Ongoing List of Topics:

- URL: http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm
- Labs - EE5224 Lab 2 - ongoing
- Term Project - details posted. Limit 1 BS student/team!
- Exercises posted

Today:

- Reclosing - radial vs. grid system
- Short circuit protection in grid systems
  - Directional overcurrent
  - Impedance
- Voltage & Current relationships during faults, §3.5-3.10
  - X/R ratio, dc offset, decay of dc offset
  - Relative angles and magnitudes of all Vs & Is during fault
- Basic connections of directional overcurrent (67) relays.
  - Phase relays - each line current is polarized with $V_{LL}$ from other phases.
  - Ground relay - residual current $(3I_{ao})$ polarized with $V_{broken delta}$ $(3V_{ao})$
- Excellent Illustrations: figures 3.7 thru 3.10
Note: N relay is set for lower pickup than phase relays.
$3$rd Harmonic = Zero Sequence

$\frac{\sqrt{1}}{3}$ Harmonic

$\text{Triplen}$

$\begin{array}{|c|c|c|}
\hline
\text{Harm} & \text{Pos} & \text{Neg} \\
\hline
\frac{\sqrt{1}}{3} & \times & \times \\
\times & \times & \times \\
\times & \times & \times \\
\hline
\end{array}$

$2, 5, \frac{26}{3}, \frac{25}{3}, \frac{12}{4}, 1$
Types of Faults:

- 3-Phase
- 3-Phase - G
- L-L
- L-L - G

"near-end" or "close-in" fault
"far-end" fault
Reclosing:
- Trip for fault
- Wait
- Reclose 79

Conditions to check for:
- NONE
Grid System:

*N-1* Contingency

2mH

Dist Sub

Radial System
Standing voltage angle between 2 ends

Reclose strategy:
1) Reclose CB at one end. Line is reenergized. Leave other CB open for the moment.
2) Check voltages across 2nd CB. Close if within acceptable range. This depends on line & util, usually ≤ 40° or ≤ 45°.
Optimize Distribution Protection, Automation, and Breaker Control

Apply the SEL-351S Relay to enhance your service quality through integrated protection, monitoring, and control.

Features and Benefits

- **Overcurrent Protection**
  Protect lines and equipment using a sensitive and secure mix of phase, negative-sequence, and ground overcurrent elements. Use directional control elements in looped systems. Provide high-speed operation, even with severe CT saturation, using SEL Adaptive Overcurrent Element. Apply “recloser” time-overcurrent curves for coordination with and sequencing of downstream reclosers.

- **Operator Controls and Reclosing**
  Use direct-action operator controls to eliminate the need for expensive, panel-mounted control switches and associated wiring. Integrate automation elements, including remote, local, and latch switches, plus display points, for remote and local control. Selectively reclose with synchronism and voltage checks.

- **Relay and Logic Settings Software**
  Use acSELerator® QuickSet™ SEL-5030 Software to reduce engineering costs for relay settings and logic programming. Use graphical tools included with acSELerator to develop SELogic® control equations.

- **Accurate Metering and Monitoring**
  Use built-in, high-accuracy metering functions to eliminate expensive, separately mounted metering devices. Improve maintenance scheduling using circuit breaker contact wear and substation battery voltage monitors.

- **Sequential Events Report**
  Analyze Sequential Events Recorder (SER) and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics.
Use any of the 38 traditional recloser curves in the SEL-351S Relay to time-coordinate with downstream circuit reclosers. Sequence coordination keeps the SEL-351S in step with downstream reclosers and prevents tripping by overreaching overcurrent elements for faults beyond reclosers.

Five standard US and IEC time-overcurrent curves provide coordination with other time-overcurrent relays.
Overcurrent Protection

Fault Source
S.E. Current

Isc = Total Fault Current / IF

Isc is Zero (no source)

Possible Strategy:
- Set SO to pick up for close-in or low-impedance faults.
- Set SI to take care of high-impedance faults or faults farther out.

EE 5210 - Power Systems Protection  Spring 2001
67 - Directional O.C.
(Can also have inst. &
time delay versions).

Key: Polarizing input
determines the
directionality of
relay. Can use
either V or I to
polarize.

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