TEACHING REFORM OF MICROWAVE CIRCUIT EDA IN CDIO MODE

Rongqiang Li, Guohong Du, Ling Yang

School of Electronic Engineering, Chengdu University of Information Technology, Chengdu 610225, China

ABSTRACT

Based on CDIO engineering education concepts, some teaching contents, teaching methods and evaluation methods are reformed by analyzing the existing problems of Microwave Circuit EDA teaching in the past, and the appropriate practice process is added. First, teacher timely update course content, selecting the most common industry software Ansoft HFSS software as a teaching software, and currently widely used microstrip devices and substrate integrated waveguide(SIW) devices as teaching contents; Then, students would quickly grasp the basic usage of a microwave simulation software HFSS by the way of mutually motive example teaching. In addition，students would form some small teams to complete some CDIO project in the teaching process and after class. Finally, teacher let each team to design two integrated CDIO projects, and selects the better one to allow them to complete for evaluation. This teaching reform effectively trains the students' conception ability, design innovation ability and team cooperation ability, and achieves good effect.

KEYWORDS

CDIO mode, Microwave Circuit EDA, Mutually motive method, Teaching reform

1. Introduction

CDIO engineering education mode is the latest achievement of international engineering education reform, which has had a profound impact on Chinese engineering education after introduction since 2005. CDIO represents Conceive, Design, Implement, and Operate, running product development to product life cycle as a carrier, allowing students to learn theory, technology and experience of the project by taking the initiative, practical, courses' organic link's way. Its purpose is to train students to apply knowledge and skills integrated to solve practical problems, innovation, team cooperation ability and the sustainable development ability.

Electronic Information Science and Technology aims to develop advanced engineering technical personnel, who have the basic theories of electronic information science and technology, basic knowledge and experimental skills, and can engage in RF, microwave circuits and systems, electronic information systems research, design, development, application and management.

Computer simulation is a dynamics and relatively realistic imitation, which applying computer system structure, function and behavior and participation system to control human thought processes and behavior. Computer simulation technology has economic, secure, repeatable advantages without climate, site, time-limited, which is called the third means which human

understanding nature, transform nature except for the theoretical derivation and scientific experiments.
Microwave Circuit EDA course is an application of computer simulation in the electronic information science and technology field, and the course requires students to use electromagnetic simulation software Ansoft HFSS to design passive microwave circuits and antennas, with operational, multidisciplinary characteristics, and students generally feel difficult to learn. In order to improve teaching effect, this teaching reform introduce CDIO engineering education idea into Microwave Circuit EDA course teaching to solve some problems and shortcomings in the current educational mode, focusing on teaching content, teaching methods, evaluation methods three aspects of the curriculum reform, training the students' ideation ability, design innovation ability and team cooperation ability.

2. The existing problem under the current teaching mode

2.1 The obsolete teaching content

With the development of electronics and communications technology, the content of microwave circuit is constantly updated and developed. From the metal waveguide devices to microstrip transmission line devices, and then to the substrate integrated waveguide devices. In addition, some advanced technologies, such as damaged ground structures, the composite right-hand structures and the LTCC structures are also promptly applied on these devices. However, our teaching content is still stay in simulation of some old microwave components, and there is no update in accordance with the needs of society and industry dynamics.

2.2 The single teaching method

This course is still stayed in the traditional teaching method that teacher teaches and students operate on the computer. Teachers first teach the basic features and operation process of simulation software, and then let the students operate related teaching examples according to the steps on the computer. This teaching method can not lead to students' interest in learning software, and they do not know how to solve other problems and can not solve practical problems after class.

2.3 Adhering to the traditional evaluation method

The traditional course examination uses the usual scores (attendance, work, etc.) as auxiliary assessment method, and test scores as primary assessment methods. But this does not fit the software simulation courses because such courses require students to have a strong ability to solve problems using the software, so the students' comprehensive ability to use software should be an important part of the course assessment.

2.4 The lack of necessary practice process

Microwave Circuit EDA is a strong practical course, and it is constantly developing and improving in the microwave circuit simulation, analysis process. The current teaching mode lack the necessary practice, students can not intuitively understand how the link between simulation course and the actual products, the lack of perceptual knowledge and practice opportunities, being puzzled for usefulness of the course.

3. The reform of teaching content, teaching method in CDIO mode

Microwave Circuit EDA course reform is under CDIO engineering education mode, and CDIO engineering education concept needs to be flexible throughout the teaching activities, to establish a student-centered educational philosophy, and fully mobilize the students' enthusiasm, initiative and creativity.

3.1 Timely update teaching content

Microwave Circuit EDA is a courses closely linked social demand, industry trends， Teaching content should be with the times. Teachers should use the most common software and timely update teaching examples in teaching, so theoretical knowledge and engineering technology are linked to lay a good theoretical basis for the implementation of CDIO project. In order to find the widely used software in related businesses for microwave technology field, we made some research for the needs of the community, which will allow students to quickly adapt to their posts when they enter the enterprise to work after graduation. Moreover, we are also made a research for a number of universities and research institutes in the microwave field to find frequently used microwave simulation software for them, which would has a positive effect on students for a future high-level academic studies. Based on the above two aspects, we choose Ansoft HFSS software as a teaching software, which is three-dimensional electromagnetic microwave engineering simulation software based on finite element method (FEM). On the teaching examples, we mainly select the current widely used microwave components based on microstrip transmission line and substrate integrated waveguide transmission line, and this is consistent with the trend of microwave circuit miniaturization, integration.

3.2 Team teaching method

To develop students' team spirit, we let five students form a small team. In teaching, we will set up some CDIO project and allow team members to discuss and answer. After school, students handed in CDIO project in the form of small team and required to specify the division of labor in each task. In addition, a team score will account for a large proportion for individual achievement at the final examination. That carrying out the CDIO project as a team can effectively improve students' communication skills, teamwork and project organization and management skills.

3.3 Mutually motive example teaching method

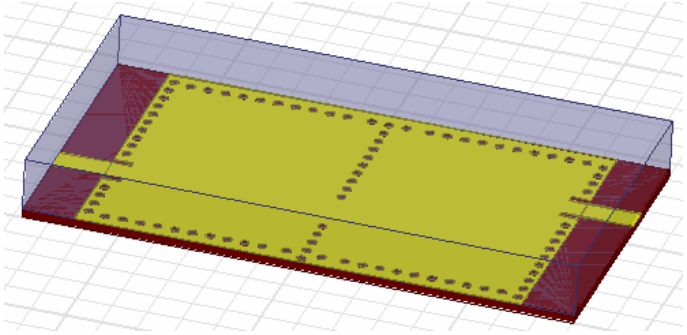

Figure 1. The simulation model of the oversized SIW filter with an air box

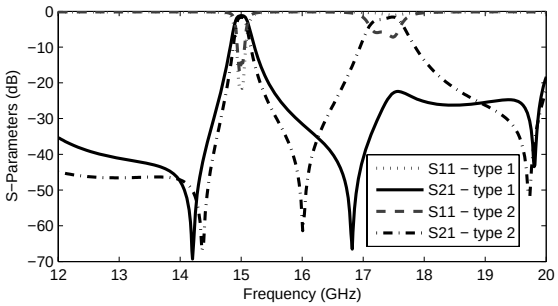

Figure 2. The simulated S-parameters of the oversized SIW filter

In the teaching process, teacher should select the current representative microwave components, such as filters and antennas based on microstrip or substrate integrated waveguide structure, as teaching examples to introduce the specific process of using Ansoft HFSS software to design microwave components for students. To a substrate integrated waveguide filter design as an example, it consists of two oversized SIW cavities, whose geometric structure is shown in Figure 1. We first introduce working environment of HFSS software and structural features of SIW filter, and then use the computer to demonstrate the process of establishing the model, finally introduce the post-processing of model. After the model is completed, we introduce error-prone areas in the process of establishing the model, such as the determination of the size of the air box. For a SIW filter in the real circuit which has a metal shield cavity, we take the size of the air box to be consistent with the required size of the cavity, or to take the air box height of 6-10 times of the substrate thickness; For a filter without metallic shield cavity, directly exposed to the air, we use similar design method with air box of microstrip antenna. The outermost metal portion of the SIW filter is not less than quarter wavelength apart with the air box, and need to add radiation boundary conditions for air box. After this filter model is completed, we carried out the simulation, and the simulated S-parameters are shown in Figure 2, where type 1 and type 2 represent different sizes of two oversized cavities.

The first step of CDIO engineering education mode is the conception, so teachers in the classroom would often ask students to solve some problems revolved around teaching content and CDIO project. In the teaching process, encountered error-prone areas, we ask a student in person to operate again, and let the student introduce considerations to other students. If the student does not, we let the other members of his team continue to supplement. For the better team completed classroom problems, we add some scores to their usual performance to show rewards. After class we arranged some CDIO project, and asked one or two teams to demonstrate and accept other team and the teachers' questions at the next class. That students complete CDIO projects through the team form, not only can expand the students' creative space, display the student's stage of learning outcomes, but can also train students' communication skills and teamwork.

That mutually motive example teaching method is closely associated with the current industry dynamics, can greatly improve the students' enthusiasm and active participation, also can make students solve engineering problems in engineering practice, and enhance the professional capabilities, that is consistent with the CDIO teaching philosophy.

3.4 The increase of practice process

In order to improve students' engineering ability, teaching should increase some CDIO project application examples. After completing the simulation of microwave components, we

explain its subsequent processing testing process, and display the actual objects for students. Figure 3 shows the photo of the oversized SIW filter as a classroom example. These actual objects enable students to intuitively understand the simulation model, stimulating students' learning interest, improving students' literacy and practical engineering ability.

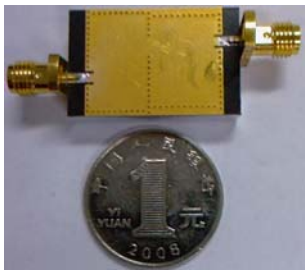

Figure 3. The photo of the oversized SIW filter

4. The reform of evaluation method

The traditional way of pure written examination can only reflect students' mastery of theoretical knowledge, is difficult to reflect the students' comprehensive ability. So we reformed the assessment methods of Microwave Circuit EDA course in CDIO engineering education mode. The total scores consist of three parts, including the usual scores, the computer experiment scores and the integrated design scores.

The usually scores account for 30% of the total scores, composing of attendance, usually work and classroom performance. Attendance refers to the case of student come to class on time; usually work mainly show CDIO project completion after school; classroom performance is based on group discussions, divided into individual performance and team performance.

The computer experiment scores account for 40% of the total scores, which is mainly on account of the completion of the required content on computer. This assessment is divided into individual and team experiment scores. Individual experiments is mainly come from the basic experimental content, ask student to complete independently. The team experiment is mainly come from expand experimental content. team members discuss each other, designing related microwave components, asking students to complete the simulation by using HFSS software and provide experimental reports.

The integrated design scores account for 30% of the total scores. As the idea of CDIO engineering education requirements for concept, integrated design part requires each group of students to design two comprehensive CDIO projects, teacher choose a better design to let student complete. Completed content should include simulation model, simulation results and experimental reports. For the team with more novel design, better completion, we manufacture and test their products, and encourage them to academic creation. Integrated design cultivates students' comprehensive ability to use knowledge and skills to solve practical problems, conception ability, innovation ability and the team cooperation ability.

In order to assess the effect of the teaching reform itself, we took a comparison about course assessments before and after the reform. We select two classes to take part in the test. Class one is to carry out the traditional teaching mode, Class Two is to execute CDIO teaching mode. Two classes were asked to complete three same CDIO projects, and the overall score of each project is 100. Figure 4 shows the assessment results. As shown in Figure 4, the grades of the class carrying out CDIO teaching mode have an obvious improvement.

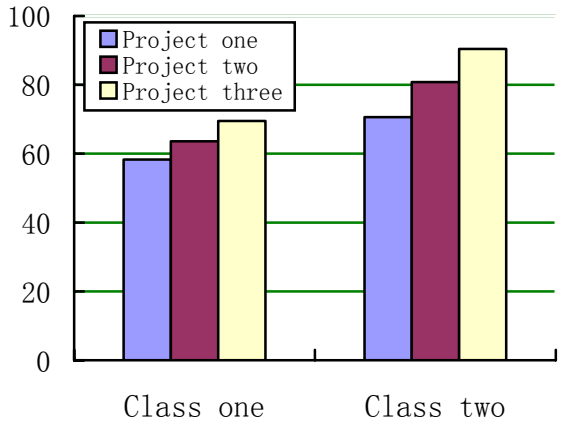

Figure 4. Comparative result before and after the reform

5. Conclusion

CDIO educational philosophy aims to cultivate students' engineering application ability and innovative ability, focusing on the cultivation of students' comprehensive quality. In the CDIO engineering education mode, the reform and practice of School of Electronic Engineering, Chengdu University of Information Technology from teaching contents, teaching methods and assessment methods for "microwave circuits EDA" conducted effectively develop the students' engineering quality, design innovation ability and team cooperation ability, and achieves good effects. With the deepening of reform, Microwave Circuit EDA course not only will play a greater role in the training system of electronic information engineering and technical personnel ability, will also provide new ideas to train undergraduate students with application-oriented electronic information engineering technology.

REFERENCES

Edward, F. C., Johan, M.,Soren, O., & Doris, B. (2007). *Rethinking engineering education: the CDIO approach*. New York: Springer.

Johan, B., & Karl, B. (2005). Benchmarking engineering curricula with the CDIO syllabus, International Journal of Enfineering Education, 21(1):121-133.

Yuan, L., & Wang, L. (2011). Teaching method reform of the drawing course by integrating CDIO mode. Proceedings of ICCSE'11, Singapore,1301-1302.

Du, G. H., & Cao, J. Y. (2009). Research on teaching reform of electromagnetic field and microwave technology courses based on CDIO. Journal of electrical and Electronic Engineering Education, 31, 52-60.

Wu, X., Gai, Q. Y., Xie, M.Y., Wu, Q., & Wu, X. (2014). Key factors affecting knowledge transfer success in CDIO project designation. Proceedings of the 10th International CDIO Conference, University Politècnica de Catalunya, Barcelona, Spain,1-10.

Chen, M., Xie, M.Y., & Yang, D. Y. (2014). Integrated active learning implementation in CDIO practical course for massive population. Proceedings of the 10th International CDIO Conference, University Politècnica de Catalunya, Barcelona, Spain,1-8.

BIOGRAPHICAL INFORMATION

Li Rongqiang is an associate Professor in Chengdu University of Information Technology, Chengdu, China. His current research focuses on the reform of teaching method in CDIO teaching mode.

Du Guohong is an associate Professor in Chengdu University of Information Technology, mainly in research of CDIO teaching mode for many years.

Yang Ling is a Professor in Chengdu University of Information Technology, dedicated in the research of CDIO teaching method, following many teachers to do research in the reform of teaching method in University.

Corresponding author

Dr. Li Rongqiang
Chengdu University of Information Technology
No24,block1,xuefuroad,hangkonggang area
Chengdu, Sichuan, China 610225
liyq2011@cuit.edu.cn.