EE 431/531: Power Systems Protection

Catalog Description

Relaying concepts, per unit calculations & symmetrical components, phasors, polarity and direction sensing, current/voltage transformers, protection fundamentals & basic design principles, system grounding principles, device protection, directional comparison, blocking & blocking pilot protection, line differential & phase comparison pilot protection, out of step tripping and blocking. Weekly Lab.

Credit hours: 4

Goals

Students will learn about and apply the principles of power system protection as applied to generators, transmission lines, transformers, loads and buses.

Course Coordinator and Committee

Robert Bass (coordinator)
Jonathan Bird
Mahima Gupta

Textbooks

J. L. Blackburn, T. J. Domin “Protective Relaying: Principles and Applications,”, Marcel Dekker Inc. (required)

The course instructor may choose to use a different textbook. Please check with your instructor before purchasing.

Prerequisites

EE 430/530

Course Learning Outcomes

Upon completion of EE 431/531, a student should be able to:

1. Explain the principles of protective relaying
2. Calculate settings, coordinate and analyze overcurrent protection schemes and complete time-current plots

3. Calculate settings, coordinate and analyze the most known protection schemes of high-voltage transmission protection systems

4. Explain, analyze and calculate basic settings of differential protection applied to generators, transformers and buses.

5. Indicate the most common elements used to protect the different elements of the power system

Topical Outline

- Damage curve; practical approximations.
- Protection with fuses.
- T-I curves.
- Damage curve of different electrical equipment
- Fundamentals of protective relaying. Primary and back-up. Protection and control.
- Overcurrent relays, electromechanical and digital
- Current transformers.
- Overcurrent relay setting calculations in radial systems. Coordination.
- Directional overcurrent relays in looped systems
- Transmission line protection using distance relays, distance pilot schemes and unit schemes
- Phase-fault generator protection using differential elements. Generator grounding principles and ground-fault protection.
- Transformer protection using differential and overcurrent elements.
- Busbar protection

Course Structure and Grading Criteria

The class will meet for lecture twice per week and lab once per week. Each lecture will be 100 minutes long and each lab session will be three hours long.

Grading Criteria:

Lecture: Homework, Midterm Exam, Final Exam

Lab: Lab Safety Quiz, Lab Reports, Project Deliverables

Grading criteria may vary with instructor; refer to the individual instructor’s syllabus for information on the grading breakdown.

Relevant Student Outcomes

The following student outcomes are supported by this course:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. an ability to communicate effectively with a range of audiences

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Prepared by: Robert Bass

Updated: 03/24/23