

Research on Teaching Practice of MATLAB Assisted High Frequency Circuit Course for Foreign Students in China

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Abstract—Aiming at the training goal of foreign students majoring in Communication Engineering, this paper makes a thorough analysis of the current teaching situation of High Frequency Circuit course for foreign students in our University. We introduce the MATLAB simulation software into the teaching practice, so as to improve the class interaction and inspire innovative thinking. The research on this topic is important for accumulating foreign students' teaching experience, exploring foreign students' talent training mode and educational innovation. Good results have been achieved from the teaching practice.

Keywords—MATLAB; High Frequency Circuit; foreign students

I. INTRODUCTION

At present, the education of foreign students is the only way to speed up the process of internationalization of higher education and promote the internationalization of universities. It has become one of the important tasks of higher education [1-2]. Our university has recruited foreign students for Communication Engineering specialty since 2014. Through the 5 years, we have accumulated rich teaching experience and a group of teachers with solid professional knowledge. It has gradually formed a relatively complete and scientific teaching system of the electrical courses for foreign students.

High Frequency Circuit is an important professional basic course of Electronic Information, Communication Engineering, Electronic Science and Technology specialties [3]. This course studies the basic concepts, basic principles and basic analysis methods of high frequency electronic circuits. It focuses on unit circuit analysis and design, and introduces the actual circuit composition. This course combines theory, engineering and practice together. Its main characteristics are as follows, numerous contents, abstract concepts and tedious mathematical derivation. It has always been a challenge course for students of telecommunications majors. It is generally difficult for students to master the relevant knowledge and the teaching effect is poor. How to let students understand and grasp the basic theory and concepts of the course in limited teaching time and train students' signal analysis and design ability are the main problems to be solved in the teaching reform of this course [4]. In view of the training objectives of foreign students

majoring in communication and information related majors, it is of great significance to learn from advanced educational and teaching concepts at home and abroad and to attach importance to practical courses in order to improve the comprehensive quality and practical level of foreign students.

This paper introduces the simulation software MATLAB to High Frequency Circuit course, which broadens the teaching means and helps students to further master the theoretical knowledge and improve the teaching effect.

II. CURRENT TEACHING SITUATION

High Frequency Circuit is a basic core course of electronic information specialty in universities. It explains the circuit structure, working principle and calculation method of high frequency transmitter and receiver in radio communication system. A typical feature of this course in teaching is the need to analyze the waveform changes of electrical signals in different circuits. From the perspective of teaching methods, some contents are not intuitive enough when drawing or analyzing with the help of blackboard or multimedia courseware, and it is not convenient to change circuit parameters for comparative explanation. In the practice of teaching, the following problems are found to be common among foreign students.

A. Weak Concept of Time

Most foreign students have a weak sense of time and have a more casual arrangement of time. Specific performance is: they usually cannot attend the class on time; many students will be 10-30 minutes late to class; if the course is scheduled at 8 a.m., more lateness will occur; even the deadline for homework was clearly stated in the email, many students were delayed or even overdue to submit their homework. Generally, there is no clear plan for their study and life, which often leads to the project not completed at the specified time points.

B. Lack of Engineering Concept

Few students can take the initiative to complete the exercises and homework assigned by teachers independently. Most of them require teachers' supervision to complete the homework. If it is the more challenge homework, the main

performance of the students is to abandon active thinking, almost completely rely on the information provided by teachers.

C. Active Thinking

Compared with domestic students, foreign students in China have active thinking. When teachers explain problems, if they do not understand, they will interrupt the teacher's lecture to ask questions. There are many abstract concepts in the course of High Frequency Circuit. If they can't understand, they will keep asking the teacher if there are any specific application cases, hoping to get inspiration from the examples. Foreign students who come to China often interact with their teachers in such a way that they can not only really grasp knowledge points, but also enable teachers to maintain a high degree of attention.

D. Lack of Basic Professional Knowledge

According to the training plan, High Frequency Circuit course is arranged in the second semester of sophomore year. There are many prerequisite courses, such as circuit principles, analog electronic circuits and so on. These prerequisite courses are the basis of learning High Frequency Circuit. In the practice of teaching, it is found that many knowledge points of prerequisite courses are not really grasped by foreign students. This leads to the need to constantly help them with relevant advance knowledge in the course of teaching, and that will take a lot of energy and valuable time. In addition, due to the weak foundation of foreign students' professional knowledge, strong dependence on teachers is common. Students can solve the intuitive problems, but they are lack of analysis ideas for comprehensive circuits.

E. Urgent Need for Suitable Textbook

The selection of textbooks for High Frequency Circuit for foreign students has always been a difficult task. Although the original English textbook is good at language expression and easy to understand and accept, the content arrangement of each textbook is different from the requirements of the training plan of the telecommunications students in our university. Some of them are too cumbersome and some of them are not covered all the teaching needs. Therefore, we need to cut down and add teaching content according to the requirements of the syllabus.

III. MATLAB

MATLAB is a high performance language for technical computing [5]. It integrates computation, visualization, and programming in an easy to use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Modeling, simulation, and prototyping
- Algorithm development
- Scientific and engineering graphics
- Data analysis, exploration, and visualization
- Application development

MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state of the art in software for matrix computation. MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the toll of choice for high productivity research, development, and analysis.

MATLAB features a family of application specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

The method of using simulation software to promote teaching has been adopted in many colleges and universities. We introduce MATLAB to the course of High Frequency Circuit. It not only simulates the signal, but also help analyzes the signal and circuit. MATLAB let students observe the generation, the operation and the results both in time and spectrum domain including corresponding processing signal graphics through simulation. It can play a connecting role between theoretical and experimental contents.

IV. APPLICATION OF MATLAB IN HIGH FREQUENCY CIRCUIT TEACHING

In High Frequency Circuits, we can use MATLAB to simulate the experiment process, such as super heterodyne receivers, AM (Amplitude Modulation), DSB (Double Side Band), FM (Frequency Modulation), Oscillator and so on. We can draw and analyze the waveform of the signal going through transmission and transformation by MATLAB. First, we apply the LC resonant circuit simulation experiment as an example. Fig. 1 is a typical principle circuit of a LC resonant circuit.

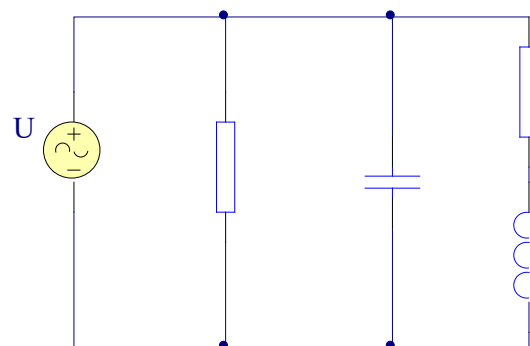


Fig. 1. LC parallel resonant circuit

The resonant frequency can be calculated as:

$$\omega_0 = \frac{1}{\sqrt{LC}}, \quad (1)$$

and the resonant impedance is denoted as

$$Z_p = \frac{1}{\frac{1}{R_s} + j\omega C + \frac{1}{R + j\omega L}} \quad (2)$$

We use MATLAB simulate the circuit; plot the amplitude and the angle of the resonant impedance which are shown in Fig. 2. Students can change the parameters of the components in the circuit to see the change of the wave. This figure will help students to understand the principals of the LC parallel resonant circuit better.

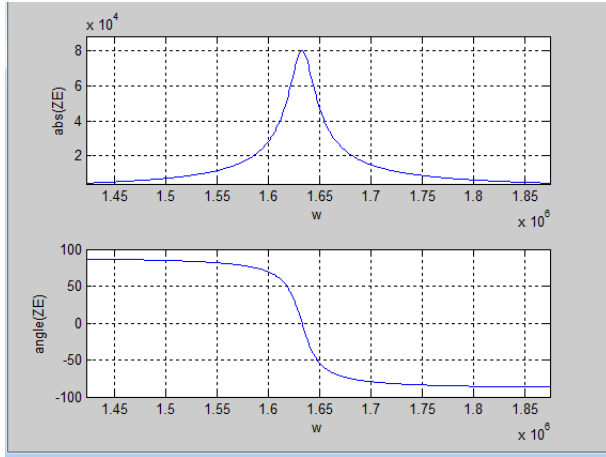


Fig. 2. Plot of resonant impedance

Next, we introduce another example, the LC Oscillator analysis experiment.

Fig. 3 shows us a principal circuit of Colpitts oscillator and Fig.4 is the equivalent circuit of Colpitts oscillator. Colpitts Oscillator is a type of LC oscillator which falls under the category of Harmonic Oscillator and was invented by Edwin Colpitts in 1918 [6]. Fig. 3 and Fig. 4 show a typical Colpitts oscillator with a tank circuit in which an inductor L is connected in parallel to the serial combination of two capacitors.

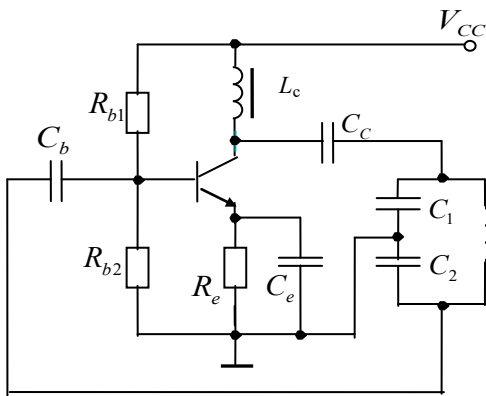


Fig. 3. Principal circuit of Colpitts oscillator

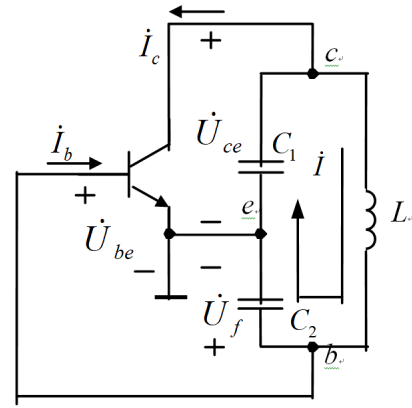


Fig. 4. Equivalent circuit of Colpitts oscillator

According to the equivalent circuit, the feedback coefficient is the ratio of capacitor C_1 and C_2 , which can be calculated as:

$$|F| = \frac{i \frac{1}{j\omega C_2}}{i \frac{1}{j\omega C_1}} = \frac{C_1}{C_2} \quad (3)$$

The total capacitor is:

$$C = \frac{C_1 C_2}{C_1 + C_2} \quad (4)$$

Thus, the oscillation frequency can be expressed as:

$$\omega \approx \sqrt{\frac{1}{LC}} \quad (5)$$

Then, we can use MATLAB to simulate the different influence of the key components on the circuit.

MATLAB simulation of Colpitts oscillation circuit is shown in Fig. 5. We can find that in the Colpitts oscillation circuit, feedback coefficient F increase with capacitor C_1 and decrease with capacitor C_2 , but F remains the same when inductor L changes. Moreover, in the Colpitts oscillation circuit, oscillation frequency ω decreases with capacitor C_1 and capacitor C_2 , also decrease with inductor L .

This analysis of Colpitts oscillation circuit is intuitive to the students, they can get the characteristic of the circuit easily by the simulation graph results.

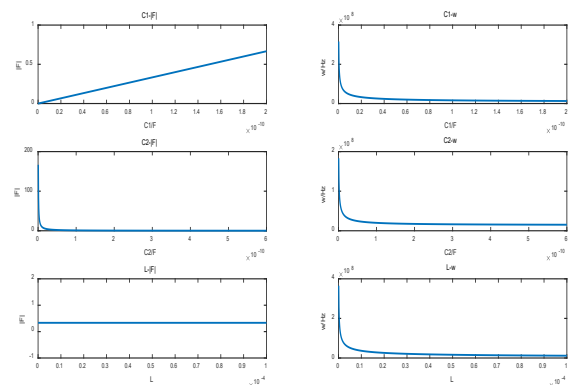


Fig. 5. MATLAB simulation of Colpitts oscillator

V. CONCLUSION

Signal simulation is a very practical simulation tool for High Frequency Circuit course. It can not only deepen the understanding of theory, verify the theory and experimental results, but also realize further signal processing through simulation. The simulation results of signal processing under different conditions can be obtained. At the same time, through training students' ability to simulate and practice, it broadens the teaching ideas, stimulates students' interest and enthusiasm in learning, and has a good role in improving the teaching effect.

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