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Exploration of the course design of high-frequency electronic circuit under the new engineering background

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Abstract: *This paper aims to explore the design and implementation of high-frequency electronic circuit courses under the background of the new engineering education. With the continuous development of technology, high-frequency electronic circuits have become an important component of the field of electronic engineering. However, under traditional teaching methods, students often find it difficult to truly master the relevant knowledge and skills. Therefore, guided by the concept of the new engineering education, this paper proposes a project-driven design scheme for high-frequency electronic circuit courses, combining practical experience. Through the implementation and evaluation of this scheme, it is found that students' learning enthusiasm has been effectively stimulated, and they can better understand and apply the knowledge they have learned. Finally, this paper summarizes the key points of course design and proposes prospects for future teaching practices.*

Keywords: *New Engineering Education, High-Frequency Electronic Circuits, Course Design, Project-Driven, Teaching Practice*

1. Introduction

With the rapid development of information technology, high-frequency electronic circuits are increasingly widely used in fields such as communications, radar, and radio. However, traditional teaching methods often fail to meet the needs of students. They often lack practical operation and project practice opportunities, resulting in a gap between theory and practice. Therefore, there is an urgent need for an innovative course design scheme that can cultivate students' practical ability and innovative thinking in the context of the new engineering education.

2. Background and Significance

2.1 Introduction to the New Engineering Education Concept

The introduction of the new engineering education concept is an innovative attempt to reform the traditional engineering education model. Under the traditional model, engineering education focuses on the impartation of theoretical knowledge, with students often passively receiving information in the classroom, lacking the motivation for active learning. The new engineering education concept emphasizes interdisciplinary integration and innovation, highlighting the cultivation of students' practical abilities and teamwork skills. This new educational model not only requires students to have solid disciplinary knowledge but also emphasizes the application of knowledge to solve practical problems, cultivating students' comprehensive literacy to meet the demands of future societal development.

2.2 Analysis of the Current Status of High-Frequency Electronic Circuit Courses

The main problem with current high-frequency electronic circuit courses is the disconnection between theory and practice. Traditional courses emphasize the impartation of theoretical knowledge but lack integration with engineering practice, making it difficult for students to apply the knowledge learned to actual projects. Additionally, due to the specialized nature of high-frequency electronic circuits, course content tends to be abstract, leading to difficulties in learning and low interest among students. Therefore, it is necessary to introduce more practical activities and project cases in course

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design to stimulate students' interest in learning, enhance their learning enthusiasm and practical abilities. Moreover, combining the new engineering education concept, interdisciplinary content should be integrated into the curriculum to help students better understand the applications of high-frequency electronic circuits in different fields and cultivate their interdisciplinary literacy.

3. Course Design Scheme

3.1 Project-Driven Course Design Philosophy

The project-driven course design philosophy is an innovative teaching method in modern education that immerses students in real engineering project scenarios to learn relevant theoretical knowledge and skills by solving practical problems. For high-frequency electronic circuit courses, adopting a project-driven teaching approach can greatly enhance students' interest and engagement in learning.

Firstly, project-driven course design can stimulate students' learning motivation. By placing students in real engineering projects, they can perceive the practical application and significance of the knowledge learned, thereby taking a more proactive approach to exploring and learning relevant content. For example, having students design a wireless communication system requires them to delve into the principles of high-frequency electronic circuits and apply them to system design, which can stimulate their interest in learning and enhance their learning initiative.

Secondly, project-driven course design can promote interdisciplinary integration. High-frequency electronic circuits involve knowledge from multiple disciplines such as electronic engineering and communication engineering. The project-driven teaching method can organically combine knowledge from these different disciplinary fields, enabling students to think and learn across disciplines while solving practical problems, thereby cultivating their ability to comprehensively apply knowledge.[1]

Lastly, project-driven course design can cultivate students' practical abilities and teamwork spirit. In the process of project practice, students need to engage in hands-on activities, solve real problems, and collaborate with team members to complete tasks. This not only enhances their practical abilities but also fosters their teamwork, communication, and collaboration skills, laying a solid foundation for their future engineering practice.

In summary, the project-driven course design philosophy provides an innovative approach for teaching high-frequency electronic circuit courses, effectively enhancing students' learning interest and engagement, promoting interdisciplinary integration, cultivating students' practical abilities and teamwork spirit, and possessing significant educational significance and practical value.[2]

3.2 Course Content and Organizational Structure Design

3.2.1 Course Content Design

The course content design aims to comprehensively cover the fundamental theories and practical applications of high-frequency electronic circuits. Firstly, it covers the basic characteristics of high-frequency circuits, such as frequency response and gain-frequency characteristics, enabling students to understand the behavioral characteristics of circuits at high frequencies. Secondly, the course includes principles and design of transmission lines, involving topics such as impedance matching and signal transmission, helping students grasp the transmission rules of high-frequency signals on transmission lines. Next, the course incorporates the design and analysis of power amplifiers, covering amplifier classification, working principles, and performance parameters, enabling students to understand and design different types of power amplifier circuits. Finally, it introduces the principles and methods of frequency synthesis, including phase-locked loops and frequency synthesizers, allowing students to understand the basic principles and application scenarios of frequency synthesis.

3.2.2 Experiment Project Design

The experiment project design aims to closely align with practical engineering applications, helping students consolidate theoretical knowledge and cultivate practical operational skills. For example, designing and testing various types of amplifier circuits to verify their performance indicators through experiments, allowing students to master practical amplifier design skills. Designing and optimizing parameters of transmission lines, physically constructing transmission lines, and conducting performance tests to help students understand the characteristics of transmission lines and their applications in communication systems. Using simulation software for the simulation design of

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frequency synthesizers to verify their frequency synthesis effects, cultivating students' simulation and experimental capabilities.[3]

3.2.3 Organizational Structure Design

The course organizational structure should be designed based on three components: theoretical teaching, experimental practice, and project practice. During the theoretical teaching phase, teachers impart basic theoretical knowledge to students through lectures and discussions, enabling students to establish a fundamental understanding of high-frequency electronic circuits. In the experimental practice phase, students conduct experiments to consolidate theoretical knowledge, cultivate practical operational skills, and deepen their understanding of course content through the design and completion of experimental projects. In the project practice phase, students apply their acquired knowledge and skills to participate in actual engineering projects, solve practical problems, enhance their comprehensive application abilities and teamwork spirit. This phase is also the core and climax of the course.

3.3 Selection of Teaching Methods and Means

3.3.1 Selection of Teaching Methods

In the teaching of high-frequency electronic circuit courses, various teaching methods can be adopted to meet students' diverse learning needs and improve teaching effectiveness. Firstly, lectures are fundamental, helping students establish a complete knowledge system through systematic explanations. Secondly, discussions promote student thinking and communication and can be organized in the form of group discussions or class-wide discussions, encouraging active participation from students. Additionally, case studies combine theoretical knowledge with practical cases, enabling students to apply theoretical knowledge to solve practical problems. Furthermore, laboratory experiments are crucial for consolidating theoretical knowledge and cultivating practical skills, allowing students to intuitively understand and master knowledge. Finally, during the project practice phase, group collaboration is adopted to allow students to work together and complete project tasks, cultivating their teamwork and problem-solving abilities.

3.3.2 Selection of Teaching Means

In addition to traditional classroom lectures and laboratory experiments, modern teaching methods can be employed to enhance teaching effectiveness. Firstly, utilizing online platforms for sharing and exchanging teaching resources provides students with more learning resources and practical opportunities. Secondly, using simulation software for remote experiments and simulation operations allows students to conduct virtual experiments on computers, reducing experimental costs and improving efficiency. Furthermore, employing multimedia technologies such as PPTs and videos can vividly demonstrate course content, stimulating students' interest in learning and improving learning efficiency. In conclusion, the selection of teaching means should be comprehensively considered based on course content and student characteristics, flexibly utilizing a combination of various methods to achieve the best teaching results.[4]

4. Implementation and Evaluation of the Course

4.1 Description of Course Implementation Process

4.1.1 Course Planning

Before the course implementation, detailed course planning was conducted by the teachers. Firstly, based on the teaching outline and students' learning needs, the teaching objectives, content arrangement, and schedule for each stage were clarified. This included determining the course themes and key contents, arranging specific content and teaching methods for each class session, and formulating assessment and evaluation methods for the course. In devising the course plan, the teachers fully considered the integration of theoretical teaching, experimental operations, and project practices to ensure the systematic and comprehensive nature of the course content while making it more closely aligned with practical engineering applications, thus enhancing students' learning interest and effectiveness.

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4.1.2 Application of Various Teaching Methods

During the course implementation, a combination of various teaching methods was employed. In addition to traditional lectures and laboratory experiments, activities such as case analysis, discussions, and group cooperation were conducted. Through case analysis, students could integrate theoretical knowledge with practical problems, deepening their understanding of the knowledge; while group cooperation cultivated students' teamwork and communication skills. The application of various teaching methods enriched the forms of classroom teaching, better meeting the diverse learning needs of students, and improving the teaching effectiveness of the course.

4.1.3 Conducting Project Practices

The focus of course implementation was on conducting project practices. Students were divided into groups according to the project tasks provided by the teachers and collaborated to complete project design, implementation, and report writing. During the project practices, students not only applied theoretical knowledge but also cultivated teamwork and problem-solving abilities, enhancing their practical operational and comprehensive application capabilities. Project practices allowed students to immerse themselves in real engineering projects, thereby better understanding and applying the knowledge learned, laying a solid foundation for future work and research. Through project practices, students were able to integrate classroom knowledge with actual engineering practices, deepen their understanding of knowledge, and improve their problem-solving abilities.[5]

4.2 Statistical Analysis of Student Participation

4.2.1 Attendance Rate Analysis

Statistical analysis of student attendance revealed that the majority of students exhibited a high attendance rate during the course implementation. Particularly during theoretical teaching and experimental operation sessions, students' attendance rates were generally high, reflecting their high level of attention and learning attitude towards the course. They were willing to actively participate in classroom learning, demonstrating strong learning initiative and responsibility. This high attendance rate not only demonstrated students' positive attitudes towards learning but also provided a good learning environment for them to better grasp the course content.

4.2.2 Participation Analysis

During classroom discussions and experimental operation sessions, most students demonstrated active participation. They showed the ability to ask questions, answer questions, and actively communicate and discuss with teachers and classmates, collectively exploring course content. This active participation helped create an active learning atmosphere, promote knowledge exchange and sharing, and played a positive role in deepening students' understanding of course content. However, there were also some students with lower participation levels, possibly due to a lack of interest in the course content or lack of confidence. For these students, teachers can adopt targeted guidance and incentive measures to help them better integrate into classroom learning.

4.2.3 Analysis of Participation in Project Practices

During the project practice phase, students also exhibited high levels of participation. They actively divided tasks, collaborated to complete project tasks, and demonstrated strong teamwork and problem-solving abilities. However, there were also a few students with low interest in the course content and low participation levels, requiring further attention and guidance from teachers. For these students, adjusting the project tasks to increase their interest and challenge can be beneficial. Additionally, individual communication with students to understand the reasons for their low participation and provide targeted help and support can be effective.

4.3 Teaching Effectiveness Evaluation and Feedback

4.3.1 Evaluation of Teaching Effectiveness

The evaluation of teaching effectiveness is an important part of course implementation, assessing students' learning outcomes through various means. This includes assessing course assignments, lab reports, and project outcomes. The evaluation results show that the vast majority of students were able to solidly grasp the basic theoretical knowledge and practical operational skills of high-frequency electronic circuits during the course. They could effectively apply the knowledge learned to solve practical problems and demonstrated outstanding performance in project practices. Particularly in the project practice phase, students not only exhibited high theoretical application abilities but also developed teamwork spirit and practical skills. This indicates that the course design and implementation have achieved good teaching effectiveness, significantly enhancing students' mastery of course content and practical application abilities.

4.3.2 Collection of Student Feedback

In addition to quantitative evaluation, student feedback was collected through methods such as questionnaires. Students generally believed that the course was well-structured, with rich teaching content that met their learning needs. However, some students provided suggestions mainly focusing on course content and teaching methods. They proposed adding more practical case studies and experimental operation sessions to strengthen the connection with engineering practice, thereby enhancing the practicality and interest of the course.

4.3.3 Adjustment of Teaching Methods and Content

In response to student feedback, teachers made adjustments and optimizations to the course content and teaching methods. Additional practical case studies and experimental operation sessions were incorporated to strengthen the integration of theoretical knowledge and practical operations, enhancing the practicality and interest of the course. Furthermore, the connection with engineering practice was strengthened, making the course more closely aligned with actual engineering applications, further improving teaching effectiveness and student satisfaction. These adjustments and optimizations made the course more targeted and practical, helping students better grasp knowledge and improve learning outcomes.

5. Summary of Key Points and Prospects

5.1 Summary of Key Points in Course Design

5.1.1 Project-Driven Course Design Philosophy

The project-driven course design philosophy aims to immerse students in real project contexts, allowing them to learn theoretical knowledge and skills by solving real problems. This design philosophy not only stimulates students' interest and initiative in learning but also promotes the integration of different disciplines, cultivating students' practical abilities and teamwork spirit. Through participating in project practices, students can consolidate their knowledge through practical operations and develop problem-solving skills, better preparing them to tackle future work challenges.

5.1.2 Course Content and Organizational Structure Design

The design of course content and organizational structure should closely revolve around the basic principles and practical applications of high-frequency electronic circuits. When designing the course, consideration should be given to students' learning needs and the requirements of actual projects, designing corresponding experimental projects accordingly. The course content should be reasonably distributed across different stages, including theoretical teaching, experimental practice, and project practice, to ensure that students can comprehensively grasp the content learned and apply theoretical knowledge to actual engineering projects.

5.1.3 Selection of Teaching Methods and Means

In course design, the selection of teaching methods and means is crucial. Emphasis should be placed on flexibility and interactivity, adopting a combination of various teaching methods such as lectures, discussions, case studies, and experimental operations. Additionally, the use of modern teaching methods, such as online platforms and simulation software, should be utilized to provide more learning resources and practical opportunities, thereby enhancing teaching effectiveness and student engagement. Such teaching methods can stimulate students' interest in learning, promote in-depth understanding of knowledge, and cultivate students' practical abilities and innovative spirit.

5.2 Outlook and Suggestions for Future Teaching Practices

5.2.1 Continuous Optimization of Course Design

The primary task for future teaching practices is the continuous optimization of course design.

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Teachers should adjust course content and teaching methods promptly according to changes in the discipline's development and students' needs, ensuring the course's cutting-edge and practical nature. Regular course evaluations and feedback collection should be conducted to understand students' learning situations and teaching effectiveness, making timely adjustments and improvements based on feedback. This approach can continuously enhance the quality and adaptability of the course, better meeting students' learning needs, and cultivating their comprehensive abilities and innovative thinking.

5.2.2 Expansion of Teaching Methods

With the continuous development of technology, teaching methods are also evolving. Future teaching practices should expand teaching methods, fully utilizing advanced technological means and teaching resources. For example, establishing virtual experimental platforms allows students to conduct practical operations through simulated experiments, providing a safer and more convenient experimental environment. Additionally, utilizing online teaching platforms can diversify the dissemination of teaching content, providing students with learning opportunities anytime, anywhere. Through these innovative teaching methods, students' interest in learning can be stimulated, their engagement can be increased, and teaching effectiveness can be further enhanced.

5.2.3 Strengthening Practical Components and Improving Teaching Quality

Future teaching practices should strengthen practical components to cultivate students' practical operational and innovative abilities. Teachers should focus on the design and implementation of practical teaching, providing rich practical projects and cases, guiding students to actively participate in practical activities, thereby training their ability to solve real-world problems. Meanwhile, teachers should continuously improve teaching quality by using carefully designed teaching plans and effective teaching methods to enhance students' learning outcomes and satisfaction. This can make greater contributions to cultivating high-level, applied talents and meeting society's talent demands.

6. Conclusion

Based on the concept of the New Engineering Education, this paper proposes a project-driven course design scheme for high-frequency electronic circuits and explores and practices it in actual teaching. Through course implementation and evaluation, it is found that this scheme can effectively stimulate students' learning enthusiasm, promote the integration of theory and practice, and cultivate students' practical abilities and innovative thinking. However, there are still some shortcomings in the course design that need to be further improved and optimized in the future to better meet the teaching needs under the background of the New Engineering Education.

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