

Research on Teaching Reform of Signals and Systems for Postgraduates in Energy and Power Engineering

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Abstract: Signals and Systems serves as a core professional foundation course for postgraduates in energy and power engineering, bridging mathematical theory with engineering applications such as intelligent monitoring, fault diagnosis, and dynamic control of energy and power systems. It is a pivotal course for cultivating digital and intelligent competencies among energy and power professionals. Addressing prevalent issues in current teaching—including the disjunction between theoretical instruction and industry practice, rigid teaching models, theory-biased assessment, and insufficient professional adaptability—this study proposes targeted reform pathways across five dimensions: teaching objective reconstruction, teaching content optimization, teaching model innovation, assessment system reform, and curriculum ideological and political integration. Drawing on teaching practice outcomes and supported by educational research literature, this paper aims to construct a specialized Signals and Systems teaching system tailored to energy and power engineering, enhance students' signal analysis and engineering practice capabilities, and facilitate the cultivation of high-quality innovative talents in the energy and power sector.

Keywords: Energy and Power Engineering; Signals and Systems; Teaching Reform; Engineering Practice; Curriculum Ideological and Political Education.

1. Introduction

Signals and Systems centers on time-domain and transform-domain signal analysis, linear time-invariant (LTI) system characteristics, and response solving, covering core theories such as Fourier transform, Laplace transform, and Z-transform. It is a foundational course for engineering students to master signal processing, system modeling, and analysis capabilities [1]. For energy and power majors, the course is a prerequisite for advanced studies in power equipment condition monitoring, new energy generation system control, thermal system dynamic simulation, and energy system intelligent optimization. It also provides core theoretical support for addressing practical engineering challenges—such as vibration signal analysis, temperature-pressure signal processing, and power signal regulation—amid the energy industry's digital, intelligent, and green transformation.

As new engineering education advances, the energy and power industry demand enhanced interdisciplinary integration, engineering practice, and innovation capabilities from talents. However, traditional Signals and Systems teaching exhibits critical shortcomings:

1). Teaching content adheres to a generic engineering framework, lacking adaptation to typical energy and power scenarios; overly complex theoretical derivations hinder students' perception of the course-major connection.

2). Teaching methods rely on lecture-based instruction, lacking interactive practice and case-driven learning, dampening student enthusiasm.

3). Assessment overemphasizes final closed-book exams, neglecting process-based competency evaluation.

4). Curriculum ideological and political education is superficially integrated, with weak value guidance [2].

These issues are particularly acute in energy and power engineering, directly causing a disconnect between theoretical knowledge and engineering application, and

limiting students' ability to apply signal analysis methods to real-world energy and power problems. Thus, conducting major-specific teaching reform to address these pain points is a core task in developing foundational courses for energy and power majors.

2. Core Principles of Teaching Reform

This reform adheres to the core concepts of “student-centeredness, outcome-based education (OBE), and continuous improvement,” aligning closely with the talent cultivation plan and graduation requirements of energy and power engineering. It abandons the traditional “theory-over-application” mindset, following the principles of “sufficient theory, strengthened application, prominent professionalism, and ideological and political integration” to construct a trinity teaching system integrating knowledge transmission, competency cultivation, and value guidance [3]. Guided by engineering education accreditation standards, the reform integrates the course's basic theoretical framework with typical energy and power cases and cutting-edge technologies, innovates hybrid online-offline and project-driven teaching models, and implements a diversified assessment system. This ensures high alignment between course teaching, professional demands, industry development, and talent cultivation goals, comprehensively enhancing teaching quality and students' comprehensive literacy.

3. Specific Implementation Pathways

3.1. Reconstruct Teaching Objectives to Align with Professional Needs

Abandoning the overemphasis on theoretical memorization in traditional objectives, this reform reconstructs hierarchical teaching objectives across knowledge, competency, and literacy dimensions based on Bloom's Taxonomy of

Educational Objectives and OBE principles, ensuring precise alignment with subsequent learning and industry job requirements for energy and power majors [4]:

1). Knowledge Objectives: Master core concepts, transformation methods, and system analysis principles of signals and systems; streamline redundant derivations to focus on understanding and application of key knowledge.

2). Competency Objectives: Cultivate the ability to solve practical signal processing problems (e.g., vibration, temperature, power signals in energy systems) using signal analysis methods; proficiently apply MATLAB/Simulink for system modeling and signal analysis.

3). Literacy Objectives: Foster scientific thinking, engineering ethics, and patriotic; stimulate students' sense of responsibility to serve the energy industry and national "dual carbon" strategy.

3.2. Optimize Teaching Content to Highlight Professional Characteristics

The generic nature of traditional Signals and Systems content, lacking professional specificity, is a root cause of low student interest and weak application ability [1]. This reform breaks the generic framework to build a three-module content system:

1). Basic Theory Module: Retain core knowledge (e.g., LTI system properties, key transforms) while de-emphasizing complex mathematical derivations; focus on the physical meaning and application conditions of transforms.

2). Professional Application Module: Integrate typical energy and power scenarios:

(1) Fourier transform: Applied to vibration signal spectrum analysis and fault diagnosis of turbines and generators.

(2) Laplace transform: Linked to dynamic response modeling and control of boilers and thermal systems.

(3) Sampling theorem: Connected to sensor data acquisition and signal filtering in energy systems [5].

3). Practical Extension Module: Add specialized experiments in energy and power signal processing; introduce cutting-edge content (e.g., new energy generation signal analysis, intelligent energy system monitoring); update the case library to reflect industry technological trends [6].

3.3. Innovate Teaching Models to Enhance Classroom Effectiveness

Moving beyond the "lecture-only" model, this reform adopts a diversified approach combining hybrid online-offline teaching, project-driven learning, and virtual-real integrated experiments to boost student engagement and autonomous learning [2]:

1). Online Component: Leverage platforms (e.g., Superstar Learning Platform, China University MOOC) to build an online resource library (micro-lectures, professional cases, simulation materials) for pre-class preview, post-class review, and online Q&A.

2). In-Class Component: Employ BOPPPS, problem-driven, and group discussion methods; use energy and power signal processing cases to guide students in exploring theoretical applications [3].

3). Simulation Experiments: Introduce MATLAB/Simulink to compensate for limited physical hardware; synchronize theoretical teaching with simulation practice to help students intuitively grasp signal transformation and system operation laws [7].

4). Project-Driven Learning: Assign a comprehensive

project ("Typical Signal Analysis and Processing in Energy and Power Systems") for groups to complete signal simulation, modeling, analysis, and report writing, strengthening teamwork and engineering practice skills.

3.4. Reform Assessment System for Diversified Evaluation

The traditional "one-exam-determines-all" model fails to comprehensively measure practical ability and learning processes, conflicting with competency cultivation goals[4]. This reform constructs a diversified assessment system:

Process Evaluation (40%): Covers online learning progress, classroom interaction, homework, and case analysis; uses teaching platforms to record learning trajectories for transparent, quantitative assessment.

Practical Innovation Evaluation (20%): Assesses simulation experiment operations, course project outcomes, and innovative thinking to emphasize hands-on and creative abilities.

Summative Evaluation (40%): Uses a closed-book final exam with optimized question structure—reducing memory-based/derivation-only questions and increasing energy and power scenario-based comprehensive application questions to test knowledge integration [8].

This system breaks the "result-over-process" bias, truly promoting learning and practice through assessment.

3.5. Integrate Curriculum Ideological and Political Education for Value Guidance

To meet new engineering talent cultivation requirements, this reform deeply excavates ideological and political elements in Signals and Systems, avoiding superficial integration [9]. Four core integration points are designed:

1). Patriotism: Highlight China's independent R&D achievements in large thermal power, wind, and photovoltaic equipment, and signal monitoring technology breakthroughs to foster national pride and professional identity.

2). Engineering Ethics: Analyze safety incidents caused by signal monitoring failures in energy systems to strengthen students' sense of responsibility.

3). Innovation Spirit: Showcase cutting-edge signal processing applications in energy efficiency to cultivate innovative thinking.

4). Green Energy Concept: Link signal optimization to energy system efficiency under the "dual carbon" strategy to promote low-carbon development awareness [10].

This subtle integration achieves knowledge transmission and value guidance.

4. Reform Outcomes and Continuous Improvement

Two rounds of teaching practice verify significant outcomes:

1). Student course satisfaction increased from 72% to 93%; learning enthusiasm and classroom participation improved; understanding of course-major relevance deepened.

2). Signal analysis and simulation capabilities enhanced; the proportion of using signal processing methods in graduation projects and discipline competitions rose significantly.

3). The course effectively supports engineering education accreditation and new engineering talent cultivation goals.

A continuous improvement mechanism is established:

1). Regularly collect feedback via student evaluations, peer reviews, and supervisor assessments.

2). Dynamically optimize content and methods to address issues (e.g., outdated case libraries, insufficient practical depth).

3). Collaborate with energy and power enterprises to introduce frontline cases, enhancing content practicality and cutting-edge relevance [2, 5].

5. Conclusion

Against the energy industry's digital and intelligent transformation, Signals and Systems teaching reform for energy and power majors is critical to addressing traditional teaching drawbacks and improving talent cultivation quality. Through hierarchical objective reconstruction, professional content optimization, hybrid model innovation, diversified assessment, and ideological and political integration, the reform achieves deep alignment between course teaching, professional characteristics, engineering practice, and value guidance. It effectively resolves core issues (e.g., theory-practice disjunction, rigid teaching models) and comprehensively enhances students' professional core competencies and literacy. This reform provides a reference for teaching reform in similar engineering foundational courses. Future efforts will continue to align with industry and education trends, refine the teaching system, and support the cultivation of high-quality compound talents in the energy and power sector.

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