

# **Interdisciplinary Practice of the "Four-in-One" Teaching Reform for "AI + Courses"**

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**Abstract:** Addressing the common challenges in the Artificial Intelligence (AI) course within the Electrical Engineering and Automation major—such as weak foundational knowledge, disconnection from application, and misaligned evaluation—this study proposes a comprehensive "Four-in-One" teaching reform scheme. The curriculum framework adopts a "three-layer progression, specialty-general integration" structure: the general foundation layer eliminates technological intimidation, the professional core layer focuses on power scenarios, and the advanced practical layer connects with complex engineering problems. The teaching model employs "virtual-real integration and dual-teacher collaboration", using virtual simulation to lower practical barriers and involving AI teachers, professional faculty, and industry engineers to bridge the gap between technological knowledge and industry needs. The practical system implements "micro-project chains and competition-course integration", deconstructing large projects into progressive micro-tasks and aligning them with industry competitions. The evaluation mechanism introduces "multi-dimensional scoring and competency alignment", replacing single written exams with comprehensive process evaluation, with indicators mapped to engineering education certification competencies. This scheme effectively enhances students' AI literacy and engineering practical abilities, providing a replicable and scalable paradigm for interdisciplinary teaching reform in the context of "AI+".

**Keywords:** Electrical Engineering and Automation; Artificial Intelligence+Course; Teaching Reform

## **1. Introduction**

The inclusion of "AI+" in the 2024 Government Work Report has positioned artificial intelligence technology as a core engine driving the development of new quality productive forces. Its deep integration with education is emerging as a pivotal direction for higher education reform [1,2]. In August 2025, the State Council issued the "Opinions on Deepening the Implementation of the 'AI+' Initiative," which calls for the accelerated cultivation of new quality productive forces to ensure that all individuals benefit from AI development and to better serve the modernization of Chinese-style development. In the field of Electrical Engineering and Automation, AI technology presents extensive application scenarios and urgent implementation needs. Consequently, designing an AI curriculum specifically tailored for Electrical Engineering and Automation has become a crucial focus for teaching reform in this discipline.

Domestic universities have conducted diverse explorations in teaching practices of AI courses within their respective disciplines. Chen Jingyuan et al.[3] proposed the "AI STEP" hierarchical approach, offering differentiated content tailored to various majors. Li Liangli et al. [4] established a trinity system of "knowledge-thinking-practice," designing core technology and application modules specifically for engineering, business management, arts, and liberal arts disciplines. Gu Xiaolin [5] introduced a three-tier curriculum paradigm of "basic-intermediate-advanced" to accommodate the needs of humanities and social sciences, as well as non-information technology engineering majors and information technology-related majors. Li Yue et al. [6] explored the "integration of general and specialized education" model, achieving a connection between artificial intelligence and professional

fields through a four-step teaching approach: "easy-to-understand introduction - interactive experience - programming participation - professional expansion." Wang Hao et al. [7] offered a series of courses on "Artificial Intelligence Fundamentals + Big Data Technology + Python Programming" to enhance the integration of AI with disciplinary applications. Lu Bibo et al. [8] utilized the Baidu EasyDL platform to improve operational skills through tasks such as AI painting competitions and model creation. Internationally, institutions like Stanford University and the Massachusetts Institute of Technology (MIT) emphasize the "integration of specialization and generalization" [9]. MIT offers general education courses such as "Artificial Intelligence and Social Governance" while retaining specialized courses like machine learning. The University of California, Berkeley [10] provides a course on "Responsible AI Innovation," focusing on ethical and social impacts. Oxford University and Harvard University promote fundamental AI concepts and applications through online courses, catering to both the general public and student populations [11]. (1) The curriculum system is fragmented and lacks a systematic knowledge chain. (2) There is a shortage of practical teaching resources and insufficient implementation in engineering scenarios. (3) Faculty knowledge structures are singular, with inadequate interdisciplinary capabilities. The misalignment between the evaluation system and engineering competencies fails to effectively assess students' abilities to "apply modern tools to solve complex problems" [12].

## 2. Three - Tier Progressive and Integration of Specialization and Generality Curriculum System

To address the challenges of a "weak foundation and impractical application" in teaching artificial intelligence courses for Electrical Engineering and Automation majors, this paper proposes a "three-tier progressive, discipline-general coupling" curriculum system. The "three tiers" are designed to align with students' cognitive patterns, facilitating instruction across three levels: general foundation, specialized core, and practical advancement. The "discipline-general coupling" concept aims to achieve a deep integration between AI literacy and professional

requirements, thereby avoiding the "disconnection between learning and application." The three-tier progressive curriculum system is illustrated in Figure 1.

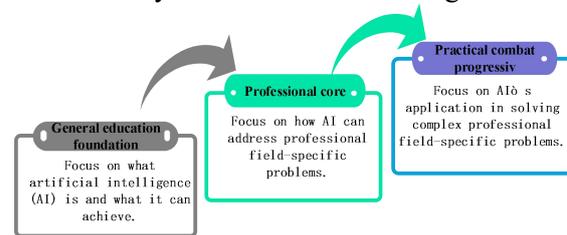


Figure 1. Three-Tier Progressive Curriculum System Structure Diagram

### 2.1 General Education Foundation Tier

The general foundation level mainly aims to develop a basic understanding of artificial intelligence (AI) rather than develop technical research and development capabilities. This means removing deep dives into subjects like the math behind neural networks and the derivation of algorithms (like gradient descent equations and connection between convolution and filtering) from the usual teaching. Besides, there has to be a reduction of content for calculating complex data and optimizing model training. When we talk about what AI can do, we must think about three things, namely processing, pattern recognition, and prediction. In order to make it easier for students to understand how the technology works and its limitations, students could be provided scenarios that would help them see the utility of AI. This will help students not develop at the opposite ends of the spectrum regarding this technology, like believing that this technology can do anything on the one hand and with on the other hand being scared of it.

### 2.2 Professional Core Tier

In the advanced stage of "AI + Electrical Engineering" integrated talent cultivation, AI teaching in the professional core tier should form a progressive "cognition-application" relationship with the general education foundation tier. Targeting upper-class students with electrical engineering basics, whose core demand has shifted from understanding AI to applying it to professional practical problems, teaching reform must focus on electrical engineering scenarios, aim to serve professional needs with AI technology, break the disconnection between AI teaching and professional courses, and build a teaching

system driven by professional pain points, oriented by AI solution implementation and engineering processes, ultimately enabling students to master core competencies in applying AI to electrical engineering optimization, fault diagnosis and efficiency improvement.

The key of the professional core tier is the seamless integration of AI into core electrical engineering courses rather than adding independent AI courses. Centering on core knowledge points of key courses (e.g., Power System Analysis, Condition-based Maintenance of Power Equipment), typical engineering scenarios where traditional methods are ineffective or inefficient should be selected to embed AI as an optimization tool or solution, realizing in-depth integration of professional knowledge and AI technology.

The reform aims at two core objectives: 1) Establishing a technology perspective of "AI serving professionalism": Through scenario-based integration, students abandon the perception of AI as an independent technology and develop a rational mindset of AI as a tool for solving electrical engineering problems, achieving a transformation from passive acceptance to active application of AI. 2) Mastering core competencies in engineering-oriented AI implementation: Through process-based teaching (data preprocessing, model adaptation, result verification), students acquire practical abilities to transform AI into electrical engineering solutions, laying a foundation for subsequent graduation projects, engineering practice and scientific research innovation.

### **2.3 Practical Combat Progressive Tier**

In the advanced stage of "AI + Electrical Engineering" integrated cultivation, the practical combat progressive tier should build on the general education foundation tier's "cognitive establishment" and the professional core tier's "scenario application," forming a complete "cognition-application-innovation" progressive chain. Targeting senior students with professional core knowledge and basic AI application capabilities, whose core demand has evolved from solving single professional problems with AI to integrating multidisciplinary technologies to address complex real industry engineering problems via AI, teaching reform must focus on real industry needs, take cross-curricular, full-process and

practical projects as carriers, break inter-course knowledge silos, and construct a "problem-driven, technology-integrated, system-implemented" teaching system to ultimately foster students' systematic thinking and engineering practical abilities in proactively applying AI to complex electrical engineering problems.

The key of this tier is abandoning fragmented single-course or single-technology teaching, instead simulating real industry scenarios through cross-curricular integrated projects. Smart microgrids, a core platform for distributed energy integration and energy storage synergy, face complex challenges that align with the teaching objective of using AI to break traditional control limitations. This project needs to deeply integrate four core modules (sensor technology, AI modeling, power system analysis, embedded technology) to form a closed-loop system of data collection-intelligent decision-making-control execution-effect verification.

### **3. "Virtual-Physical Symbiosis and Dual-Teacher Collaboration" Teaching Model**

To address the challenges of high practical equipment cost and weak connection between technology and professional needs in AI teaching for the Electrical Engineering and Automation program, this paper proposes the "virtual-physical symbiosis and dual-teacher collaboration" teaching model. It resolves practical bottlenecks by lowering barriers through virtual simulation and enhancing implementation via physical operation, and bridges the gap between technology teaching and professional demands through collaborative teaching of AI teachers, professional teachers and enterprise engineers. The ultimate goal is to realize the progression of AI application from "being able to use" to "using well" and improve the cultivation of students' engineering practical competence.

#### **3.1 Virtual-Physical Integrated Teaching: Reducing Practical Barriers via a "Simulation-Verification" Closed Loop**

The core value of the "virtual-physical symbiosis" philosophy is overcoming the inherent bottlenecks (high cost, high risk, difficulty in reproduction) of traditional physical experiments through virtual simulation technology, and promoting the transformation

of theoretical knowledge into engineering applications with lightweight physical experimental devices[13]. An integrated practical teaching chain of "virtual modeling → parameter optimization → physical verification" is constructed. This symbiotic path not only reduces the cost and safety risks of experimental teaching and breaks time and space constraints, but also fosters students' systematic thinking and ability to solve complex engineering problems by combining virtual simulation and physical operation.

### **3.2 Dual-Teacher Collaborative Teaching: Bridging the Demand Gap through "Technology-Professional Complementarity"**

The core of "dual-teacher collaboration" lies in addressing the pain point of "insufficient knowledge coverage by a single teacher." AI teachers are responsible for "how to use the technology," while professional teachers/enterprise engineers are in charge of "why to use it and where to apply it." They collaboratively design teaching content to ensure that each AI technology point corresponds to the practical needs of the electrical engineering major, thereby avoiding the disconnection issue where "teachers teaching AI lack expertise in power engineering, and those teaching power engineering have insufficient knowledge of AI."

Computer/AI teachers center their instruction on AI technology practical operation: they impart "instrumental knowledge" of AI without delving into complex algorithmic principles, instead focusing on the practical workflow encompassing "data processing, model invocation, and result analysis." In contrast, electrical engineering teachers and enterprise engineers prioritize professional scenario alignment: they anchor AI technology to the specific needs of electrical engineering, address questions such as "why AI is required for this problem" and "how AI is applied in the industry," and conduct comparative analyses of the limitations of traditional technologies.

## **4. Practical Teaching of "Micro-Project Chain and Competition-Course Integration"**

To address the challenges of "high task difficulty, slow achievement feedback, and weak student participation motivation" in artificial intelligence (AI) practice teaching for the Electrical Engineering and Automation

program, this paper proposes a practical teaching system of "micro-project chain and competition-course integration." By "decomposing large projects into micro-tasks," it resolves the fragmentation of practical learning. Relying on "aligning course practice with competitions," it stimulates students' active learning, enabling them to gradually master the engineering application methods of AI technology through "making steady progress with visible achievements and enhancing capabilities through competition-driven learning."

### **4.1 Micro-Project Chain Design: Resolving Practical Difficulty through "Progressive Tasks"**

The core of the "micro-project chain" teaching model lies in systematically decomposing comprehensive large-scale projects in the interdisciplinary field of electrical engineering and AI (e.g., "AI-based power equipment fault diagnosis," "AI-based new energy output prediction") into 3-5 moderately difficult micro-projects with clear boundaries, in accordance with the curriculum progress and cognitive rules. Each micro-project focuses on one core knowledge and skill point and can be completed within 1-2 weeks, thereby constructing a progressive practical path characterized by "progressive skills, visualized achievements, and manageable processes." This model effectively reduces students' learning burden and fear of difficulty, avoids the problems of unsustainability or abandonment caused by high project complexity and long cycles, and significantly improves the implementability and learning effectiveness of practical teaching.

### **4.2 Competition-Course Integration Mechanism: Enhancing Practical Motivation through "Competition-Driven Learning"**

The "competition-course integration" mechanism is not a simple combination of "courses + competitions," but a systematic solution based on the characteristics of the Electrical Engineering and Automation program and educational laws, with three core bases:

(1) Professional Scenario Adaptability: Selecting power scenario-oriented competitions aligns practical content with core professional fields, as the power industry has clear demands for AI (e.g., power equipment monitoring, grid load forecasting);

(2) Low-Threshold Participation Principle: Prioritizing AI competitions with low-code operations and modular tasks lowers the threshold, accommodating electrical engineering students without a computer background and expanding coverage;

(3) Effective Incentive Mechanisms: Based on educational psychology's "goal-setting theory," linking competition results to course evaluation via credit incentives and honor recognition builds a "practice-competition-feedback" positive cycle, stimulating students' internal motivation for active exploration.

To ensure implementation, advance in the logic of "competition selection → task decomposition → evaluation linkage," forming an operable path:

(1) Competition Selection: Prioritize low-threshold power scenario-oriented AI competitions (industry-exclusive competitions or power-themed sub-tracks in general AI competitions) that meet both scenario matching and threshold adaptability criteria;

(2) Task Decomposition: Decompose competition tasks into sub-tasks synchronized with course practice progress, based on specific competition tasks.

(3) Evaluation linkage: Clarify the rules for linking competition outcomes to course evaluation, establish a clear "competition-course" evaluation conversion mechanism, and prevent incentives from becoming a mere formality.

## **5. "Multi-Dimensional Scoring and Competency-Aligned" Evaluation Mechanism**

To address the challenge of "disconnection between scores and competencies, and failure of evaluation to reflect engineering application capabilities" in artificial intelligence (AI) teaching for the Electrical Engineering and Automation program, this paper proposes a "multi-dimensional scoring and competency-aligned" evaluation mechanism. By covering the learning cycle through "full-process formative assessment + profession-oriented summative assessment," and relying on "strong binding between evaluation indicators and certified competency points," the mechanism ensures that scores truly reflect students' ability to "solve electrical engineering-specific problems using AI technology."

### **5.1 Multi-Dimensional Evaluation Dimensions: Replacing "Single Examination" with "Full-Process Coverage"**

The core of the "multi-dimensional scoring" evaluation system lies in breaking through the limitations of traditional summative assessment. It integrates evaluation throughout the entire process of AI course learning, constructing a multi-dimensional assessment mechanism that organically combines formative and summative evaluations. The system emphasizes a 60% weight allocation to formative assessment, focusing on phased verification and real-time feedback on students' knowledge understanding, skill mastery, and problem-solving abilities during the learning process. A 40% weight is assigned to summative assessment, which primarily examines students' comprehensive application of AI technology, as well as their professional transfer and implementation capabilities in engineering practice. All evaluation links are closely anchored to typical scenarios and practical problems in the electrical engineering field, ensuring deep integration of evaluation content with professional connotations. This resolutely avoids the phenomenon of "disconnection between evaluation and professional practice," thereby truly realizing the teaching goal of "promoting learning and application through assessment."

### **5.2 Competency-Aligned Design: Anchoring "Evaluation Direction" with "Accreditation Indicators"**

The core of the "competency-aligned" system lies in establishing a clear mapping relationship between evaluation indicators and the core competency points of the electrical engineering program, while ensuring direct alignment with the core connotations of the China Engineering Education Accreditation Standards (CEEAS). This achieves the dual goals of effectively assessing students' comprehensive capabilities through the evaluation process and strictly complying with accreditation norms. By establishing such a structured and systematic alignment mechanism, professional evaluation is no longer confined to traditional knowledge reproduction but delves into the diagnosis and assessment of competency achievement. It not only provides clear guidance for teaching activities but also offers measurable and comparable data support for continuous

improvement, ultimately ensuring that the quality of talent cultivation meets the substantive equivalence requirements for engineer qualification certification.

### 6. Conclusion and Outlook

Addressing the problems of fragmented curriculum systems, insufficient practical implementation, weak interdisciplinary competence of teachers, and misalignment between evaluation and competencies in artificial intelligence (AI) teaching for the Electrical Engineering and Automation program, this paper proposes a "four-in-one" reform framework anchored in professional needs, centered on technological application, and oriented toward competency improvement. Specifically: the "three-tier progressive and integration of specialization and generality" curriculum system fosters students' AI cognition and professional application capabilities in a hierarchical manner; the "virtual-physical symbiosis and dual-teacher collaboration" teaching model resolves practical bottlenecks and weak connection between technology and profession; the "micro-project chain and competition-course integration" practical system stimulates learning motivation; and the "multi-dimensional scoring and competency-aligned" evaluation mechanism aligns with engineering education accreditation standards. Together, these components form a "cognition-application-practice-evaluation" closed loop, providing a viable path for cultivating "talents who understand electrical engineering and master AI technology."

Future efforts can be directed toward several directions: further deepening university-enterprise collaboration to introduce real enterprise data and projects; adding AI ethics and safety modules to the curriculum; optimizing courses by integrating emerging technologies such as digital twins; and establishing a dynamic iteration mechanism based on feedback. These measures will ensure the reform remains aligned with industry development and accreditation standards, better serving the needs of the "AI + Electrical Engineering" field.

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