2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
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ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #50954

Sparking Interest: Redesigning an Introductory Power and Energy Course for Deeper Student Engagement

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Work-in-Progress: Redesigning an Introductory Power and Energy Course for Deeper Student Engagement

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Abstract
This Work-in-Progress paper describes the structure and instructional components of ECE 3072: Electric Energy Systems, an introductory course in power and energy taught in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. The paper presents innovations in the teaching of an introductory course in power systems and energy. The paper discusses the topics covered and highlights three new elements: a debate, a guest talk, and Kahoot! quizzes, introduced in the Fall 2025 semester to improve student engagement and participation. To evaluate the impact of these additions, an end-of-semester survey was administered among students in the class. Preliminary feedback from students indicated high overall satisfaction with the course, with particular praise for the effectiveness of the lectures, industry talk, and Kahoot quizzes. Although most of the class valued the debate, a few students had concerns about the implementation method. Future iterations of the course will address these challenges and integrate additional components on engineering ethics and the application of artificial intelligence in power and energy systems to further enrich the learning experience.
Keywords: Power and Energy Systems Education; Active Learning; Student Engagement

Introduction
Introductory electrical engineering courses play a critical role in shaping students' interest and engagement in the discipline[1]. These foundational courses often influence students' choice of major and, more specifically, their focus areas within electrical engineering[2]. At colleges with large electrical engineering programs, such as the Georgia Institute of Technology (Georgia Tech), multiple introductory courses are offered to introduce students to concepts in the subdisciplines of electrical engineering, including energy, nanotechnology, computer architecture, and telecommunications. This work focuses on one such class at the School of Electrical and Computer Engineering (ECE) at Georgia Tech, ECE 3072: Electrical Energy Systems[3]. This course serves as the introductory course for all other power and energy courses within the ECE department.

With the global shift toward cleaner, more sustainable energy technologies, it is increasingly valuable for students to learn the fundamentals of modern power systems. It is crucial that courses are carefully crafted to equip students with the requisite skills to meet the demands of industry and higher education. The IEEE Workforce Initiative also supports this by encouraging the IEEE to expand its outreach to attract K-12 students to energy careers and to the science, technology, and engineering disciplines. These initiatives support the demand to meet the industry's urgent workforce needs[4]. Altogether, these highlight the need for specially designed courses to meet society's demand for socially trained power engineers. Educators must design and teach introductory

courses effectively to encourage students to become interested and continue working in this area. Consequently, this work-in-progress paper presents innovations in teaching the introductory course on power and energy at Georgia Tech during the Fall 2025 academic semester. This course, ECE 3072: Electrical Energy Systems, introduces concepts and prepares students for subsequent power systems courses in the School of Electrical and Computer Engineering at Georgia Tech.
In this paper, we outline the already existing components of the class and outline the changes implemented during the Fall 2025 Semester. It combines novel inclusions with best practices from the literature. The overall impact of the course and the specific effect of the new additions were assessed at the end of the semester through a comprehensive survey. The feedback would inform revisions to the course, improving it for subsequent semesters.

ECE 3072: Electrical Energy Systems Overview

This is the first of many power and energy classes in ECE at Georgia Tech. It is a prerequisite for all other classes in the Energy thread within ECE, but can be taken as an elective by students from other threads. The course employs multiple modes of instruction, including interactive 50-minute lectures, in-class discussions, audio-visual demonstrations, hands-on lab sessions, and comprehensive homework sets. The course was handled by a single instructor and three graduate teaching assistants (GTAs)[5]. The instructor delivered all lectures and provided weekly scheduled and impromptu office hours as needed. GTAs handled the nine (9) laboratory sessions, which formed a part of the class.
Topics covered in the lectures include the conversion of non-renewable and renewable energy sources to electrical energy, principles of electric power delivery, and principles of electric energy processing and conversion. In the lab sessions, students have the opportunity to conduct hands-on experiments on AC Circuits, single-phase transformers, three-phase circuits, photovoltaic cell characteristics, wind turbine generators, energy storage performance analysis, buck converters, single- and three-phase rectifiers, and power supplies for electronic equipment[3].

Enhancements Introduced This Semester

For the Fall 2025 semester, three new additions were made to the course to enhance students' appreciation of the content. They combine best practices documented in the literature with novel additions that align with this class's course content and structure.

End-of-Semester Debate: The first novel addition to the class was the inclusion of the in-class debate in the in-class activities. Debates are common in everyday life[6]. However, in the classroom, they are an effective means of active learning and can significantly enhance student comprehension[7,8].
In ECE 3072, the debate took place at the conclusion of the semester. Students were assigned to advocate for one of three electricity generation technologies: solar, nuclear, and combined cycle natural gas, using the state of Georgia as a case study. Throughout the semester, we spent weeks learning about these technologies, so the task was designed to assess how well they could apply this knowledge in a practical scenario.
To implement this, I asked for volunteers to serve as speakers in the debate (2 per team) and for the rest of the class to provide reflections on their experiences. Each team was tasked with preparing a 10-minute presentation to the Georgia Public Service Commission (PSC) in support of the state's investment in its preferred technology. They were required to use real facts and practical examples to support their arguments. This activity aligns closely with Georgia Power's real-world leadership obligations before the Georgia Public Service Commission[9].

To ensure participation from all students, the remaining students in the class who were not presenting were required to submit a paragraph-long reflection indicating which technology they would vote for if they were on the Georgia Public Service Commission, with reasons for their choice. Ten (10) extra homework points were awarded to the debaters and to anyone who participated in the reflections as an incentive for participation.

Industry Talk: Guest talks are commonly incorporated into engineering courses for several pedagogical reasons[10]. Prior work highlights that guest speakers can provide expert perspectives on specific topics, practical insights, and firsthand industry experiences, thereby better preparing students for professional practice and enriching the overall learning experience[11]. In ECE 3072, a guest speaker was invited to share industry experiences and expose students to the range of career paths available within the power and energy sector. It was held at the end of the semester after the lectures were completed and all materials had been introduced. For many students, this course represented their first formal exposure to the field, making it especially important that they left with a clear understanding of potential professional opportunities.

The invited speaker was a seasoned researcher with extensive industry experience, including collaborations with several major power and energy companies across the United States. The session consisted of a brief presentation followed by an interactive question-and-answer segment. Students asked questions about the speaker's professional journey, day-to-day industry work, and lessons learned throughout their career. The session concluded with general advice on navigating career decisions and identifying pathways within the power and energy workforce.

Kahoot! quizzes: Rather than using traditional quizzes in which students submit responses on paper or via a learning management system like Canvas or Blackboard, I implemented quizzes on the online quiz platform Kahoot! This game-based platform has been shown in the literature to be an effective way to increase student engagement and promote learning[12,13,14]. Competitive in-class games provide substantial value not only because they help students naturally assess their understanding of the material, but also because the competitive nature encourages students to study in advance for quizzes.

Quizzes were held bi-weekly during our Friday lectures from the beginning of the semester to the last lecture. Consequently, the quizzes covered the entire semester's topic list. Each quiz had 10 theory-based questions, simple enough to be answered in under 30 seconds. An example of the questions used during the Kahoot! quiz is shown in Figure 1. The highest-scoring student in each quiz was awarded some Georgia Tech souvenirs sponsored by the academic office.

Results

In this section, we present a detailed discussion of student feedback on the class's impact and the changes made this semester. At the end of the semester, a comprehensive survey was administered to students to assess the class's overall impact on their learning and the value of the new additions in supporting it. The survey was administered through Canvas, the web-based learning management system. It included both Likert-scale and open-ended questions to facilitate analysis and ensure a range of responses. All responses received were anonymous. The complete survey sent out is provided in the Appendix .

Enrollment and Participation

For the Fall 2025 academic semester, thirty-three (33) students enrolled in the class. This consisted of junior and senior electrical engineering majors. All thirty-three students participated in this survey, thereby ensuring that the results accurately reflect the entire class's feedback.

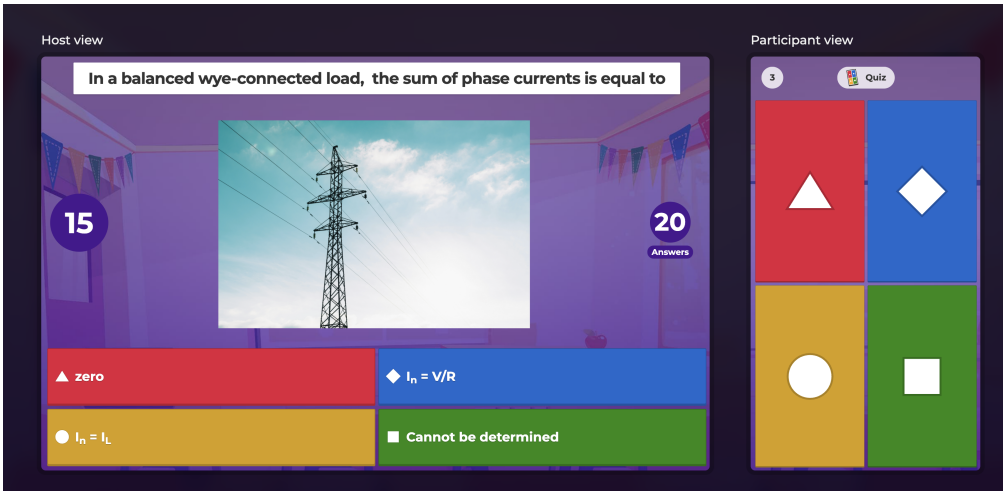

Figure 1: Example of the Kahoot! question.

Survey Results - Likert scale questions

The results generally indicated that the class was well-received. Table 1 provides a summary of the responses to the survey, color-coded to the percentage of responses to each. More than 90% of respondents agreed or strongly agreed that the course increased their interest in power and energy, was relevant to real-world applications, and improved their confidence in solving power and energy problems. There was also an overwhelming majority ($> 90\%$) agreeing on the value of the course structure and modes of implementation.

The industry talk and debate, on the other hand, did not receive the same overwhelming levels of approval and satisfaction. More specifically, there were higher numbers of neutrality towards the effectiveness of the additions. 36% of students believed the debate was not impactful, while 21% felt it did not improve their critical thinking. Similarly, 21% of respondents were neutral about the prospect of guest industry talks in the future. At the same time, 24% were neutral about the speaker's ability to motivate them to seek further roles in the power and energy industry. The final Likert-scale question did not follow the same format, and the results for that are shown in Figure 2. Although the majority rated the debate's contribution as either *Good* or *Excellent*, 2 of 33 students rated it as *Poor*, which is undesirable.

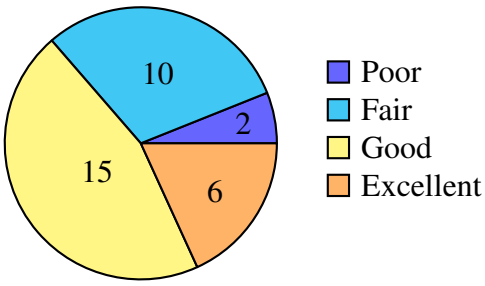

Figure 2: Survey response distribution to Q12 - How would you rate the debate activity in terms of its contribution to your understanding of electricity generation technologies?

Table 1: Distribution of responses for Likert-scale survey questions.

General Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The course increased my overall interest in electrical engineering.	0	0	3	10	20
The overall structure of ECE 3072 helped me understand key concepts in electric energy systems.	0	0	1	16	16
I found the course content relevant to real-world engineering applications.	0	0	2	13	18
The course improved my confidence in analyzing and solving power and energy problems.	1	1	1	18	12
The mix of lectures, discussions, and assignments enhanced my learning.	0	0	3	12	18
Debate Questions					
Participating in or observing the debate improved my ability to communicate technical ideas and support them with evidence.	0	2	10	15	6
The debate format helped me think critically about trade-offs between different energy technologies (solar, nuclear, natural gas).	0	1	6	15	10
Industry Talk Questions					
I would like to see more industry talks or guest lectures incorporated into future courses.	0	0	7	14	12
The talk motivated me to explore future roles or research in the power and energy industry.	0	1	8	14	10
The speaker provided valuable insights into career opportunities in the power and energy sector.	0	0	5	18	10

Survey Results - Open-Ended questions

The majority of responses were positive toward the class overall, consistent with the Likert-scale items. When polled on which aspects of the class they liked the most, students expressed satisfaction with the lectures, Kahoot!, and in-class problem-solving sessions. Of 33 responses, only one (1) each indicated that the debate and the industry guest talk were the aspects of the course that most enhanced their learning.

This brings us to the responses to Q13 and Q14: What improvements would you propose to the debate and the industry guest talk? The most common themes include the need for more time for the debate and the inclusion of cross-examination. The students expressed dissatisfaction with the 50-minute allocation for the three presentations, citing that it was not enough time for the presenters and for audience members to ask questions. Additionally, a couple of students expressed dissatisfaction with the current format of our debate, in which speakers deliver a 10-minute presentation followed by Q&A with the audience. Responses indicate a preference for a more open panel format with shorter presentations and greater participant interaction.

Furthermore, during the industry talk, students requested a greater variety in speakers. Specifically, requests were made to convene a panel of experts from different fields (consulting, utilities, research) to share diverse perspectives and experiences. Alternatively, allocate more than one lecture period to industry talks to accommodate more speakers from diverse fields. Below are selected responses from the survey that reflect the themes discussed above.

- **What improvements or changes would you suggest for future debates?**
  Maybe change the format so that presenters are actively debating rather than just giving presentations? Or maybe they can start with a brief 5-minute presentation and then go into an active debate? Not quite sure, but I think it would be more engaging.
- **What improvements or changes would you suggest for future industry talks?**
  I think more than one industry talk could be beneficial. This allows for greater insight into a broader range of work experiences from professional electrical engineers.
- **Which course activity or component most enhanced your learning this semester?**
  I think the Kahoots and prizes are a great incentive to learn the material and come prepared for a chance to win a prize.

Conclusions and Discussions

This work-in-progress paper describes and documents the initial steps in designing a robust, high-quality introductory course in power and energy systems for electrical engineering majors at the Georgia Institute of Technology. We discuss the class and describe the novel additions included for the Fall 2025 semester. We also present the results of a survey administered to students at the end of the semester to assess the impact of the modifications made to the class.

Initial feedback from students on the redesign was positive. The survey results indicate that students were generally appreciative of the course content and the instructional modes used by the instructors. Although a majority of students were satisfied with the new additions, a small number recognized their value but were concerned about the implementation approach and identified areas for improvement. This warrants further investigation for subsequent semesters. In future semesters, alternative formats for the in-class debate would be explored, including incorporating cross-examination of debaters, allocating more time for submissions, or exploring different debate topics. Furthermore, to allow the industry guest talk to provide a more holistic overview of the power and energy industry, it would be valuable to invite professionals from various fields (e.g., research, consulting, utilities) to share diverse perspectives and experiences with students.

Beyond the ideas discussed in the paper, there are opportunities to develop more dynamic approaches to engaging students and sustaining their interest in power and energy courses. Our ongoing work for future iterations of the course would include providing a research pathways lecture, incorporating ethics and societal impacts[15], and highlighting applications of artificial intelligence in the evolving power and energy landscape. In the full paper, we will incorporate these aspects and examine our students' feedback and responses.

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Appendix

This appendix presents the survey instrument used to collect student feedback for ECE 3072. The survey includes a combination of Likert-scale and open-ended questions designed to assess student learning, engagement, and perceptions of course activities, including the in-class debate and guest industry talk. Responses were collected anonymously and used solely for instructional improvement and educational research purposes.

ECE 3072: End-of-Semester Student Survey

Your feedback is extremely valuable and will help improve future offerings of this course. The goal is to better understand how different learning activities—especially the end-of-semester debate and the industry fireside chat—impacted your engagement, learning, and interest in the field of power and energy.
Your responses are anonymous and will only be used for instructional improvement and research on effective teaching practices. Please answer each question honestly and thoughtfully. Once you respond, 10 extra points will be added to your total homework score.

Likert-Scale Questions

Unless otherwise specified, the following statements were rated using a five-point Likert scale:

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

Q1. The overall structure of ECE 3072 helped me understand key concepts in electric energy systems.

Q2. The mix of lectures, discussions, and assignments enhanced my learning.

Q3. The course improved my confidence in analyzing and solving power and energy problems.

Q4. The course increased my overall interest in electrical engineering.

Q5. I found the course content relevant to real-world engineering applications.

Q6. The debate format helped me think critically about trade-offs between different energy technologies (solar, nuclear, natural gas).

Q7. Participating in or observing the debate improved my ability to communicate technical ideas and support them with evidence.

Q8. The speaker provided valuable insights into career opportunities in the power and energy sector.

Q9. The guest talk helped me understand how classroom concepts apply to industry challenges.

Q10. I would like to see more industry talks or guest lectures incorporated into future courses.

Q11. The talk motivated me to explore future roles or research in the power and energy industry.

Q12. How would you rate the debate activity in terms of its contribution to your understanding of electricity generation technologies?

(Poor Fair Good Excellent)

Open-Ended Questions

The following questions allowed free-text responses.

Q12. What aspects of the debate did you find most valuable (e.g., research, teamwork, discussion, reflection)?

Q13. What improvements or changes would you suggest for future debates?

Q14. What improvements or changes would you suggest for future industry talks?

Q15. Any additional comments about your overall experience in ECE 3072?

Q16. What changes or additions would you recommend to improve the course in future offerings?

Q17. Which course activity or component most enhanced your learning this semester?