

NORTH CAROLINA STATE UNIVERSITY
ELECTRICAL AND COMPUTER ENGINEERING
ECE 551: Smart Electric Power Distribution Systems
Spring 2024

Instructors:

Dr. Mesut Baran
Office: 100 Keystone Rm. 21, Email: baran@ncsu.edu

Grader:

Ken Crawford, Gokhan Cakir
Xxxx, Xxxx@ncsu.edu

Class Lectures: M W 10:15 – 11:30 am, Monteith Engineering Research Center 313

Prerequisites: ECE 451 or equivalent

Credit Hours: 3 Hours

Course Description:

Features and components of electric power distribution systems, power flow, short circuit and reliability analysis, power quality and motor start calculations, basic control and protection, communications and SCADA, new "smart" functionality such as integrated volt/var control, automated fault location isolation and restoration, integration of distributed generation, electric vehicles and energy storage.

Student Learning Outcomes:

- Have a working knowledge of distribution system components and system topologies.
- Perform a power flow and short circuit analysis on a distribution circuit.
- Understand basic concepts of distribution voltage control and protection.
- Perform an analysis of system reliability and power quality.
- Understand options for device communications and remote control.
- Have a working knowledge of advanced volt/var control and automatic restoration schemes.
- Understand impact of new smart grid technologies such as microgrids.
- Analyze impact of distributed renewable generation and energy storage.

Textbook References:

Tom Short, Electric Power Distribution Handbook, CRC Press, 2nd Edition, 2014, eBook.
William H. Kersting, Distribution System Modeling and Analysis, CRC Press, 2017, eBook.
Richard E. Brown, Electric Power Distribution Reliability, CRC Press, 2nd Edition, 2009, eBook.
John D. McDonald (Editor), Electric Power Substations Engineering, CRC Press, 3rd Edition, eBook.

Grading:

Homework	20%
Projects	25%
Mid-Term Exam	25%
Final Exam	30%

Homeworks:

Homeworks will be assigned about once a week. Homework solutions will be posted on the Wolfware web site. Late homework (without permission from instructor) will be accepted for one week after the due date for 60% credit, but only until the solutions are posted.

Exams:

A mid-term exam and final exam will be administered to the class. Only the University approved reasons will be accepted for missing an exam (See <https://policies.ncsu.edu/regulation/reg-02-20-03>). A make-up exam will be administered at the mutual convenience of the student and the Instructor. In all cases, signed documentation must be provided to the Instructor and in order to obtain credit.

The Mid-term and the Final Examination will be closed book and closed notes with exception of formula sheets. Due to the size of the room, student seating will be assigned by the instructor.

Term Project:

The goal of the course project sequence is to provide the students an opportunity to apply smart distribution concepts to a model distribution system. Students will work in teams and utilize distribution modeling tools.

Academic Integrity:

Work in this course is to be done under the Academic Integrity Honor Pledge:

"I have neither given nor received unauthorized aid on this test or assignment."

Students must abide by the Code of Student Conduct articulated at: <https://policies.ncsu.edu/policy/pol-11-35-01>

Evidence of copying, including copying of source code, or any other use of unauthorized aid will be investigated and potentially referred to the University judicial system as a violation of the **Code of Student Conduct**. The *minimum sanction* for a violation is a zero on an assignment or exam. Recycling of projects from another resource will be considered an academic integrity violation.

Students with Disabilities:

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the [Academic Accommodations for Students with Disabilities Regulation](#) (REG 02.20.01).

N.C. State University Policies, Regulations, and Rules (PRR):

Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: <http://policies.ncsu.edu/policy/pol-04-25-05> (Equal Opportunity and Non-Discrimination Policy Statement), <http://policies.ncsu.edu/policy/pol-11-35-01> (Code of Student Conduct), and <http://policies.ncsu.edu/regulation/reg-02-50-03> (Grades and Grade Point Average).

Mental Health

As a student you may experience a range of personal issues that can impede learning, such as strained relationships, increased anxiety, alcohol/drug concerns, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may impact your ability to participate in daily activities. It is very important that you have a support system and that you ask for help when you are struggling.

The Counseling Center at NC State offers confidential mental health services for full time NC State students, including same-day emergency services. Please visit <https://counseling.dasa.ncsu.edu/> to get connected.

WolfPack Wellness Resources (<https://wellness.ncsu.edu/resources/>)

Tentative Lecture and Exam Schedule:

Lecture	Date	Topic	Reading Assignment
1	1/10/2022	Distribution System Fundamentals	Short Ch1
2	1/12/2022	Load Characteristics	Kersting Ch2
	1/17/2022	Martin Luther King Jr. Holiday	
3	1/19/2022	Transformers - Single Phase	Short Ch5
4	1/24/2022	Transformers - Three Phase	Short Ch5
5	1/26/2022	Substations & Primary Feeders	McDonald Ch3, Kersting Ch3
6	1/31/2022	Overhead Lines	Short Ch2, Kersting Ch4
7	2/2/2022	Underground Distribution	Short Ch4, Kersting Ch4 & Ch5
8	2/7/2022	Voltage Regulation and Voltage Drop Analysis	Short Ch6, Kersting Ch3&7
9	2/9/2022	Distribution Power Flow Analysis	Kersting Ch10
10	2/14/2022	Distribution Simulation using WindMil	WindMil PPT Notes
11	2/16/2022	Capacitor Applications Part 1	Short C7
12	2/21/2022	Capacitor Applications Part 2, Distribution Cost Benefit Analysis Framework	Short C7
13	2/23/2022	Distribution Short-Circuit Analysis	Short Ch8, Kersting Ch10, Brown Ch3
14	2/28/2022	Distribution Protection Operation	Short Ch9
15	3/2/2022	Midterm Exam	

16	3/7/2022	Reliability Analysis Part 1	Short Ch10, Brown Ch4&5&6
17	3/9/2022	Reliability Analysis Part 2	Short Ch10, Brown Ch4&5&6
	3/14/2022	Spring Break	
	3/16/2022	Spring Break	
18	3/21/2022	Distributed Energy Resources (DER) and Distribution Circuit Impact	Short Ch15
19	3/23/2022	DER Standards, Penetration Analysis and Mitigation	Short Ch15
20	3/28/2022	Distribution Simulation using OpenDSS	OpenDSS PPT Notes
21	3/30/2022	DER Analysis Examples in WindMil and OpenDSS	Short Ch15
22	4/4/2022	Power Quality: Voltage Sags and Customer Impact	Short Ch11
23	4/6/2022	Power Quality: Motor Startup and Harmonics	Short Ch11
24	4/11/2022	Automated Fault Location, Isolation and Service Restoration (FLISR)	FLISR PPT Notes
25	4/13/2022	Integrated Volt Var Control (IVVC)	IVVC PPT Notes
26	4/18/2022	Microgrids	PPT Notes
27	4/20/2022	Electric Vehicles and Energy Storage	PPT Notes
28	4/25/2022	No Class	
29	4/29/2022	Final Exam	