

# ***Research on the Course Reform of Power System Relay Protection Technology Driven by Digital Intelligence***

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**Keywords:** University Education, Digital Intelligence, Power System Relay Protection Technologyoints

**Abstract:** This paper explores the curriculum reform of relay protection technology in power systems driven by Digital Intelligence (DI) to enhance the modernization and practicality of the course. By analyzing the application of DI technologies, such as big data, artificial intelligence, and the Internet of Things, in power systems, the study examines their impact on relay protection technology and their importance in curriculum design. A series of reform proposals are presented, including updates to course content, improvements in teaching methods, and strengthening practical training, with the aim of cultivating students' innovative abilities and practical skills to meet the demand for high-quality professionals in modern power systems.

## **1. Introduction**

"Power System Relay Protection Technology" is one of the core courses in the field of electrical engineering. It serves as an essential course for gaining further insights into the operational modes and mechanisms of power systems<sup>[1]</sup>. This course covers fundamental principles, common technologies, and analytical methods employed in various relay protection systems used in power systems to date<sup>[2]</sup>. Its aim is to familiarize students with the operational characteristics of multiple typical relays and their associated protection setting methods, thereby laying a solid theoretical foundation for practical engineering applications<sup>[3]</sup>. Known as the "guardian of power systems," relay protection technology provides crucial responses to various faults within power systems, playing a vital role in ensuring their safe and stable operation<sup>[4], [5]</sup>. Given the engineering complexities involved, both in classroom teaching and laboratory guidance, achieving a balance between depth of understanding and clarity of explanation is challenging.

"Educational informatization" refers to the process of integrating informatization technology with education, reflecting a transformation in educational ideologies. It constitutes a fundamental component of the educational system, emphasizing the practical application of information technology tools in teaching. This integration facilitates the realization of educational modernization and aligns with current trends in educational reform and development.

A comprehensive understanding of the essence of educational informatization requires an analysis from two perspectives:

**Technological Perspective:** This involves the application of various technologies such as computers and networks.

**Educational Perspective:** This focuses on fostering and enhancing students' abilities to acquire, analyze, process, and utilize information, thereby promoting the cultivation of information literacy.

By addressing these perspectives, educators can avoid superficial interpretations and foster a correct and holistic understanding of educational informatization.

Educational informatization encompasses several fundamental characteristics. Specifically, from a technological perspective, it involves the digitization of information processing, the networked transmission of information, the multimedia presentation of information, and the intelligentization of information systems. These advancements are supported by advanced information technologies and drive innovation in educational reform.

From an educational perspective, educational resources become globalized, educational processes emphasize personalization, educational environments are virtualized, fostering greater student autonomy. Additionally, computer systems enable automation in educational management. These transformations overturn traditional and outdated educational practices, promising enhanced educational outcomes.

## **2. Thoughts on the Teaching Reform of the Course of "Digitalized" Power System Relay Protection Technology**

The course "Power System Relay Protection Technology" is undergoing a transformation and upgrade to a modernized teaching mode. Drawing on research in educational informatization, this initiative explores reforms in teaching objectives, teaching entities and methods, and instructional models within the course.

Implementing a DI approach in teaching "Power System Relay Protection Technology" the curriculum integrates content and utilizes various teaching methods to enable students to learn about various types of faults in power systems, as well as the setting calculation methods, components, operating principles, and operational characteristics of different protection systems, in contexts that closely simulate real-world scenarios such as substations and power plants.

Throughout the teaching process, contextual scenarios from substations and power plants are interwoven, aiming to stimulate students' initiative and enthusiasm in learning, thereby improving teaching effectiveness and enhancing students' practical skills and innovative spirit.

Traditional teaching emphasizes students' knowledge and skills. The development of information technology provides teachers and students with abundant teaching and learning resources. In addition to focusing on students' knowledge and skills, modern teaching also emphasizes students' ability to utilize online platforms to gather, analyze, and select learning resources. It encourages students to take initiative in learning through information technology, thereby enhancing their abilities in self-directed learning, efficient learning, and innovative practices.

In the process of educational informatization, teachers are required to transition from being lecturers to becoming instructional guides. They guide students to learn through various means such as online platforms and course resources provided by teachers. As facilitators of student learning, teachers help students establish clear learning objectives and provide pathways for students to achieve these objectives.

During the learning process, teachers encourage students to be proactive, shifting them from being passive recipients of knowledge to active creators of knowledge. Simultaneously, students utilize modern information technology to engage in discussions with teachers, explore learning

content, identify and solve problems, thereby creating opportunities for communication and discussion between teachers and students.

The course "Power System Relay Protection Technology" implements a blended teaching mode reform, highlighting student-centred approaches. It integrates the strengths of traditional and digital teaching methods, leveraging teachers' roles in leading, guiding, and supervising, while fully embodying students' initiative, exploratory spirit, and creativity in learning. The teaching method combines classroom instruction with online course learning, forming a pattern where learning progresses from platform-based lectures to classroom reinforcement.

In the context of educational informatization, the course "Power System Relay Protection Technology" emphasizes the integration of theory and practice, highlighting the characteristics of an informatized curriculum. The teaching focuses on the principles and setting methods of various protection mechanisms, including current protection, distance protection, blocking type pilot protection, and reclosing, which are commonly used in transmission lines. The course leverages online information platforms, encouraging students to engage in self-directed and collaborative learning through these platforms, in addition to traditional lectures. Diversified teaching methods effectively stimulate students' interest in learning, enhance interpersonal relationships, and foster teamwork skills among students.

### **3. An Exploration of the Teaching Reform of Intelligent Digital Relay Protection Technology in Power Systems**

This study addresses the issues of a single, less practical teaching model in the original "Power System Relay Protection Technology" course. It proposes an innovative and applied teaching model driven by intelligent digitalization. The study emphasizes the importance of integrating power system relay protection theory with modern educational methods.

#### **3.1. Implementing Diverse DI Teaching Concepts**

To implement diverse DI teaching, it is essential to first transform teaching concepts and embrace new educational ideas. During the teaching process, promoting diverse DI approaches can capture students' attention. Additionally, providing necessary training for students is crucial. Advocating for flipped classroom methods, relying on online information platforms, and encouraging autonomous learning through digital platforms are key strategies. Students should be guided to search for MOOC resources that interest them from the vast array available on the internet. This approach aims to stimulate students' enthusiasm for using online resources for learning, fostering a sense of autonomy and achievement. Such an environment is conducive to the successful implementation of diverse DI teaching methods.

#### **3.2. Optimizing Teaching Content and Establishing a Diverse Curriculum System**

It is essential to emphasize the continuity of this course with preceding foundational courses and its significance for subsequent specialized courses, thus motivating students' enthusiasm for learning. The course "Power System Relay Protection Technology" is highlighted for its critical role as the "guardian" of power systems. A diverse curriculum system should be established, focusing on creating engaging course content that attracts students and prepares them for advanced professional courses and future work in relay protection. The integration of theory with practical engineering applications is crucial. By exploring fault types and their impacts on power system components such as transmission lines, transformers, buses, and generators, students' innovative thinking is stimulated, further enhancing their creative abilities.

### 3.3. Establishing Reforms in Teaching Methods and Techniques

The heuristic and progressive teaching methods are utilized in this teaching plan, incorporating practical exercises and problem-solving in the classroom. Additionally, it combines multimedia teaching with traditional lecture methods, integrating teaching approaches from both the virtual and real worlds. This fusion of teaching techniques enhances the learning experience by making it more interactive and engaging.

### 3.4. Developing Virtual Laboratory Software for "Power System Relay Protection Technology"

We need to develop a virtual laboratory platform for the "Power System Relay Protection Technology" course based on Pspice and Matlab software in this study. This platform will support multi-level simulations from component-level and circuit-level to system-level experiments. Additionally, the open structure of the virtual laboratory platform allows for the continuous integration of the latest technologies into the course, catering to students' pursuit of new advancements.

## 4. Conclusions

This study effectively explores the deep integration of modern technology with curriculum development. Through the design and creation of various intelligent "micro-lessons," it enhances teachers' instructional design capabilities, strengthens the in-depth application of information technology in teaching, and improves the overall teaching competence of educators.

The construction of the "Power System Relay Protection Technology" course driven by intelligent digitalization is organized into thematic and series-based modules centred around specific knowledge points. This approach better accommodates personalized learning needs, allowing students to select and study different topics as needed, unrestricted by time and location. Before and after class, students can engage in self-directed learning, discussion, and review through "micro-lessons," cultivating their abilities to identify, analyze, and solve problems.

This teaching reform project will release a wealth of extracurricular resources and provide updates on industry trends and technical standards in the field of power system relay protection technology, broadening students' perspectives. Additionally, the use of external platforms will facilitate communication and learning exchanges between the university's students and external teachers and students.

## Acknowledgements

The authors acknowledge the financial support provided by Zhejiang Sci-Tech University Curriculum Construction Project (Grant No. JGYBYLXM231099)

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