

**1. Course number and name**

EE 494: Protective Replay Lab

**2. Credits and contact hours**

3 credits, 3 lecture hours

**3. Instructor's or course coordinator's name**

Brent Carper

**4. Textbook, title, author, and year**

U.S. Dept. of Agriculture, Rural Utilities Service; Design Guide for Rural Substations; RUS Bulletin 1724E-300; Issued June 2001. Available for free pdf download at: <[www.rd.usda.gov/files/UEP\\_Bulletin\\_1724E-300.pdf](http://www.rd.usda.gov/files/UEP_Bulletin_1724E-300.pdf)>. (Required)  
Any textbook on Power System Protection (e.g. from EE493 or similar) for reference on Per Unit calculations, Symmetrical Components, and other general power system calculations.

Cooper Power Systems. 1990. *Electrical Distribution System Protection Manual* (3rd ed.).

Wayne Beaty and Donald Fink. 2013. *Standard Handbook for Electrical Engineers* (16th ed.). McGraw-Hill. ISBN 978-0-071-762-328. (Recommended)

J. Lewis Blackburn and Thomas J. Domin. 2011. *Protective Relaying: Principles and Applications* (4th ed.). CRC Press. ISBN 978-1-439-888-117. (Recommended)

Stanley H. Horowitz and Arun G. Phadke. 2014. *Power System Relaying* (4th ed.). Wiley. ISBN 978-1-118-662-007. (Recommended)

Werstiuk, Chris. 2012. *The Relay Testing Handbook: Principles and Practice*. Valence Electrical Training Services LLC; ISBN 978-1-934348-20-8. (Recommended)

**5. Specific course information**

- a. *Catalog description:* Experiments and measurements of protective relay equipment under test, simulated fault and fault conditions.
- b. *Prerequisites or co-requisites:* EE 361 with a C or better; EE 493 with a C or better; certified major in Electrical Engineering, Computer Science, or Computer Engineering.

**6. Specific goals for the course**

At the end of this course, students must be able to understand the principal and functionalities of the following topics:

- Substation design fundamentals for protection and control (1,6)
- Fundamentals of Protection and control engineering (1,6)
- Protective relay characteristics and settings (1,6)
- Fault studies and software systems (1,6)

**7. Brief list of topics to be covered**

- Course overview and Introduction to P&C
- P&C Equipment, Substation bus configurations, One-line diagrams

- Relay one-line diagrams, ANSI device numbers, Zones of protection
- Relay types & construction
- Relay input devices
- Three-line diagrams
- Relay and switch nomenclature
- Control system fundamentals
- Control system design
- Wiring diagrams and methods
- IEEE breaker control standard
- Relay panel wiring
- Trip/reclosing schemes
- Instantaneous overcurrent relaying
- Introduction to digital relays
- Digital relays
- Fault studies
- System modeling for fault analysis
- Overcurrent coordination