

Thoughts on the Teaching Reform of Power System Protective Relaying

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Abstract—Under the background of upgrading of electric power related industries and development of emerging strategic industries, which represented by smart grid and new energy technology, based on the requirements of modern grid enterprise on personnel and the training objectives of electrical engineering and Automation Specialty, discuss the teaching reform of relay protection in power system, mainly from the aspects as teaching content, teaching methods, and the organic combination of practice and curriculum, etc.

Keywords—*relay protection; teaching reform; practical scheme; teaching methods*

I. INTRODUCTION

Power system relay protection course is one of the key courses in electrical engineering and automation with outstanding characteristics of practicality and applicability ^[1]. The outline of China's medium and long term scientific and technological development plan (2006-2020) puts forward the key areas of large scale power transmission and distribution and grid security. At the same time, it puts forward higher requirements for the security technology of large-scale interconnected power grid, which is under the background of electric power related industries and development of emerging strategic industries, it is necessary to carry out a new round of reform, innovation and practice in the teaching content, teaching methods and means of power system relay protection. The order of traditional teaching system is theoretical teaching, and then the final exam, and then course design and cognitive practice, which results in making teaching time-consuming, students lose interest in the course, and ultimately cannot achieve the desired teaching effect ^[2]. This paper discusses the reform from the teaching contents, teaching methods, practice and evaluation system of relay protection of power system, in order to cultivate high-quality, innovative talents to relay protection.

II. ANALYSIS OF THE CURRENT SITUATION OF POWER SYSTEM RELAY PROTECTION

The principle of power system relay protection is the main course of electrical engineering, at present almost all the textbooks tend to organize teaching according to some part of the power system: basic element, principle of line protection, principle of transformer generator protection and bus protection principle, reclosing and microcomputer protection, all colleges and Universities have taken actions to strengthen the teaching work, but there are still some problems.

A. The Teaching Content Disjoins the Actual Project

At present, the relay protection devices are mostly microprocessor-based protection, but now the electromagnetic type or integrated protection device with complex structures are mostly used to explain the protection principle, students cannot understand the arrangement, learning is difficult, and the students generally reflect the knowledge from the actual work after they get to work. At the same time, the teaching content covers a variety of voltage line protection, transformer, generator protection capacities and bus protection, the contents are much too complex which caused the phenomenon of "more than fine", make students feel stressed to grasp the basic knowledge and cannot grasp the basic knowledge completely.

B. Lacking the Teaching Idea of Large Course System

The course of power system relay protection principles make students master the prerequisite courses including circuit theory, electromechanics, power system analysis, automatic control, power electronics technology etc. However, on the one hand students in learning led to its cannot grasp the strong theoretical knowledge inaccurate, cannot be contact with the engineering reality ^[3], and the course of relay protection principle, because they cannot have a complete understanding of electrical engineering and its automation. On the other hand, student have learning pressure, due to the teacher lack overall situation carding about the whole large course system, make some knowledge repeat teaching, so that students have a general sense "the teaching purpose is not clear".

C. The Teachers Take Themselves as the Main Body in Teaching Process with Single Teaching Methods

The teaching method of the traditional relay protection course takes the teacher as the main body, the student as the object, the instructor unidirectionally imparts the theory knowledge to the student. Students learning activities are more passive, due to the lack of learning initiative and initiative. Students do not have fun from learning, lack the ability to use knowledge and learning over time, which reduce learning interest, leading to a vicious circle. This kind of teaching mode binds students' innovative thinking, which makes it difficult for students to combine the theoretical knowledge with the actual situation in the field and cannot solve the practical application problem.

D. The Imperfection of Practical Ability Training Program

The strong practicality and application of the course of power system relay protection principles. Students are short of practice opportunities, reasonable practice training programs. Therefore, students are difficult to master a variety of principles and tuning, debugging technology. At present, laboratory equipment is difficult to carry out a large number of designed, comprehensive and verified experiment. School make cooperation with enterprises, establish the practice base, but most of the process flow on the surface reflect from the student's internship report. There is no actual harvest, in addition to the experience of large-scale and complex power grid etc. It will be unfavourable to students' ability of practical, learning and adapt to society.

In view of the above teaching situation, the author explores teaching reform from these aspects of teaching content, teaching methods and practice training programs. Based on engineering practice and integrate teaching content, so that students are close to the actual situation to learn a variety of protection of the setting calculation method, composition, working principle and predicting run characteristics, in order to improve the teaching effect, improve students' innovation ability.

III. TEACHING CONTENT OPTIMIZATION REFORM

According to the requirement of relay protection talent in electric power industry, the author combined with the school electrical engineering and its automation professions' specific requirements about training objectives and previous graduate employment situation to analyze the content of teaching materials and optimize the reform of teaching content.

A. Conduct a Comprehensive Comb for Professional Courses

Integrating optimization for interactive and closely linked courses, sort out the repetitive part of the prerequisite and postgraduate course. And then re-modify the curriculum syllabus and teaching plan. To strengthen the overall concept of the professional power system, improve the overall curriculum system, which will help reduce the burden of students' learning and help students to combine professional knowledge with engineering practice. For example, in the Circuit Course we may strengthen the explanation of the relay, heat sensitive components and the fuse, and in the Power System Relay Protection Course, only involves that how to use them to protect equipment; The increase of MATLAB in the teaching plan, provides the opportunity to practice on computer protection; In order to ensure students learn secondary system of relay protection better, advance the course "Secondary circuit of power plant and substation" to the course "Principle of relay protection" in teaching scheme, add more explanations to the secondary circuit diagram of the protection device. There are some repeated contents in the course "Computer protection" and "digital signal processing", "Microcomputer Principle" course, such as data acquisition and digital signal processing, this part can be reduced or deleted directly^[4]. Based on the existing teaching materials, teaching content can be integrated into four parts, the protection of basic knowledge, transmission line relay protection, transmission line protection, phase element protection technology and application, insert the splitted practice session into each module unit.

B. Pay Attention to the Combination of Teaching Content and Engineering Practice

Power system relay protection technology has entered the era of microprocessor-based relay protection, in the actual power system, the application of protective devices widely used microcomputer relay protection device. Therefore, in the teaching process, it's necessary to reduce the proportion of the traditional relay protection of relevant content, and increasing the content of the microcomputer relay protection device in power system. This fully reflects the advanced nature of teaching content and timeliness, to ensure that the teaching content and engineering practice closely.

IV. REFORM OF TEACHING METHODS AND MEANS

In addition to the teaching of curriculum, teachers should pay attention to not only each module, each knowledge point, but also the relation between knowledge point, theory teaching and practice teaching, theory and practice, and focus on studying the methods and forms of explaining the connection points, in order to enable students to have a better understanding on the whole knowledge so as to be better to grasp the knowledge points.

A. Using Heuristic Teaching

The application of heuristic teaching can improve students' learning enthusiasm and stimulate their thinking activities^[5]. Heuristic teaching should be based on the characteristics of teaching materials and students, design, organization, and put forward

the problem, inspire students to think actively. For example, the current protection part of the grid can be designed as follows: what is the task of protection in power system? What is the difference between current line fault and normal operation? How to ensure the protection of terminal disorder and head obstacle of the next line is the correct action of current I segment protection? What are the advantages and disadvantages of current I, and how to improve it. By asking questions of teachers, it can lead students to link the relevant content of Power System Protective Relaying course. In this way, the Power System Protective Relaying can be introduced to the students, and the students can master the basic knowledge of relay protection.

B. Using Student-centered Teaching Model, Under the Guidance of Teachers

"Under the guidance of teachers" refers that, in the whole teaching process, the teacher plays the role of leading the students to study in a planned way, and it is mainly reflected in a planned and focused teaching content, teaching methods to analyze and solve problems. The "student-centered" refers to the students is the subject of study in the whole teaching process. According to the guidance of teachers, students should focus on the learning plan to complete the course. The specific form is that teachers ask the students to complete the key, difficult chapters of the preview report, and ask students to write special reports and lectures, and discuss in the class.

V. PRACTICE TEACHING REFORM

According to the lack of Practice training program, effective measures are being taken to bond Practicing step and Relay protection course. In case, we could inspire students' interests and improve their practicing ability, so they can master basic principle better.

A. Confirm the Effective Combination Points and the Way of Combination

How to determine the effective combination point is the key point of the effective combination of practice and principles of relay protection. Combined with the characteristics of Relay Protection Curriculum and practice base, using Relay protection configuration and setting as the joint point, students can study the protections which are equipped in lines of different voltage grades and transformers of different capacity, using these protections as the object for setting and comparing them with the actual values. This can help students better understand the setting of the protection and the principles of relay protection setting. In the meantime, during the visit, the led teacher can put forward specific requirements for students according to the actual system and the practice condition, then students can combine classroom knowledge with practice to complete the design requirements.

B. The Practice Part is Combined with Relay Protection Course Experiment, Course Design

Take three-stage current protection experiment for example. In theory teaching, a three-stage protection is in the majority. But actual site is two stage protection, even one stage protection. Students are asked to configure protection according to the actual situation and verify the site configuration of protection is satisfied according to the four basic requirements in the laboratory in order to inspire the enthusiasm of students. Content of course design such as design requirements and system parameters mostly rely on the teachers' experience. In the process of practice, students can accumulate a large amount of internship units of each main equipment parameters and make it as a design basis. In this way, students can design a set of relay protection configuration scheme, and then compare it with the actual in order to draw the advantages and disadvantages of different schemes, so the students' ability to analysis and solve the problem can be enhanced.

VI. CONCLUSION

Based on Intelligent Electric Grid, promoting Electric power industry especially new energy technology and developing new strategic industry, this paper presents a detailed analysis of problems in teaching Power System Relay Protection. Combined with employment requirements, we do some exploration reform in teaching contents, teaching methods and practicing teaching. It has important meaning for teaching Power System Relay Protection under the background of modern power system.

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