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Course Construction and Practice of Computational Electromagnetics

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Abstract: Computational Electromagnetics, as an important course for electronic information majors. In recent years, with the continuous development of related technology, the content of the course is updated slowly, and the teaching method of the course is generally traditional. Combined with the foundation of the previous electromagnetic fields and microwave technology series of related courses, we focus on the construction of knowledge and the cultivation of application ability, selecting the basic theoretical knowledge related to the core elements of the specialty. Starting from the basic knowledge, virtual experiment and discussion of phenomena and results are carried out by topic, numerical simulations are carried out by topic, and teaching materials are prepared. At the same time, relevant software is introduced for algorithmic practice, guiding the students to learn and master how to apply this kind of software in conjunction with the actual problems of engineering, and establishing a teaching system that combines teaching and practice.

Keywords: Computational Electromagnetics; Courses; Teaching and practice

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1. Introduction

The course of Computational Electromagnetics is an undergraduate core course in electronic science and technology and other majors, and it is a professional course that introduces the development history and basic knowledge of computational electromagnetic methods. It requires more prelude courses and is a practical theoretical knowledge with wide coverage and multidisciplinary intersection, which plays an important role in training students to apply relevant electromagnetic theories to many engineering problems in the electronic information industry [1-3]. This course has been recognized as a very difficult course by college students at home and abroad [4]. Because the course requires students to master a certain amount of mathematical knowledge, both theoretical knowledge and scientific algorithms and analysis. There are complex numerical analyses and calculations, and obscure computational programming and formulas [5]. In particular, a large number of applications of vector calculus in electromagnetic fields appear in the book, which is difficult for many students to learn and master. Because it is well known that Calculus is the essence and difficulty of Advanced Mathematics, and the disconnect between vector and reality always confuses students; electric and magnetic fields are invisible and intangible, much more abstract than macroscopic circuits. The difficulty of rubbing these three together can be imagined. Therefore, in order to improve students' interest in learning, and also let students have a real sense of gain, the traditional teaching content and method need to be fundamentally reformed.

2. Construction and Practice Content

As a specialty course closely related to practical applications, the teaching content of Computational Electromagnetics course should cover the basic principles of numerical calculation methods of electromagnetic fields, but also be designed with its latest development and practical applications. In order to better integrate these two parts of the teaching focus, but also to overcome the

shortcomings of traditional teaching, we plan to use group seminar teaching. The specific content of the course teaching is also constructed in various aspects to match the teaching method. In terms of teaching content, the three typical numerical methods are taken as the core of basic knowledge, the study and application of commercial simulation software are taken as the focus of practical teaching content, and the latest research progress of computational electromagnetics is planned dynamically. In terms of teaching methods, the main form of teaching is to take the topic discussion, integrating the reverse classroom teaching method, and combining the software operation with practical teaching.

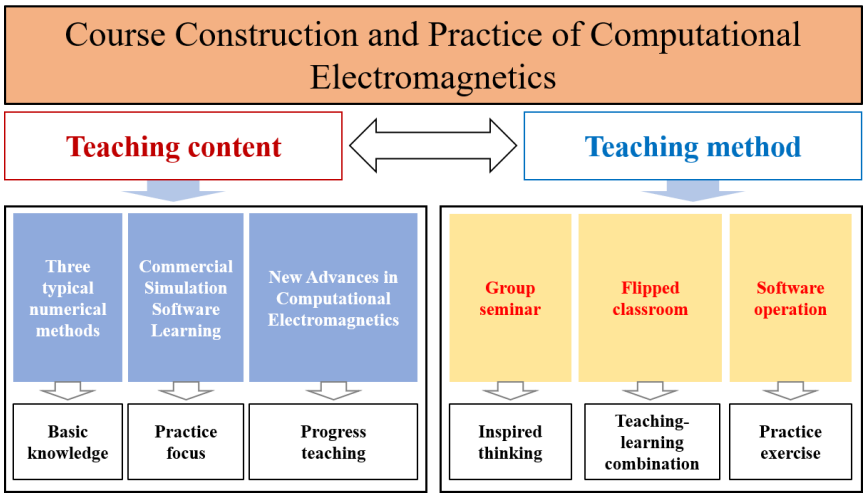

Figure 1. The idea of course construction.

2.1 Core pedagogical content based on three typical numerical methods as the basis of knowledge

Computational electromagnetics courses are difficult to learn. When designing the initial teaching content, some colleges and universities only take the Finite Difference Method, which is a kind of computational electromagnetics, as the key content of the course explanation. Although this design reduces the difficulty of the course, it is not conducive to students' comprehensive understanding of the commonalities and characteristics of computational electromagnetics. After changing the lecture mode of the course to a small class seminar mode, we can add seminars and practice sessions for students to better learn the basics, which also creates conditions for the reform of the teaching content.

2.2 Learning and applying commercial simulation software as the focus of the practical part of the instruction

For learning to use computational electromagnetics to solve the latest practical application problems, the best way is to use all kinds of commercial software teaching based on computational electromagnetics. Because the latest application problems are often very complex, only rely on the basic knowledge of the algorithm can not be a good solution to such problems, and commercial simulation software is based on the basic algorithms to do a variety of optimization of the program, you can better calculate the actual problem. We plan to first explain the operation of one of the most commonly used electromagnetic field simulation software in the teaching process, and then explain the use of simulation software to solve the three latest application problems, focusing on the analysis of the results of the new applications. As we use group seminar teaching, we can arrange the explanation of this part of the content in the computer room.

2.3 Dynamic planning for teaching recent research advances in computational electromagnetics

In the second part of the course, which introduces the development of electromagnetic numerical methods and new practical applications, in addition to a part of the credit hours focusing on the application of simulation software, another small part of the credit hours is planned to explain the latest research progress in Computational Electromagnetics. This part of the content will be updated very frequently, we will dynamically adjust the content of this part of the lecture. We will design this part of the teaching content with the algorithmic advances that are more relevant to the basic knowledge of the course and easier for students to understand. At the same time, due to the use of group seminar teaching, this part of the content of the teaching form can be more flexible, including the invitation of related research experts to give lectures.

2.4 Classroom instruction centered on seminar topics

The focus of seminar teaching is on "seminar", unlike traditional teaching where the teacher explains the points in the classroom in the order they are presented. The core content of the course is designed to be implemented in a way that each lesson addresses a small

seminar topic. For example, when learning the content of finite difference method, we focus on small topics such as discretization of solution models, discretization of solution equations, numerical solution of systems of linear equations with distinctive features, validation of results and accuracy analysis. The students were allowed to first look up information, preview the material, and then work on typical problems posed by the instructor in class.

2.5 Incorporating a reverse classroom approach to teaching and learning

The course "Computational Electromagnetics" is closely related to practical applications, and it has always been difficult to explain the application knowledge of the course. This is not only because of the difficulty of solving application problems, but also because of the rapid progress of application research, which makes it difficult to select suitable examples for undergraduate classes without necessarily meeting the interests of students. We plan to incorporate inverted classroom instruction in this course. Firstly, students will be divided into groups, and then each group of students will work together to search for information, make PPTs, and give lectures on the stage about the applications they are interested in, while the students on the stage can ask questions and discuss, and then the teacher will make comments and summarize at the end.

2.6 Laboratory instruction incorporating software manipulation

The traditional "Computational Electromagnetics" course, in the classroom teaching only the theoretical part of the teaching. Since the course content adds the study and application of commercial simulation software, in order to achieve better teaching effect, the theoretical part of the course is integrated with the experimental teaching of software operation. The design of the 8 credit hours of the course in the machine room to explain, so that students can learn while the actual operation, faster and better to learn the operation of the software. Hands-on classroom tests are also conducted in the classroom, assigning simple problems for students to implement in software and explaining the main points of the algorithms involved.

3. Conclusion

After the above construction, the teaching quality of Computational Electromagnetics should be able to be significantly improved. Through the reform and exploration of teaching content, we can realize the content connectivity and relevance of this course with other electromagnetic field and microwave series related courses; through researching, organizing and teaching the latest progress in electromagnetic numerical simulation and electromagnetic science application, we can overcome the problem of insufficient timeliness of traditional teaching content; through the adjustment and optimization of teaching methods, i.e., integrating the flipped classroom, discussion of the subject, software operation and other diversified teaching methods. The problem of insufficient practicability in the traditional teaching process is overcome through the adjustment and optimization of teaching methods.

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