

APPROACHING THE ELECTRIC CIRCUITS COURSE THROUGH A DIALECTICAL MATERIALIST METHODOLOGY TO ENHANCE THE THINKING CAPACITY OF ELECTRICAL ENGINEERING STUDENTS

TIẾP CẬN HỌC PHẦN MẠCH ĐIỆN THEO PHƯƠNG PHÁP LUẬN BIỆN CHỨNG NHẪM NÂNG CAO NĂNG LỰC TƯ DUY CHO KỸ SƯ NGÀNH KỸ THUẬT ĐIỆN

Bui Thi Thu Huong*, Luu Quoc Cuong, Nguyen Thi Kha, Tran Thi Ngoc Tam,
Pham Thi Hoa, Tran Van Bien

Nam Dinh University of Technology Education, Vietnam

*Corresponding author: btthuong@nute.edu.vn

(Received: July 15, 2025; Revised: March 20, 2026; Accepted: March 26, 2026)

DOI: 10.31130/ud-jst.2026.24(4).357E

Abstract - Marxist-Leninist philosophy is a scientific discipline that equips students with a scientific worldview and dialectical materialist methodology, thereby enhancing their ability to understand and apply knowledge effectively to real-world challenges. The teaching of Marxist-Leninist philosophy in universities aims to foster and develop students' critical thinking abilities; however, the identification of specific subjects for students to apply and conduct research on has not received adequate attention. This paper examines the application of the core content of dialectical materialism in Marxist-Leninist philosophy to the teaching of the Electric Circuits course at the university level. It serves as a case study demonstrating the practical application of the dialectical materialist methodology to make its core concepts more accessible and meaningful to students.

Key words - Marxist-Leninist Philosophy; Dialectical Materialism; Electric Circuits; Methodology; Technical Education

1. Introduction

In the context of ongoing reforms in higher education, Marxist-Leninist philosophy, as a foundational scientific worldview and methodological framework, should be applied flexibly and creatively in teaching practices, particularly within engineering disciplines. Nevertheless, in practice, the application of philosophical foundations in specialized engineering curricula remains limited. This article seeks to elucidate the role and pedagogical effectiveness of applying the dialectical method in the teaching of the Electric Circuits module. By doing so, it aims to contribute to the enhancement of instructional quality and the overall effectiveness of training programs for electrical engineering students.

2. Theoretical Basis

2.1. Dialectical Thinking and the Dialectical Method

The study of Marxist-Leninist philosophy plays a pivotal role in equipping students with a scientific worldview and a dialectical materialist methodology. Rather than viewing knowledge as a collection of static facts, this framework provides a logically structured foundation that supports holistic learning and fosters critical engagement. By mastering a system of core

Tóm tắt – Triết học Mác – Lênin là một môn khoa học trang bị cho sinh viên thế giới quan khoa học và phương pháp luận duy vật biện chứng, từ đó nâng cao khả năng hiểu và vận dụng kiến thức một cách hiệu quả vào các thách thức trong thế giới thực. Việc giảng dạy triết học Mác – Lênin tại các trường đại học nhằm mục tiêu nuôi dưỡng và phát triển khả năng tư duy phản biện của sinh viên; tuy nhiên, việc xác định các đối tượng cụ thể để sinh viên vận dụng và tiến hành nghiên cứu vẫn chưa nhận được sự quan tâm đúng mức. Bài báo này nghiên cứu việc vận dụng những nội dung cốt lõi của chủ nghĩa duy vật biện chứng trong triết học Mác – Lênin vào việc giảng dạy học phần Mạch điện ở bậc đại học. Đây được xem như một nghiên cứu điển hình nhằm chứng minh việc ứng dụng thực tiễn của phương pháp luận duy vật biện chứng, giúp các khái niệm cốt lõi trở nên gần gũi và ý nghĩa hơn đối với sinh viên.

Từ khóa - Triết học Mac – Lênin; Chủ nghĩa duy vật biện chứng; Mạch điện; Phương pháp luận; Đào tạo kỹ thuật

concepts, categories, and laws, students gain the intellectual tools necessary to counter mechanical thinking and superficial perspectives, thereby reinforcing their confidence in scientific inquiry and professional practice.

Through this pedagogical process, students internalize the laws pertaining to nature, society, and cognition. This enhances their capacity for abstraction and generalization, enabling them to transition from theoretical understanding to solving complex practical problems. Dialectical materialism - a core component of this philosophy - guides students to perceive phenomena through the lens of dynamic, interconnected, and developmental relationships. This intellectual maturity is essential for engaging with modern scientific issues in both academic and practical domains.

The dialectical materialist method is structured around two central principles, six fundamental category pairs, and three core laws:

The Principle of Universal Connection [1]. This principle posits that all entities and phenomena in the world exist in a state of mutual interconnection and interdependence; nothing exists in isolation. Accordingly, any phenomenon or problem must be understood within its broader systemic context, taking into account its

relationships with other relevant elements. Recognizing these interrelations enables a more profound comprehension of the nature, causality, and developmental trajectory of phenomena, thereby facilitating more accurate and effective decision-making in both theoretical and practical domains.

The Principle of Development: the principle posits that the material world is inherently dynamic, undergoing continuous motion and transformation, wherein development constitutes an intrinsic and inevitable tendency of all phenomena. Such development is neither arbitrary nor linear; rather, it is driven by internal contradictions within entities, helping people understand the developmental trends of phenomena. Understanding this principle equips individuals with the capacity to help people understand the development trends of phenomena, overcome conservative or stagnant mindsets, and actively engage in innovation, adaptation, and continuous improvement in learning, professional practice, and life.

The category pairs and the fundamental laws of dialectics. According to this principle, contradiction constitutes the fundamental source of motion and development in the objective world. It is the internal struggle between opposing forces within a phenomenon that drives its transformation and evolution. The fundamental laws of dialectics include the law of the transformation of quantity into quality, the law of contradiction, and the law of the negation of the negation, which help us understand and explain the manner, origin, and trend of motion and development of phenomena.

The application of dialectical methodology in education, particularly in technical and scientific disciplines, not only deepens learners' understanding of the intrinsic nature of phenomena but also fosters the development of comprehensive, flexible, and adaptive thinking - qualities essential for navigating the rapid technological and engineering changes of the contemporary era.

2.2. Current Situation of Teaching and Learning the Electric Circuits Module

The Electric Circuits module serves as a cornerstone of the electrical and electronics engineering curriculum. Its primary objective is to equip students with fundamental electrical laws, properties of passive components, and systematic methodologies for circuit analysis. However, the current pedagogical approach faces several critical limitations that hinder the development of high-order thinking skills:

Firstly, **the disconnect between theory and practice:** The current curriculum is heavily weighted toward abstract theoretical constructs and mathematical derivations. While students may master complex formulas, they often struggle to integrate this knowledge with modern engineering applications and emerging technologies. This "theoretical bias" frequently results in a passive learning experience, making it difficult for students to perceive the practical value of the module and diminishing their motivation for self-directed inquiry.

Secondly, **the lack of systemic and dialectical perspectives:** Although active teaching methods like flipped classrooms and group work have been introduced, their implementation remains largely superficial. Circuit problems are often analyzed in a "piecemeal" or fragmented manner - focusing on isolated components rather than the holistic, dynamic interactions within a system. Without a dialectical methodology, students fail to develop the "systems thinking" required to navigate complex, real-world engineering challenges.

In summary, the transition from mechanical, formula-based learning to a dialectical, system-oriented approach is not merely a pedagogical preference but a necessity. Addressing these shortcomings is essential for preparing students to adapt to the rapid technological shifts in the contemporary engineering landscape.

3. Apply the dialectical materialist method in teaching the Electric Circuits course

3.1. Structuring the Electric Circuits Module through a Dialectical Approach

To enhance the depth and systemic coherence in students' learning processes, instructors must integrate the Dialectical Materialism methodology of Marxism–Leninism into the Electric Circuits curriculum. This philosophical framework is crucial for developing conceptual depth and systematic thinking, as it provides a holistic overview of circuit phenomena, enabling students to penetrate and rationalize their underlying essence. Consequently, students grasp the internal motion and development of the interrelationships within the circuit system.

Adopting a dialectical methodological approach to the Electric Circuits module [2] represents a direction of profound pedagogical insight aimed at fostering comprehensive and flexible thinking in learners. This approach emphasizes understanding electrical concepts, phenomena, and laws not as static entities, but as dynamic, evolving processes interconnected within a system.

To fully leverage this approach, the instructional content must be organized according to a dialectical orientation, emphasizing the continuous interaction among theory, practice, and interdisciplinary integration.

Theory-Practice Linkage: each theoretical concept should be reinforced through practical examples, applied exercises, and simulation-based experiments, bridging the gap between abstract reasoning and technical practice. For example, relating Ohm's Law to resistor selection in phone charging circuits to prevent overheating; or analyzing RLC circuits by simulating resonance in audio signal filters.

Analysis of Parameter Interactions (Principle of Universal Connection): instruction must clarify the dynamic relationships and interactions among electrical parameters (current, voltage, resistance, power) within specific circuits. A salient illustration is the graphical method (load-line method) for solving nonlinear circuits, which visually manifests the Principle of Universal Connection (holistic nature): An electrical circuit is an integrated system where its components are not isolated but

interact and influence one another to establish a collective operational state.

Contextualizing Historical Development: clarifying the origins, contexts, and evolution of scientific knowledge not only deepens students' understanding of its nature but also fosters dialectical thinking about the progression and refinement of knowledge. For instance, when introducing Faraday's law of electromagnetic induction, instructors might present the historical context of Michael Faraday's 1831 discovery and connect it to modern applications such as generators or wireless charging.

Interdisciplinary Integration: the module should be designed with an open structure, closely linked to related disciplines such as Electronics, Control Systems, and Renewable Energy. This approach supports the development of systems thinking and broadens the applicability of circuit knowledge across diverse engineering domains.

3.2. Illustrative Application of Dialectical Principles

The application of Dialectical Materialism in teaching Electric Circuits plays a vital role in developing creative thinking and systematic thinking among students. This philosophical methodology not only provides a holistic overview of specific objects and phenomena within the electrical circuit but also enables students to penetrate and rationalize their underlying essence. Consequently, students can grasp the internal motion and development of the interrelationships within the circuit system.

A salient illustration of this philosophical integration is demonstrated when instructing the method for solving nonlinear Electric Circuits using the graphical method (or the load-line method) as the Figure 1.

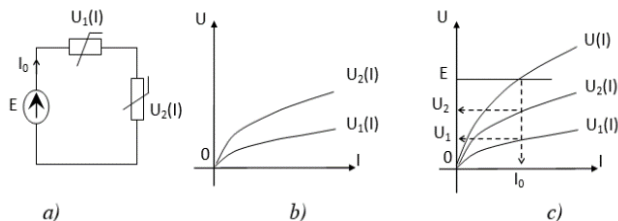


Figure 1. The nonlinear electric circuit and the graph of the curves $u(i)$. a. The nonlinear electric circuit; b. The curve of elements $U_1(I)$ and $U_2(I)$; c. The sum-curve

This technique visually manifests the Principle of Universal Connection, which asserts that all phenomena and objects exist in constraining, regulating, and transforming relationship. An electrical circuit constitutes an integrated system; its components (sources, resistors, nonlinear elements, etc.) are not isolated but interact and influence one another to establish a collective operational state.

The V-A characteristic curve (Volt-Ampere characteristic) of the nonlinear element and the load line of the remaining linear sub-circuit are representations of the properties of these two interacting subsystems. Placing them on the same graphical coordinate system is an indispensable requirement for determining the solution to the problem.

The static operating point (the intersection of the two

graphs) symbolizes the established equilibrium state.

At this intersection, the interaction and constraint between the nonlinear element and the linear sub-circuit are simultaneously satisfied. This represents the unique condition where the current and voltage concurrently satisfy both: the nonlinear characteristic of the element and the governing laws of the external linear sub-circuit.

This study was conducted using a pedagogical experimental method applied to a sample of 79 students from the Faculty of Electrical and Electronic Engineering at Nam Dinh University of Technology and Education. The primary objective of the research is to evaluate the efficacy of applying Dialectical Materialism to the process of analyzing and solving electrical circuit problems. The experimental process was structured into two integrated phases:

Integrated Instruction: students concurrently enrolled in the *Marxist-Leninist Philosophy* and *Electrical Circuits* modules. During specialized lectures, instructors actively interpreted circuit phenomena and mathematical problems through the lens of the worldview and methodology of dialectical materialism.

Survey and Evaluation: following the pedagogical intervention, a quantitative survey was administered to assess students' comprehension of philosophical principles. Furthermore, the study analyzed the practical effectiveness of utilizing dialectical laws in enhancing students' circuit-solving skills.

The survey instrument (detailed in Appendix 1) utilized a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), to quantify learners' perception and their ability to apply philosophical theory to their technical expertise. The survey comprised 36 criteria, categorized into three primary groups:

- + Group 1 (Items 1–12): assessment of students' perception regarding the fundamental principles and laws of DM (Dialectical Materialism).

- + Group 2 (Items 13–24): evaluation of the effectiveness of applying DM in analyzing basic electric circuit problems.

- + Group 3 (Items 25–36): evaluation of the effectiveness of applying DM in analyzing transient processes in electric circuits.

3.2.1. Analysis of Experimental Results

Fundamental Perception of Materialist Dialectics

Results illustrated in Figure 2 show that over 80% of students rated the first group of criteria at levels 4 and 5. The mean value for this group was 4.62, with a standard deviation of 0.58. These findings indicate a successful transition from abstract philosophical concepts to a functional methodological framework.

However, data for Items 8 and 10 (related to the cause-effect category) recorded a significantly higher rate of level 3 responses. This reality indicates that a segment of the student population still encounters difficulties in bridging abstract philosophical categories with specialized technical practice.

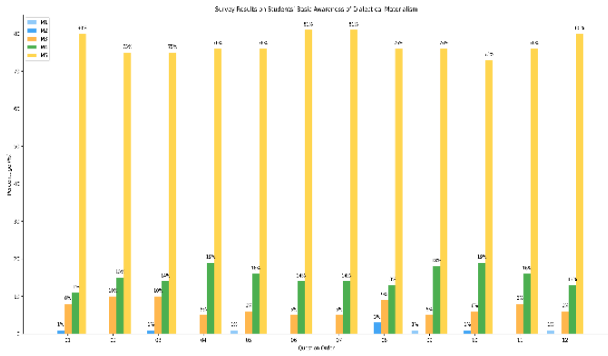


Figure 2. Survey results on students' basic perception Marxist dialectics (Items 1-12). Likert Scale Levels: M1: Strongly Disagree; M2: Disagree; M3: Neutral; M4: Agree; M5: Strongly Agree

Effectiveness in Analyzing Basic Circuits and Transient Processes

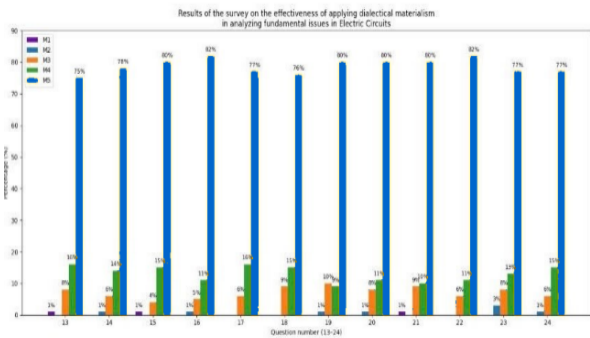


Figure 3. Survey results on students' basic perception Marxist dialectics (Items 13-24). Likert Scale Levels: M1: Strongly Disagree; M2: Disagree; M3: Neutral; M4: Agree; M5: Strongly Agree.

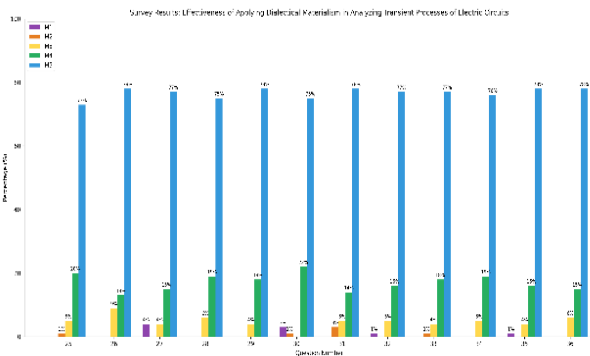


Figure 4. Survey results on students' basic perception Marxist dialectics (Items 25-36). Likert Scale Levels: M1: Strongly Disagree; M2: Disagree; M3: Neutral; M4: Agree; M5: Strongly Agree

Effectiveness in Analyzing Basic Circuits and Transient Processes

Based on the data in Figures 3 and 4, students demonstrated a marked improvement in analyzing transient processes. The mean scores for these two groups were 4.71 and 4.68, with standard deviations of 0.49 and 0.53, respectively. By applying dialectical principles of motion and development, students were better able to describe the transition of energy states over time, shifting from mechanical formula substitution toward a deeper grasp of the underlying physical phenomena.

3.2.2. General Evaluation

A comprehensive analysis of the survey results allows for the following conclusions:

- + Regarding Perception: students have established a solid methodological foundation, creating a prerequisite for applying philosophical thinking to resolve specialized problems.

- + Regarding Cognitive Capacity: there is a distinct improvement in systemic and critical thinking. The transition from theoretical cognition to academic practical competence not only enhances the quality of learning in the Electric Circuits course but also contributes to the innovation of teaching methods aimed at holistic student development.

3.3. Innovating teaching and assessment methods

The shift from traditional teaching methods to modern methods is aimed at enhancing the quality of instruction in Electrical Circuit courses. Modern methods emphasize bidirectional interaction between instructors and students [3].

Active Learning Models: this is facilitated through activities such as group discussions, open-ended questioning, and technical debates, as exemplified by the flipped classroom model [4], [5]. Notably, the integration of the Problem-Based Learning [6] (PBL) model fosters student autonomy in knowledge acquisition, enabling them to analyze and resolve real-world scenarios related to Electric Circuits. For instance, in a PBL-based session, students may be tasked with designing a power supply system for a smart home model, requiring current calculations, component selection, and safety assurance.

Integrating Technology and Simulation: specialized tools such as Multisim, Proteus, LTSpice, and MATLAB/Simulink allow students to visually simulate circuits, thereby gaining a clearer understanding of operational principles and validating theoretical analyses. Encouraging students to independently design and simulate circuits based on assignment requirements promotes creative thinking and practical application.

Developing Critical and Analytical Skills: by designing exercises that require students to predict circuit behavior when components are altered or to analyze the causes of circuit faults, learners are encouraged to apply knowledge flexibly and deeply. Organizing technical presentation sessions where students explain their solutions and defend their analytical perspectives also cultivates reasoning and technical communication.

Innovating Assessment Methods through an Open-Thinking Orientation: diversifying assessment methods is a key strategy for enhancing the quality of teaching and learning in the Electric Circuits module. Alongside pedagogical innovation, instructors should reform assessment to foster open thinking and practical competencies [7]. Rather than relying solely on traditional written tests, instructors are encouraged to design open-ended assignments and learning projects - such as simulations, group projects, technical presentations, and lab reports - that more comprehensively evaluate students' abilities. This approach promotes active learning, independent research, creativity, and interdisciplinary

integration. Assessment should be conducted continuously throughout the learning process, rather than being concentrated solely at the end of the course. Additionally, incorporating self-assessment and peer evaluation among student groups fosters active engagement and contributes to the development of critical thinking, collaboration, and self-directed learning - essential skills in modern engineering environments.

3.4. Contradiction and Development

The law of contradiction and Development is a core principle of dialectical methodology and can be effectively applied in the learning process to create opportunities for students to identify and resolve contradictions within the course content.

Theory vs. Practice: instructors are encouraged to prompt students to explore internal contradictions within electrical phenomena - such as between current and voltage, loss and efficiency, or theory and practice - thereby guiding them toward the development of new cognitive insights. For example, students might be assigned to simulate an ideal circuit based on theoretical models and then compare the results with real-world experiments, where discrepancies arise due to wire resistance or environmental noise.

Resolution and Development: analyzing these differences helps students recognize the contradiction between idealized models and practical realities, thereby developing critical thinking and design adjustment skills. Confronting and resolving such contradictions not only deepens students' understanding of the subject matter but also critically serves as a driving force for the development of independent, critical, and creative thinking. Through this process, students are trained to conduct multidimensional analysis, evaluate technical alternatives, and make informed decisions in complex engineering situations - essential competencies for engineers.

4. Conclusion and Recommendations

4.1. Conclusion

When students are guided to apply the dialectical materialist method of Marxist–Leninist philosophy, they tend to develop a deeper understanding of the subject, become more proactive in their learning, and demonstrate an improved ability to logically explain technical phenomena. Moreover, integrating the dialectical materialist method significantly contributes to enhancing teaching quality in the Electric Circuits course. This

methodological integration not only elevates instruction quality but also fosters the development of dialectical thinking and demonstrably improves students' problem-solving abilities.

4.2. Recommendations

For Instructors: instructors should take the initiative to study and apply dialectical methodology in lecture design, organization of learning activities, and student assessment. Additionally, they should enhance the use of active teaching methods such as Problem-Based Learning (PBL), technical simulations, and project-based learning to foster deeper engagement and critical thinking.

For Students: students are encouraged to shift from passive to active learning mindsets, actively participating in learning activities and cultivating critical and creative thinking through solving real-world problems. Approaching the Electric Circuits module through a dialectical lens not only enhances the quality of electrical engineering education but also represents a necessary step in the broader reform of higher education aimed at forming and developing learners' competencies.

REFERENCES

- [1] Ministry of Education and Training, *Marxist–Leninist Philosophy Textbook, National Political*, Publishing House – Truth, 2023.
- [2] V. T. K Oanh, “Applying Dialectical Materialist Methodology to Enhance Students’ Thinking Ability”, <https://ukh.edu.vn/08/04/2019> [Online] Available: <https://ukh.edu.vn/chi-tiet-tin/id/1359/Van-dung-phuong-phap-luan-bien-chung-duyvat-de-nang-cao-nang-luc-tu-duy-cho-sinh-vien>. [Accessed June 04, 2025].
- [3] N. T. Hieu, “Some Principles of Dialectical Materialist Methodology in Developing ProblemSolving Skills for Students Today”, <https://tgu.edu.vn/05-11-2021> [Online] Available: <https://tgu.edu.vn/dept/topic/?14982>. [Accessed June 04, 2025].
- [4] T. V. Hung, M. Yellishetty, N. T. Thanh, A Patil, and L. T. Huy, “The application of flipped classroom in teaching university students: A case study from Vietnam”, *International Journal of International Journal of Quality Assurance in Engineering and Technology Education*, vol. 6, no. 1, pp. 40-52, 2017. DOI:10.4018/IJQAETE.2017010104
- [5] A. Karabulut-Ilgu, N. J Cherrez, and C. T. Jahren “A systematic review of research on the flipped learning method in engineering education”, *British Journal of Education Technology* Vol 49 No 3 2018, pp 398-411, 2018. <https://doi.org/10.1111/bjet.12548>
- [6] E. Dermentzi, M. Zotou, E. Tambouris, and K. Tarabanis, “Using the problem based learning method and education technologies to tech open data: A sign- based research approach”, *Education and Information Technologies*, vol. 27, pp 8859-8882, 2022. <https://doi.org/10.1007/s10639-022-10995-9>
- [7] N. T. Ha, “Competence-based Teaching and Assessing in Education: Some Basic Theoretical Issues”, *VNU Journal of Science: Education Research*, vol. 30, no. 2, pp. 56-64, 2014.