Ongoing List of Topics:

- URL: http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm
- Labs - EE5224 should be on track.
- Term Project ?? – teams of 3. Details in week 5.
- Aspen -- need to use for Assn. #6. View tutorial!

Ongoing list of topics:

- Radial coordination - basic approach to coordinate “51" relays
- CT ratios, MR (multi-ratio) CTs (Print out CT handout)
- CT saturation & accuracy issues: deration for less than full turns
- Iterative method to calculate CT measurement error
- Print out MOCT & CCVT handout from web page
- MOCTs - Magneto-Optic Current Transformers
- CCVTs
- Voltage & Current relationships during faults
  - X/R ratio, dc offset, decay of dc offset
  - relative angles and magnitudes of all Vs & Is during fault
$t \times I = C$

**E-mail Forum:**

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- Technologies, examples, questions...
- Homeworks: Conceptual, not solutions.

**G1:** Separate relay
- Co-11
- Co-9
- Co-7

**G2:** Select from curves

**G3:** Add'l Functions
Time = Damage!

\[ \text{Thermal} \propto t \]
\[ \text{Damage} \propto I^2 \]

\[ P = I_F^2 R \]
\[ J = \frac{P t}{I} \]
- Max Load Current
- Min Fault Current

Fault Types
- 3φ
- LL
- L-G
- L-L-G

- Triplen Harmonics
- Phase Imbalance
2. [20 pts] Two time-overcurrent relays protect adjacent sections of a radial system. Bus 3 is at the end of the radial line. 7000 amps of fault current will flow for a fault at point A; 5000 amps for a fault at point B. Load currents at buses 2 and 3 are 100A and 350A respectively. Loads at buses 2 and 3 have the same power factor.

![Diagram of a radial system with relays labeled.] (Diagram showing relays and currents)

a) Determine the tap settings for the relays at buses 1 and 2. Assume that taps can be set so they are just above rated load current. Available tap settings are: 1.0, 1.2, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0, 6.0, 7.0, 8.0, 10.0, and 12.0 amps.

\[ R_2: \quad I_{R_2} = \frac{350}{80} = 4.375A \Rightarrow 5A \text{ Tap?} \]

\[ R_1: \quad I_{R_1} = \frac{450}{120} = 3.75A \Rightarrow 4A \text{ Tap?} \]

b) Keeping in mind that the relay at bus 2 protects the last section at the end of the line, what must its time dial setting be? Why?

\[ R_2: \quad I_{R_2,F} = \frac{7000}{80} = 87.5A \]

\[ R_1: \quad I_{R_1,F} = \frac{7000}{120} = 58... \]

c) Based on the fault at point A, what should the time dial setting be for the relay at bus 1? Assume that the circuit breakers operate in 4 cycles, and that the CTI is 0.25 seconds.

\[ R_2 \text{ trips at 0.1 s} \]

\[ R_1: \text{ waits } 0.1 + \frac{4}{60} + 0.25s \]

d) How long will it take for the relay at bus 1 to pick up for a fault at point B if the relay at bus 2 fails to operate?
Fig. 15. Typical Time Curve of the Type CO-9 Relay
MINIMUM MELTING TCC
Curves of M-E fuse links in M-E cutouts • Basis for data: NEMA Standard SG2
Tests at 240 Volts ac, high pf, starting at no initial load, 25°C
Minimum test points plotted so variations should be plus

EEI-NEMA TYPE K-TIN

McGraw-Edison Company
Power Systems Division

February 1970
25-Amp Coil—Recloser Clearing Time

Curve A: Maximum clearing time for one operation, variations negative.
Curves B, C, and D: Average clearing time for one operation, variations ±10%.
Tests conducted at 25°C.