Charles Kim, "Lecture Notes on Fault Detection and Location in Distribution Systems," 2010.

Lecture Note on Fault Detection and Location in Distribution Systems

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2010

June 1 – 3, 2010 @TKK

FAULT DETECTION AND LOCATION IN DISTRIBUTION SYSTEMS
Post-Graduate Course (4 cr)

Aalto University
School of Science
and Technology

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Course Description

- Fault location
  - Along with, restoration scheduling, the essential functions of outage management
  - Accurate fault location and fast restoration of power in distribution systems is still a challenging problem.
- Focus
  - Review on faulted power system analysis (with practices on Mathcad)
  - Fault location algorithms (emphasis on impedance methods) – practice with Mathcad
  - Fault Indicators – important players in Distribution Network Fault Detection – Practice with Mathcad
  - Sub-cycle fault location (experience with real data) – Mathcad code
  - Fault location with smart sensors and smart meters – Introduction and Research Topics
  - Intermittent/Incipient Line Fault Detection as a sentry for self-healing and fault anticipation

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Course Objectives

- to provide a strong background (and review) in the analysis of faulted power systems with hands-on coding experience,
- to guide to the fault detection and location in power distribution systems through the detailed instruction (and hands-on practice) on conventional fault location algorithms as well as new sub-cycle fault location and intermittent fault detection approaches,
- to introduce a new way of achieving the fault location integrated with utility communication infrastructure to achieve the self-healing feature of the Smart Grid concept.

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Course Outcomes

- Brushing up on Faulted Power System Analysis with Symmetrical Components (and practice with Mathcad coding)
- Understanding and application of fault location algorithms (and practice them in Mathcad environment)
- Understanding of fundamental concepts of sub-cycle fault location, and exploring for improvement (and practice in Mathcad)
- Exposure to emerging technology of distribution fault location and outage management
- Exposure to the features of Smart Grid and carrier based intermittent fault detection method as an enabling technology for self-healing

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Lecture 2
- Faulted Power System Analysis

- Faulted power system variables
- Symmetrical fault current calculation
- Asymmetrical fault calculation
- Symmetrical (sequence) component
- Sequence component application to asymmetrical faults
- Fault current distribution
- Review and Practice with Mathcad Tutorial

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Lecture 3 - Fault Location Methods

- Fault location basics
- Impedance equation in distance relaying and residual compensation
- Other Impedance/Reactance approaches and Takagi method
- Differential equation approach
- US patent and recently filed patent applications (Exam)
- MathCad coding and testing of the algorithms

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Lecture 4 - Fault Indicators

– A few patented approaches
– Application of them with Mathcad coding

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Lecture 5 – Sub-Cycle Fault Location

- Problems of the conventional fault location methods

- Challenge with less than 2 cycle transitory fault location

- Sub-cycle transient analysis

- Distance to fault formula

- MathCad coding and testing of sub-cycle algorithm using actual data

- Research topics and improvement opportunities

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Lecture 6 – AMI Based Fault Location

- AMI (Advanced Metering Infrastructure) based approach
  - Emerging digital approach of distribution fault location
  - Complex network nature of distribution system
  - Utilization of digital/communication systems, intelligent devices, and fault indicators
  - Smart meter and its other uses
  - Research Topics and Suggestions

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Lecture 7 – Fault Anticipation and Self-Healing

- Self-healing feature and incipient fault detection and location

- Problems and challenges

- Carrier signal-based intermittent fault detection method

- Research topics and opportunities

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Assignment and/or Exam

- Breaks and Lunch Hour
  - 10 minute break + 1 lunch hour + 10 minute break
- Assignment (in-class)
  - Novosel Algorithm Implementation
- Exam
  - Monday 14 JUNE 2010 @9 – 12
  - Problem (a patent or publication) will be delivered OR announced at the last hour of the lecture
  - (1) Implementation (testing) with Mathcad coding for a given problem and (2) Improvement.
  - Email submission time period will be given --- Monday 14 June 2010 by 11pm (?)

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