagnetics is a core course for postgraduates majoring in Electronic Science and technology in Colleges and universities. Computational electromagnetism is a core course for graduate students majoring in Electronic Science and technology in Colleges and universities, which is a theoretical knowledge involving a wide range and interdisciplinary, and plays a very great role in modern electronic technology. Based on electromagnetic field theory and numerical calculation method, it aims to solve electromagnetic problems by using modern computer technology. Practice has proved that many complex practical electromagnetic problems can be solved by using computational electromagnetics. However, this course has always been recognized as a very difficult course by college students at home and abroad. Because the course requires students to master certain mathematical knowledge, not only theoretical knowledge, but also scientific algorithm and analysis. There are complex numerical analysis and calculation, and obscure calculation programming and formulas. In particular, there are a large number of applications of vector calculus in electromagnetic field in the teaching materials, which is difficult for many students to learn and master.

As everyone knows, calculus is the essence and difficulty of higher mathematics, and vector always makes students feel confused and disconnected from reality. Electric field and magnetic field cannot be seen or touched, which is much more abstract than macro circuit. When these three points are combined, the learning difficulty can be imagined. If we follow the traditional classroom teaching methods, we will inevitably face a large number of complex and cumbersome mathematical derivation and difficult to draw three-dimensional graphics. At the same time, this boring teaching method will stimulate students' interest in learning. Therefore, how to implement

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research-based teaching activities in professional curriculum teaching and improve graduate students' scientific research skills is not only a subject faced by the education and teaching reform of science and Engineering in Colleges and universities, but also an important subject to cultivate college students' scientific research ability. Therefore, it is imperative to carry out a series of research teaching practice in the course of computational electromagnetics.

2. Teaching Practice of Computational Electromagnetics

The course construction of computational electromagnetics is divided into two stages: the first stage: the determination of course content, the second stage: the establishment of teaching system,as shown in Figure 1.

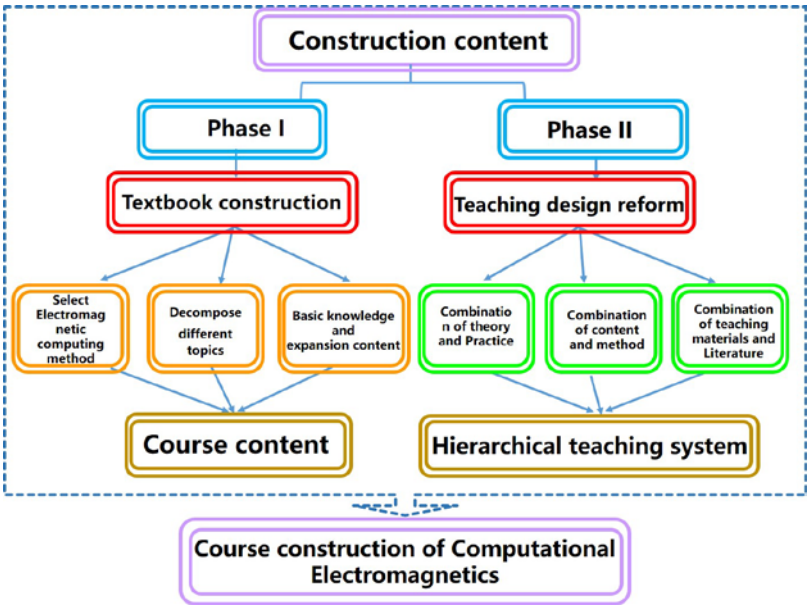

Fig.1 Course Construction Content

2.1 Determining Course Content

The course of computational electromagnetics mainly introduces several important computational electromagnetics methods which are widely used in engineering practice. These methods include finite difference method, finite element method, moment method, boundary element method and spectral domain method. The first three are the most basic methods in electromagnetic field numerical analysis. The course content is mainly based on these three methods, which are relatively independent in content, as shown in Figure 2.

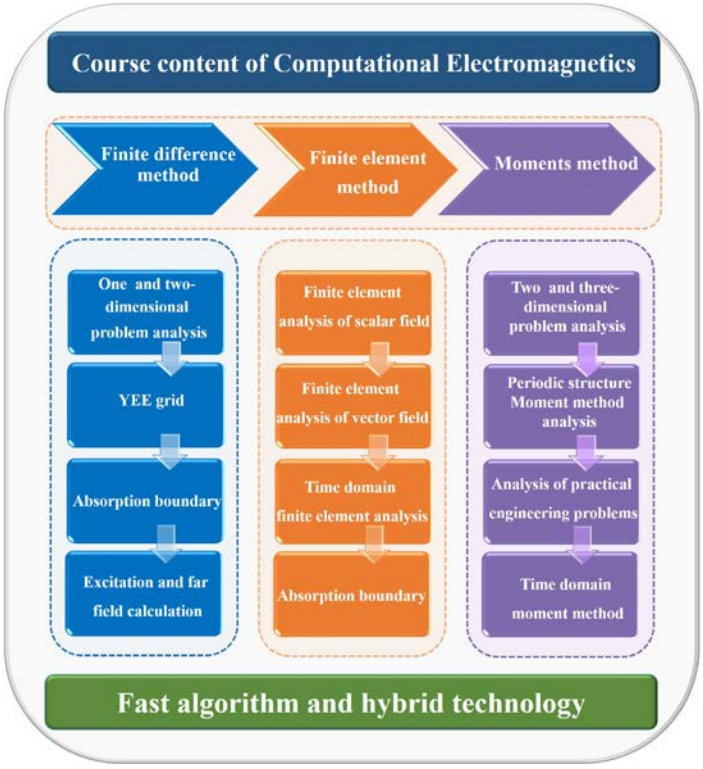

Fig.2 Course Content

Computational electromagnetics is usually offered in the second semester of graduate students. With the increasing research pressure, students will face the challenge of dealing with specific scientific and engineering problems, and need to deeply use computational simulation software. Therefore, it is urgent to carry out student-centered teaching practice of computational electromagnetics. We will implement teaching practice reform from the following three aspects

2.2 Combining Theory and Practice

Computational electromagnetics is a course connecting electromagnetic field theory and engineering practice, whose learning and research goal is to solve specific scientific and engineering problems. The course's study only stays at the theoretical level and lacks practical links, which is not conducive to students' learning to solve typical problems and the realization of curriculum objectives. In the teaching process, the reasonable organization of teachers' teaching and students' classroom practice will be conducive to the strengthening and internalization of teaching content. In addition, the course contains a large number of formula derivation, which will make students' learning more boring. Properly adding practice will help to improve students' participation and ensure classroom effect.

2.3 Combining Content and Method

The field of computational electromagnetics is quite extensive, and it is not feasible to explain its content comprehensively in limited class hours. In the course, We will adopt project-based teaching method and explain the three most typical methods by topics. It is not that the contents of these three methods are enough to solve various problems, but that they can extend a lot of contents. Therefore, it is particularly important to master these three basic methods. In the course implementation, we should pay more attention to the students' understanding of methods rather than the course content. Through the study of this course, students are expected to master the general methods of electromagnetic field numerical calculation.

2.4 Combining Teaching Materials and References

In the course teaching process, excessive emphasis on teaching materials is not conducive to cultivating students' thinking habits and scientific research thinking, but also to students'

understanding of the discipline's frontier. Most of the teaching materials are traditional basic contents, which is not conducive to understand the development history, latest development and actual use effect of the method. Therefore, on the basis of teaching materials in the course, it is necessary to select auxiliary reference materials such as classic references according to special knowledge points, decompose the principles, calculation methods, knowledge structure and technical scheme involved in the reference materials, and integrate them into the course teaching. The specific implementation steps are shown in Figure 3, which helps students understand the causes and consequences of method development and the scientific laws contained in the process of method development.

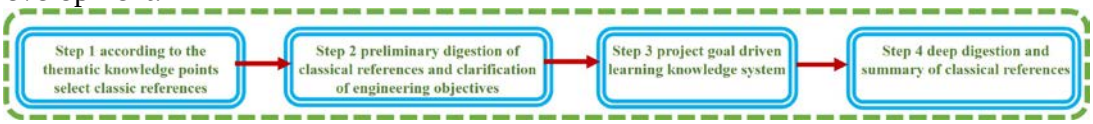

Fig.3 Integration Process of Teaching Materials and References

2.5 Constructing Teaching System

Though introducing the relevant software into the classroom of computational electromagnetics, will establish a curriculum system of physical process visualization and a hierarchical teaching practice system of design after principle, reality after virtual, device after simulation. The textbook emphasizes the basic theories and methods, the reference materials determine the practical engineering application, and the software can realize the concretization and visualization of complex engineering problems. The three parts complement each other, so that the teaching system can be divided into three levels: basic cognitive type, comprehensive type and innovative design type, as shown in Figure 4.

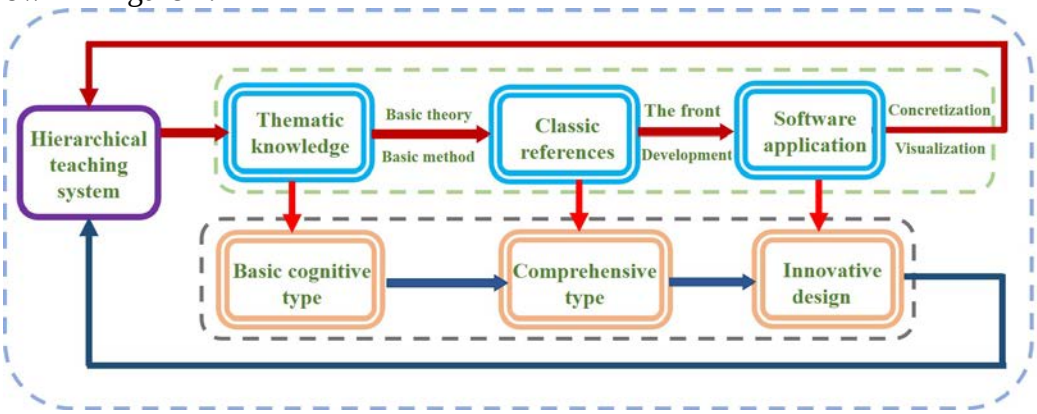

Fig.4 A Hierarchical Teaching System of Computational Electromagnetics

3. Conclusion

With the development of computational electromagnetics, computational methods and technologies have been greatly improved, which has a great impact on all fields in society. Through the curriculum construction of this course, we can cultivate students' comprehensive quality and independent learning ability, strengthen students' theoretical foundation, improve students' practical ability, facilitate the cultivation of modern information and communication talents, and lay the theoretical and technical foundation for students to go to society and engage in relevant industries.

Acknowledgement

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