Teaching Analysis of Cross-university Elective Courses Based on TRIZ Theory—"Analog Electronic Technology" Course as an Example

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Abstract. This paper proposes the combination of TRIZ theoretical innovation method and Cross-university elective courses, we can realize new ways of exploring educational reform practice, which stimulate students' interest in simulating electronic technology courses, and cultivate students' innovative thinking modes. Meanwhile it follows the law of technological evolution system in process of electronic courses learning, which solves the technical contradictions and physical contradictions in the system, and proposes a variety of active learning modes of classroom mode. Then we analyze the results of teaching students in the two academic years, it shows that the new mode of teaching reform is helpful to mobilize the initiative of students’ learning, which cultivate innovative ability of solving practical problems in engineering, it provides a broader perspective for the development of outstanding professionals in higher education institutions.

Introduction

TRIZ theory, is a comprehensive theoretical system, which Altshuller led TRIZ research group, analyze nearly 2.5 million high-level invention patents in the world, forming a system composed of methods and algorithms for solving technology and achieving innovative development. We Introduce the TRIZ theory into the curriculum system of electrical engineering, and cultivate students learning process from micro world to macro world, from individual element to whole one, from unknown areas to mastered one, which students adopt divergent thinking and use their existing theoretical systems and logical thinking methods to discover Problems, analyze problems and solve problem, which are currently hot issues in teaching reform research.

TRIZ Theory Applied to Analog Electronic Technology Courses

The law of technological evolution system in TRIZ theory

The TRIZ theory is based on the objective laws followed by the system. It consists of the laws of natural variation of production, growth, maturity, aging and extinction, which the development speed and function of each stage are different. Therefore, the evolution of the S curve is not the same. In the whole process of evolutionary development, a new technical system will naturally appear to replace the traditional method, so that the cycle forms the regular pattern of the whole system.

The analog electronic technology course mainly analyze circuit, which is to realize the amplification of voltage and power from weak small signals to big one, and the main function of its course application is to invent new electronic devices and improve the traditional circuit design. From Fig.1 to Fig.5 shows circuit development history in the analog electronic technology course. Table 1 shows voltage amplifying circuit development from the basic direct coupling circuit to integrated op amp, which the whole development process, discover problems, analyze problems, and solve problems, it is a specific description process for the realization and perfection of circuit technology functions. Therefore, the introduction of TRIZ theory in the course of analog electronic technology is...
conducive to the development and progress of inventing new electronic devices and improving optimized circuit design. The introduction of TRIZ theory can apply the patented analysis method to practical engineering problems.

Table 1. Evolution of voltage amplification circuit technology and functional parameter relationship.

<table>
<thead>
<tr>
<th>Circuit classification</th>
<th>Performance</th>
<th>Circuit example</th>
<th>Problems with the circuit</th>
<th>Circuit function improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct coupling Circuit</td>
<td>Achieve magnification</td>
<td>Fig.1</td>
<td>Waveform distortion and low efficiency</td>
<td>Improve efficiency</td>
</tr>
<tr>
<td>Single power supply circuit</td>
<td>Normal work</td>
<td>Fig.2</td>
<td>Waveform distortion</td>
<td>Stable static working point</td>
</tr>
<tr>
<td>Bias circuit</td>
<td>Stable work</td>
<td>Fig.3</td>
<td>Decrease voltage amplification</td>
<td>Increase magnification indicator</td>
</tr>
<tr>
<td>Differential circuit</td>
<td>Increased integration</td>
<td>Fig.4</td>
<td>Circuit complex</td>
<td>Integrated production</td>
</tr>
<tr>
<td>Integrated op amp</td>
<td>Cut costs</td>
<td>Fig.5</td>
<td>Expanse peripheral circuit</td>
<td>Flexible and convenient</td>
</tr>
</tbody>
</table>

Technical contradictions and physical contradictions in TRIZ theory

The innovative method of TRIZ theory is to realize the modeling process of complex problems. The technical contradiction refers to the two effects between advantages and disadvantages of the introduction of TRIZ theoretical innovation method, which is manifested as the change of two basic index parameters in the system operation: one of the parameters is obtained Improvement; while the other parameter gets worse. The physical contradiction means that the engineering parameters of the technical system have opposite requirements, and thus the contradictory representations appear: the presence and absence of parameters; the high and low of the parameter indicators; the large and small parameter values. The TRIZ theory achieves a breakthrough in engineering system design technology through the corresponding analysis of contradictions and conflicts.
The static operating point stable bias amplifying circuit realizes the static working point stability by the base voltage dividing and the current-carrying negative feedback circuit structure, and at the expense of the amplification factor of the voltage amplifying circuit. The amplification factor of the amplifying circuit is a measure of its important index parameters, and the static working point of the normal operation of the amplifying circuit is stable, and the output waveform is not distorted. As two index parameters of the system operation, when the bias circuit is introduced to ensure the stability of the static operating point, the amplification factor of the circuit itself is reduced due to introduction of the feedback resistor, and vice versa. Therefore, weigh the pros and cons, solve the contradictions and conflicts between the two, which solve the problem by increasing the bypass capacitor in the feedback circuit to ensure the stable operation of the circuit and increase the amplification.

The resistance value of the feedback circuit in the bias circuit is used as the index parameter to reflect the physical contradiction in the circuit itself. In the normal operation of the bias circuit, the reasonable resistance of the feedback resistor not only ensures the rationality of the static analysis of the amplifier circuit, but also tries to ensure the rationality of the static analysis of the amplifier circuit. Increase the amplification factor of its own amplifying circuit. When the feedback resistance is set in the circuit, if the resistance of the feedback resistor is larger, the higher the point potential of the emitter is raised. Because the base voltage is locked, the base potential is locked, so the emission is performed. The voltage of the junction is reduced, and the smaller the base current is generated, the better the negative feedback effect of the collector current is. The smaller the feedback resistance of the feedback network is, the more obvious the amplification effect of the bias circuit itself is. Therefore, the method for resolving contradictions is to split the feedback resistor into two resistors with different resistance values, and increase the in parallel bypass capacitor in the resistor with large resistance value to overcome the physical contradiction of the system parameters and optimize the bias.

![Bias circuit](image1)

![Bias circuit with bypass capacitor](image2)

Table 2. Comparison of technical contradiction of bias amplification circuit with static working point.

<table>
<thead>
<tr>
<th>Circuit classification</th>
<th>Gain</th>
<th>Input resistance</th>
<th>Output resistance</th>
<th>Static working point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directly coupling circuit</td>
<td>big</td>
<td>small</td>
<td>5 KΩ</td>
<td>unstable</td>
</tr>
<tr>
<td>Bias circuit</td>
<td>-1.92reduce</td>
<td>4.1 KΩ</td>
<td>constant</td>
<td>stable</td>
</tr>
<tr>
<td>Bias circuit with bypass capacitor</td>
<td>-7.7improve</td>
<td>3.7KΩ</td>
<td>constant</td>
<td>stable</td>
</tr>
</tbody>
</table>

The Combination of TRIZ Theory and the Application of Cross-university Elective Courses

The establishment of cross-university elective credit courses not only breaks the geographically limited teaching curriculum resource sharing model, but also highlights the overall planning and design, it promotes the sharing of educational resources, and better realizes the effective ways for students to develop in an all-round way. Under the promotion of provincial administrative
management, the Cross-university elective courses have achieved sustainable development, achieving unified coordination of teaching time; participating in the development and implementation of new curriculum models; establishing an intelligent provincial curriculum management platform to facilitate students' learning resources. Sharing; further strengthen the curriculum guidance, and realize the transformation of course learning into a change of interest learning.

The Cross-university elective course provides students with convenient learning conditions and learning opportunities that are not restricted by geography. They can be concentrated in the classroom, or they can be completed under the holidays and after school hours. Students can learn theoretical knowledge. Retractable, targeted, and more thorough understanding of knowledge points, priorities and difficulties. In the future teaching work process, theoretical teaching and experimental courses will be gradually realized by all network sharing. The construction of virtual network experimental platform is the future development direction. At present, the virtual simulation software in this course is designed and implemented in the experimental platform of our institute. it is also used as a network sharing resource for students of the school, which needs further improvement and improvement.

The combination of TRIZ theory and Cross-university elective courses, participating in Cross-university elective courses are relatively mature quality courses. Due to the adjustment of lecture programs, lecture content and class schedules, the teachers should pay attention to the observation and analysis of students' learning status. The degree will be improved, and the students will also increase their interest in the curriculum fresh mode. The two courses will be adjusted and analyzed continuously during the course of teaching. The adaptability of the course will be improved and the positioning of the course will be clearer in efficient and perfect curriculum system construction. The TRIZ innovation method provides direction, order and operability for solving problems in inter-school elective courses, transforms the problem to be solved into problem model construction, proposes solutions, and finally realizes the development of innovation mode.

The Course Teaching Effect

Comparative analysis of teaching effects in different two school years

Compare the effects of the 16th-level telecommunications majors with the 15th-level telecommunications majors: 37 students of the 16-level telecommunications majors who participated in the inter-school elective credits, with an average score of 78.35 in the final exams, 6 outstanding grades, and a maximum score of 97. Points, while the number of students in the 15th-level telecommunications majors is 46, with an average score of 68.67 at the end of the grade, 4 excellent grades, 16% of the number of students failing the grade, and the proportion of students in the 80-90 grade range is nearly 20%.

Obviously, through the practice of cross-school elective credits, the score distribution of the 16th grade students shows a normal distribution, and the teaching effect is remarkable; while the score distribution of the 15th grade students is shifted to the right and the rear, the students are subjectively unskilled and other relevant influencing factors are analyzed, and the multi-modality is adopted. Teaching methods can stimulate students' enthusiasm for learning, classroom teaching is better, and teachers and students have more close interactions, which helps teachers to focus on the difficulty and focus of expansion.

Table 3. Comparative analysis of student performance in different academic years.

<table>
<thead>
<tr>
<th></th>
<th>Average score</th>
<th>Excellent</th>
<th>Good</th>
<th>Medium</th>
<th>Pass</th>
<th>Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 15</td>
<td>68.67</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Level 16</td>
<td>78.35</td>
<td>6</td>
<td>15</td>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Rate change</td>
<td>14%</td>
<td>50%</td>
<td>87.5</td>
<td>-41.7%</td>
<td>-66.7%</td>
<td>-80%</td>
</tr>
</tbody>
</table>
Students have a strong interest in learning by conducting online classroom learning

More students will find problems and ask questions. They will organize research groups to conduct research, discussion and analysis, and raise questions on the network interactive platform. Questioning each other's questions, and then summarizing them in the classroom to the instructors for centralized answers, and students' learning is more proactive and motivated. Students will have the purpose and conscious use of problem-solving skills taught by classroom teachers, enhance students' practical skills, and improve students' thorough understanding of theoretical knowledge. At the same time, students are encouraged to think actively, dare to ask questions, and apply the theoretical teaching content to practice design to analyze and solve problems. At the same time, the teaching calendar and the teaching catalogue are clear and clear, and it is easier for students to grasp and follow up the teaching progress of the instructors. The key points and difficulties of each chapter are more obvious, and it is convenient for students to conduct daily review, weekly review and final review.

Summary

The design of Cross-university elective courses for compulsory courses also realizes the change of the classroom teaching, and the change of the practical teaching mode that brings fun into the curriculum has important significance for students and teachers. The combination of TRIZ theory and Cross-university elective courses is more suitable for courses with higher hands-on requirements. Students are more likely to explore their own innovative ability and improve the level of practical problems in the engineering design process. To expand the educational ideas for the outstanding talent training programs of higher education institutions in the new situation, and open up new development areas for the further practice of education and teaching reform.

References