Ongoing List of Topics:

- URL: http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm
- Labs - EE5224 Lab2 begins next week!
- Term Project - guidance after WC break.
- Team pre-req homework 3B - due Feb 22nd. Short circuit calcs!
- CT ratios, MR (multi-ratio) CTs - look at IEEE stds.
  - X/R ratio, dc offset, decay of dc offset
- Calculation of measurement error for given ratio & burden.
- Print out MOCT & CCVT handout from web page
- MOCTs - Magneto-Optic Current Transformers
  - Faraday effect, “faraday rotators,” Verdet constant
  - shift of polarization angle due to strength of H-field
  - Design kept to low near-linear range
- Linear Couplers, Rogowski Coils
- CCVTs
- Voltage & Current relationships during faults, §3.5-3.10
  - relative angles and magnitudes of all Vs & Is during fault
\[ e = \frac{dL}{dt} = N \frac{dB}{dt} \]

Diagram:

\[ 1200 \text{ V} \]

\[ + \]

\[ 8 \Omega \]

\[ 8 \Omega \]

\[ |I_B| < 8 \Omega \Rightarrow \text{Error} < 10\% \]

\[ |I_B| > 8 \Omega \Rightarrow \text{Error} > 10\% \]
\[ G_1 \rightarrow \text{Burdan} \]
\[ Z_B \Rightarrow \]
\[ L = \frac{N^2}{A R} \]
\[ \Rightarrow \text{Low tap settings have highest } Z_B \text{ burden!} \]
\[ G_2 \& G_3 \text{ relays: much smaller } Z_B \]
\[ \text{But: look at I.L.!} \]
\[
\left( \frac{1200}{5} \right) \times RCF = 1.004
\]

\[
240 \times 1.004 = 240.96
\]

[Diagram of a circuit with labels 1200A, 5A, 4.98, RCF, and a note "std B-8 Burden!"]

ECT sec cable + Relays

ΣB, TOT
$E_{SE}$

$I'_2, Z_{tot}$

$2\pi T = R_2 + R_{cond} + R_{relays}$

$I'_2, I_E$
$Z_B \Rightarrow L = \frac{N^2}{A'B}$

$\Rightarrow \text{Low tap settings have highest } Z_B \text{ burden!}$

$Z_B \text{ is max}$

$Z_B \text{ is min}$

G2 & G3 relays: much smaller $Z_B$

But: look at I.L.!
16 Ω on its 0.5 A tap 68° lag. To pass pickup current through the ground relay, \(0.5 \times 16 = 18\) V is required. This voltage, less the small drop through the phase relay circuit, will appear across the phase B and C current transformer secondaries to excite them. The voltage \(V_{ef}\) depends on the current that, in turn, depends on the voltage, so the exact determination is a “cut-and-try” process. At the first try, assume that \(V_{ef} = 8\) V. From the CT characteristic
L-G fault on Phase A.

Refer to LΦ3 notes on Zones of Protection.

- Refer to CT notes posted on Week 4 (webpage).

open
Phi A-G Fault

I_2'

R_2

I_e

I_e is ~ double.

51 21

I_2

I=0

CB open

open ckt.

I_e flows in CT even though its Pri current is zero!
RCF: \[ \frac{\text{RCF Actual}}{\text{RCF Ideal Ratio}} \times \text{RCF} \]

From previous example:

\[ \frac{150}{6.1} = \left( \frac{100}{5} \right) \times \text{RCF} \Rightarrow \text{RCF} = 1.23 \]

Typically, RCF ≥ 1

RCF: keep ≤ 1.1

(10°C/800°)
\[
\left( \frac{1200}{5} \right) \times RCF = \text{1.004}
\]

\[
240 \times 1.004 = 240.96
\]

1200A

\[
5\Omega
\]

4.98

5\, \text{std B-8 Burden!}