Ongoing List of Topics:

- URL: http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm
- Labs - EE5224 Lab2 started Tuesday.
- Term Project - guidance after WC break.

- 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
\[ e = \frac{d^2}{dt^2} \cdot \frac{N J d}{dt} \]

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

\[ |E_B| > 8 \Omega \Rightarrow \text{Error} > 10\% \]
G1  Burden

ZB ⇒ L ⇒ A \cdot t

\[ L = \frac{N^2}{B} \]

⇒ Low tap settings have highest ZB burden!

⑤ Taps: Q - 12 λ

ZB is max

ZB is min

G2 & G3 relays: much smaller ZB

But: Look at I.L.!
\[(\frac{1200}{5}) \times RCF = 1.004\]

\[240 \times 1.004 = 240.96\]

1200A

5A

4.98

RCF

std B-8 Burden!

ECT sec cable + Relays

ZB, TOT
\[ E = E_{\text{SE}} \]

\[ I_2' Z_{\text{tot}} = R_2 + R_{\text{cond}} + R_{\text{relays}} \]
\[ G_1 \text{ (Burden)} \]

\[ Z_B \Rightarrow L \Rightarrow \frac{A \cdot t}{\phi} \Rightarrow N_i = \phi R \]

\[ L = \frac{N^2}{A R} \]

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

\[ \text{\textcircled{51} Taps: } 4 - 12 \]  
\[ Z_B \text{ is max} \]
\[ Z_B \text{ is min} \]

\[ G_2 \& G_3 \text{ relays: much smaller } Z_B \text{ but: look at I.L.!} \]
FIGURE 5.12 Phase-and-ground relays for the protection of a circuit and the current distribution for a phase-and-ground fault.

16 \Omega\) on its 0.5 A tap 68° lag. To pass pickup current through the ground relay, \(0.5 \times 16 = 18 \text{ V}\) 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 \(V_{ef} = 8 \text{ V}\). From the CT characteristic
L-G fault on Phase A.

- Refer to LØ3 notes on "Zones of Protection".
- Refer to CT notes posted on Week 1 (webpage).
ΦA-G Fault

I\_e is \sim\ double.

I\_e flows in
CT even though
its Pri. current is
zero!
RCF:

\[
\text{Ratio}_{\text{Actual}} = (\text{Ideal Ratio}) \times \text{RCF}
\]

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 \( \leq 1.1 \) (10°C 800)
\[(\frac{1200}{5}) \times RCF = 1004\]

\[240 \times 1.004 = 240.96\]

1200A

5A

4.98

RCF

std B-8 Burden!