TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering

RE: New Graduate Course, ECE 51020 Power Distribution System Analysis

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 51020 Power Distribution System Analysis
Sem. 1, Lecture 3, Cr. 3.
Prerequisite: Introduction to Power Systems (or equivalent) OR graduate student standing

Description:
This course covers the fundamentals of electric power distribution systems. With the increased deployment of distributed generation, controllable loads, and metering devices, it has become increasingly important for researchers and power industry professionals to understand power distribution systems better. This course commences with an overview of distribution networks, including their components, typical topologies, and operational strategies. The course continues with the characteristics and representations of electric loads. Critical elements in distribution grids, including unbalanced line segments, voltage regulators, and three-phase transformers, will be studied. These topics will be further integrated into the power flow analysis for unbalanced distribution networks. Special topics, including load control, optimal power flow, and microgrids, along with the integration of renewables, electric vehicles, smart inverters, and distributed generation, will be discussed.

Reason:
Other power system courses within ECE focus on high-voltage power transmission systems. This is the only course on power distribution systems.

Course History: Spring 2024 – 21, Fall 2024 – 17

Mithuna Thottethodi,
Associate Head for Teaching and Learning
Elmore Family School of Electrical and Computer Engineering

Course Information

- **Title:** ECE 51020 Power Distribution System Analysis
- **CRN:** 32838 (Face-to-Face) and 32841 (Async-Online)
- **Meeting days and times**: MWF, 11:30 AM-12:20 PM, BHEE 226
- **Office hours:** Tue, 1:30-2:30 PM,
    - 2063 WANG for CRN 32838
    - https://purdue-edu.zoom.us/my/kekatos for CRN 32841
- **Instructional Modality:** Face-to-Face (32838) and Async-Online (32841)
- **Course credit hours:** Three (3)
- **Prerequisites (if any)**: Introduction to Power Systems or equivalent

Instructor Contact Information

- **Name of the instructor:** Prof. Vassilis Kekatos
- **Office Location:** 2063 WANG
- **Office Phone Number:** 765-494-5486
- **Purdue Email Address:** kekatos@purdue.edu

- **Student consultation hours, times, and location:** Feel free to contact me in any of these ways:
    - During office hours (see above) or right after the class.
    - By email. Please use your Purdue email and add ECE-595 to the email title. During workdays, emails will be responded to within 24 hours and faster before deadlines.
    - You are strongly encouraged to post comments and questions on Piazza.

Course Description

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Learning Resources, Technology & Texts

Required text

- The main source of information would be the instructor's lecture slides uploaded on Brightspace progressively as the semester proceeds. The books listed below should serve as supplementary sources of information.
- *Distribution System Modeling and Analysis with MATLAB and WindMil*, 5th Edition, Kersting, William H.; Kerestes, Robert, CRC Press, 2022, ISBN No. 1498772137.
- Some material from the 4th edition of the book will also be covered.
- Both editions of the book are available online at Purdue's library and on our Library Reading List on Brightspace.

Additional reading

- The list of additional readings is below. However, as we progress through the course, other resources may be added through the Brightspace course readings folder and Library Reading List.
- *Electric Power Distribution Engineering*, 3rd Edition, T. Gonen, CRC Press, 2014. Also available online at Purdue's library and on our Library Reading List on Brightspace.

Software/web resources

- MATLAB: available here https://www.mathworks.com/academia/tah-portal/purdue-university-31484706.html
- Optimization software (YALMIP, sedumi, sdpt3): free, installation instructions to be provided.
- GridLab-D: Software for simulating power distribution systems: free, installation instructions to be provided. https://www.gridlabd.org/

Use of artificial intelligence (AI) or Large Language Models (LLM)

The use of AI and LLMs is not allowed in this course. All reports should be prepared on your own to improve your technical writing and communication skills. Use of English tools (such as spell checkers) are allowed and encouraged.

Learning Outcomes

1. Compare distribution to transmission power systems.
2. Understand load modeling.
3. Solve the equivalent circuit for overhead and underground distribution lines.
4. Apply voltage regulation techniques.
5. Solve the equivalent circuit for three-phase transformers.
6. Analyze distribution feeders.
7. Implement methods for unbalanced power system analysis.
8. Optimize power distribution system operation.

Assignments

Your achievement of course learning outcomes will be assessed through a combination of homework assignments (HW), one mid-term exam, and one final project. Details on these assignments, including a schedule of due dates, rubrics to guide evaluation, and guidelines on discussion participation and evaluation will be posted on Brightspace.

Assessments	**Due**	**Contribution to final grade**
HW1	Week 4 (Sep-11)*	10%
HW2	Week 7 (Oct-2)*	10%
HW3	Week 10 (Oct-23)*	10%
HW4	Week 12 (Nov-6)*	10%
Exam	Nov 12 (9:00 AM) to Nov 13 (9:00 AM)	40%
Project	Proposal: Oct-30 Report: Dec-4 Presentation: Dec-11*	20%
	*subject to change	Total: 100%

- ***Homework assignments*** will include analytical questions, understanding questions, and numerical tests.
    - They will be announced a week prior to their due dates. The due dates mentioned above are subject to change depending on how we proceed and cover material but will be announced accordingly on Brightspace.
    - Homework assignments are individualized per student. Discussing the assignment with other students is allowed as long as you list the names of your peers.
    - Individual reports including code listings are to be uploaded on Brightspace.
    - Homework assignments must be uploaded on Brightspace by **11:59 PM US Eastern Time of the due date**.
    - Please make sure you familiarize yourself with the submission tool well before the deadline. You can make multiple submissions. Only the last one will be graded.

    - Late submissions get a 50% grade reduction per day. Reports can be typed (in MS Word, Latex, or other editors) or handwritten and scanned, as long as they are eligible.
    - All homework questions should come with explanations and comments of the results. Simply reporting the final value or providing a yes/no-type of answer receives only 2/3 of the grade even if it is correct. Comments count for 1/3 of the HW grade. If numbers are wrong but comments provide some meaningful explanation, you may get 2/3 of the full grade.
- The **exam** will be the same for all students. It covers the material covered up to and including Week 11 of the class. It is a 24-hour take-home exam. Collaboration is not allowed. The exam will be announced on Nov 12 at 9:00 AM and due on Nov 13 at 9:00 AM.
- The **project** component of the course will be customized in teams of up to 2-3 students. Each team will work on a separate project and submit a single report. The contribution of each team member should be clearly explained in the report. Project topics could be selected from a list compiled by the instructor or can be proposed by the team depending on students' research interests. The specific requirements for the project component of the course are described below and are due as specified in the table above.
    - A *one-page proposal* describing each project's motivation, goals, and expectations is due on October 30. A template will be provided. Typing project reports in Latex is strongly recommended.
    - A *final report* up to 10 pages to be submitted on December 4. A template will be provided. Typing project reports in Latex is strongly recommended.
    - *Project presentations* are due on December 12. In-person students must deliver them in class, while online students must pre-record and upload them on Brightspace. Online students are welcome to present over Zoom in real-time, too.

Grading Scale

Each assignment contributes to your final grade according to the percentages shown in the previous table. The total numerical grade will be converted to the final letter grade based on the following thresholds:

Letter grade	if grade ≥
A+	96
A	93
A-	90
B+	86
B	83
B-	80
C+	76
C	73
C-	70
D+	66
D	63
D-	60
F	0

Attendance Policy

This course follows the University Academic Regulations regarding class attendance, which state that students are expected to be present for every meeting of the classes in which they are enrolled. When conflicts or absences can be anticipated, such as for many University-sponsored activities and religious observations, you should inform me of the situation as far in advance as possible. Do not come to class if you are feeling ill but do email me.

For cases that fall under **excused absence regulations**, you or your representative should contact or go to the Office of the Dean of Students (ODOS) website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent medical care. The processes are detailed, so plan ahead.

Course Schedule

Week	Topic	Readings and assignments
W1 (Aug-19)	*Intro to power distribution systems*	*Chapter 1*
W2 (Aug 26)	*Load allocation on a feeder*	*Chapter 2*
W3 (Sep-2)	*Approximate feeder analysis*	*Chapter 3. No class on Sep-2 due to Labor Day*
W4 (Sep-9)	*Line series impedance*	*Chapter 4, HW1 due on Sep-11*
W5 (Sep-16)	*Line shunt admittance and full lines models*	*Chapters 5-6*
W6 (Sep-23)	*Load models*	*Chapter 9*
W7 (Sep-30)	*Voltage regulation*	*Chapter 7, HW2 due on Oct-2*
W8 (Oct-7)	*Three-phase transformers*	*Chapter 8. No class on Oct-7 due to Fall Break*
W9 (Oct-14)	*Distribution feeder analysis*	*Chapter 10*
W10 (Oct-21)	*Exact and approximate analysis of single- and multi-phase grids*	*Papers. HW3 due on Oct-23*
W11 (Oct-28)	*Exact and approximate analysis of single- and multi-phase grids*	*Papers.* *Single-page project proposals due on Oct-30*
W12 (Nov-4)	*Modeling new grid devices*	*Papers. HW4 due on Nov-6*
W13 (Nov-11)	*Grid optimization under uncertainty*	*Papers.* *Exam: announced on Nov-12, due on Nov-13*
W14 (Nov-18)	*Mixed-integer problems in grid operation*	*Papers*
Thanksgiving Break		
W15 (Dec-2)	*Center-tapped transformers and secondaries*	*Chapter 11*
Ex-W (Dec-9)		*Project is due on Dec-4; presentations are due on Dec-11.*

* Schedule and assignments subject to change. Any changes will be posted in the learning management system.

For important dates to ADD, MODIFY, or DROP a course, and other key University dates for the semester, please see Purdue's Academic Calendar.

Academic Integrity and Copyright

I have extremely high expectations in terms of academic integrity for this and all other courses I am teaching. It is acceptable to discuss homework assignments with peers, but you have to list them in your report. It is not acceptable to collaborate on the exam. For all assignments, it is acceptable to use online resources (such as manuals), the course book, class notes, solved problems. Use of AI and LLM is not acceptable. Copying material from peers or solved problems from prior years or other sources is not acceptable. If project reports use material of any form from published papers or data from databases, those sources should be properly cited following the standards of our technical community.

Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered.

For further details, see also the related section of Brightspace.

Nondiscrimination Statement

See related section of Brightspace.

Accessibility

See related section on Brightspace.

Mental Health/Wellness Statement

See related section on Brightspace.

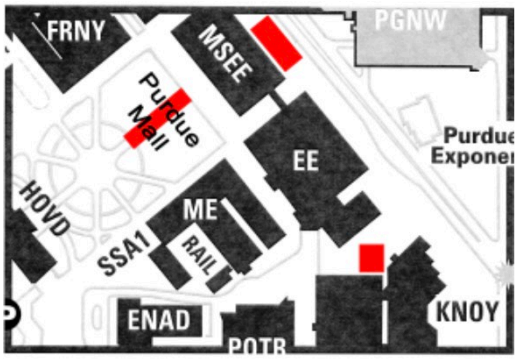
Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday.

Emergency Preparedness

Please subscribe to the Purdue text alert system. You are allowed to keep your cell phone on during class but please minimize disturbances.

If we hear a fire alarm, we need to evacuate the building and proceed to the Evacuation/Emergency Assembly Areas (EAA) shown on the map.



In case of a tornado warning, move to lower levels of building and away of windows.

In case of a hazardous material (HAZMAT) warning, close windows and doors.

In case of an active threat (such as a shooting), find a room without windows that can be locked or secured by barriers. Please watch related videos on preparedness.

For more details, see the related section on Brightspace.