

# Exploration of Teaching Methods for the Course of "Fundamentals of RF Circuits"

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**Abstract:** In response to the common problems that arise in the teaching of the traditional "Fundamentals of RF Circuits" course, traditional teaching methods are combined with new teaching concepts, fully leveraging the comprehensive advantages of online and offline, and utilizing different perspectives of theory and practice to strengthen students' understanding and mastery of abstract knowledge points. Practice has shown that this teaching method can not only improve the quality of teaching, but also effectively enhance the fun of teaching, stimulate students' interest in learning, and play a very important and positive role in cultivating students' ability to design and analyze circuits, as well as strengthening their engineering practice and independent innovation abilities.

## 1. Introduction

"Fundamentals of RF Circuits" is an important theoretical foundation course in undergraduate teaching of electronic communication majors in higher education institutions<sup>[1]</sup>. In recent years, due to the continuous emergence of interdisciplinary and professional fields, more and more majors related to wireless communication have also offered this course. From the perspective of the relevant professional curriculum system, the course of "Fundamentals of RF Circuits" plays an important role in the learning structure of undergraduate majors, and the ideal learning effect directly affects the learning of subsequent professional courses.

However, for a long time, this course has given the impression of abstract theory, numerous formulas, and complex circuit analysis, making it difficult for students to understand and master. In response to these characteristics, many teachers have made innovations and explorations in teaching methods, which have to some extent improved the effectiveness of classroom teaching. However, there are still problems with the new teaching methods. Through teaching practice, a more targeted teaching approach has been proposed. Guided by the new approach, a teaching framework has been established that combines online and offline, theory and practice. From the perspective of teaching practice effectiveness, it can effectively improve students' participation and initiative in teaching, making teaching diverse and interesting.<sup>[2]</sup>

## 2. Diversification of teaching organization methods

### 2.1. Traditional teaching

Traditional classroom teaching mainly uses textbooks, blackboard writing, and courseware. For theoretical teaching, long-term teaching of abstract concepts and content will gradually cause students to lose their desire and interest in seeking knowledge, leading to poor classroom teaching effectiveness. Therefore, in the continuous reform of teaching methods and models, this traditional and passive teaching model is no longer favored by teachers. But there are also some characteristics in traditional teaching that cannot be replaced and cannot be ignored by new technologies and methods. Textbooks can provide a general overview of theoretical knowledge, and teachers' casual lectures and writing on the blackboard can make the abstract deduction process gradual and clear at

a glance. At the same time, this teaching form is also more in line with the laws and habits of human learning.

## **2.2. Heuristic teaching**

Using simple and easy to understand examples to illustrate cumbersome charts in classroom teaching, designing more inspiring questions, and introducing them to encourage students to learn through thinking, their interest in learning can be stimulated. For example, when explaining the concept of modulation, some questions should be asked such as “Why does radio communication add modulation? Can wireless communication be achieved without modulation?”. When discussing the receiver circuit, it is proposed including “why should a mixer and intermediate frequency amplifier be added? What problems will arise if not added? “.By using the method of asking questions, students will be guided to learn and think through problems, explore problems in learning and thinking, and grasp the essence of the problem. After the learning is completed, the teacher will review and summarize the questions to deepen students' understanding.

In addition to constructive heuristic teaching, simple and understandable examples can be used to explain cumbersome charts or concepts. For example, when talking about radio communication, we compare real-life logistics transportation examples to radio communication. Through the analogy of the process of loading transportation unloading, students can be taught to understand the process and functions of modulation and demodulation, and to distinguish and master the three easily confused concepts of modulation wave, carrier wave, and modulated wave.

## **2.3. Online teaching**

With the rapid development of network technology in recent years, the platform has become a new trend of teaching, such as XuetangX, Chinese universities, etc. On the one hand, the learning of online courses is not limited by time or location, and students can easily enjoy high-quality teaching resources brought by famous schools or teachers, effectively deepening their understanding and mastery of knowledge points. On the other hand, these high-quality online teaching videos cannot completely solve all the problems in teaching, such as the large number of viewers of online videos, which makes it difficult to effectively communicate and communicate between teachers, students, and students during the teaching process

## **2.4. The combination of online and offline teaching**

Online or offline has its advantages and disadvantages respectively. Teachers attempt to effectively integrate these two teaching modes in the course of "Fundamentals of RF Circuits", so that students can not only enjoy the convenience brought by online teaching, but also enjoy the real and accessible communication experience provided by face-to-face teaching, improving their ability to understand knowledge, self-learning, expression, and collaboration with other students. The teaching group has developed a specific teaching plan using a combination of online and offline methods.

### **2.4.1. Online section**

In the vast amount of online resources, how to recommend suitable teaching videos for students is the key to the online teaching process. This job requires teachers to pay attention to and watch a large number of online videos, and make targeted choices based on the specific situation of students. Some interdisciplinary and professional students have not taken the introductory basic course of "high-frequency electronic circuits". Therefore, when choosing online courses for these students, they should avoid course resources that require higher knowledge in the communication field. For example, when selecting online teaching video resources for third year students majoring in drones, the author compensates for the students' lack of early communication knowledge by supplementing the "Communication Principles" course with an overview of communication systems at the beginning of the course. When introducing small signal amplifiers, the content on the derivation process of equivalent exchange between hybrid equivalent circuits and parameter equivalent circuits was deleted, in order to reduce the difficulty of students' learning. In summary, the basic principle

for selecting online resources is to select content with moderate difficulty based on the requirements of different majors and their training programs.

#### **2.4.2. Offline part**

Traditional teaching methods mainly focus on teachers, textbooks, and classroom teaching. After adopting a combination of online and offline teaching methods, teaching has become an open teaching method that is student-centered and teacher led. In open teaching, teachers cultivate students' awareness of participation and enhance their self-awareness in learning.<sup>[3]</sup> In the process of combining online and offline teaching, the teaching design of the offline part is the key to teaching. The author has improved classroom teaching to "classroom teaching topic discussion", abandoning indoctrination teaching and shifting to several small topic discussions, allowing students to rethink the knowledge they have learned. This approach has to some extent deepened students' understanding of the knowledge points. For example, when arranging the teaching of high-frequency power amplifiers, the author first asks students to learn some online videos before class to master some basic knowledge points. In classroom teaching, the main focus is on individual modules. ① Consolidate knowledge. Use questioning to help students consolidate the knowledge points of online learning ② Key guidance. When discussing the dynamic characteristics of high-frequency power amplifiers, students can be guided to think about "how to use dynamic characteristics to adjust the equipment if it does not achieve the ideal working state or output results in practical use". ③ Throwing a problem. After students have a comprehensive understanding of the knowledge they have learned, questions will be timely raised to guide students to conduct independent analysis and explain their own viewpoints. For example, in two different application scenarios of airborne equipment and ground equipment, students will be guided to discuss the selection principles of conduction angle, and discuss the relationship between efficiency and output power in combination with specific applications. This type of discussion can also be extended to extracurricular activities, allowing students to complete relevant discussion assignments by consulting materials. Regularly conducting such small topic discussions not only helps students develop the habit of active thinking and learning, but also provides them with opportunities to showcase and exercise. By stating viewpoints and debating and communicating with other students, students can improve their comprehensive abilities and cultivate their confidence in overcoming difficulties.

#### **2.5. Combination of theory with practice**

"RF Circuit Fundamentals" is a course based on experiments, and most of the theories described in the course need to be verified through experiments. The mastery of circuit experimental knowledge also reflects students' ability to apply theory and practical skills. Therefore, most schools and majors allocate a certain amount of experimental hours when offering this course. The existing hardware conditions and experimental hours in traditional experimental teaching cannot meet all the needs of students for experiments.<sup>[4]</sup> From years of teaching practice, the course of "High Frequency Electronic Circuits" is closely related to actual circuits. The core content of the course is circuit analysis methods based on circuit and high-frequency theory, derivation of working principles, circuit design analysis and its applicable conditions, constraint rules, approximate ellipsis, etc. It is also a key content that students need to learn and master.<sup>[5]</sup> However, due to the complexity of high-frequency circuits, many analyses and derivations are based on approximate estimates in specific environments. In actual circuits, adjustments need to be made according to specific circumstances, and the performance characteristics and specific circuit components of the circuit also need to be verified in actual experiments, requiring high flexibility in the experiment. The content of modulation and demodulation is difficult for students to understand, and the annual test paper analysis report also shows that students lose more points in this part of the exam. Therefore, the author encourages students to conduct hands-on verification in teaching, hoping that they can achieve a deeper understanding of knowledge through more emotional means, but it is difficult to achieve in traditional experimental teaching models.

### 3. Conclusions

"Fundamentals of RF Circuits", as a theoretical foundation course for communication and related majors, plays a connecting role in the entire teaching system of students' majors. Under the traditional teaching mode, due to the single teaching form, the teaching effect is not ideal. The author adopts a combination of online and offline teaching methods and establishes an open teaching concept, which allows teaching to not only stay in the classroom, effectively improving students' participation awareness, independent analysis and design ability, and laying a solid foundation for deeper professional learning and research.

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