Typical Generation Data

- $P = X_1 X_2 X_3
- X_1 = X_2 = X_3 = X_4
- $X_{trans} = 0.5 X_5$
- $X_{sub} = 0.5 X_5$
- $X_{trans} = 0.5 X_5$
- $X_{sub} = 0.5 X_5$

- $X_6 = X_7$
- $X_8 = X_9$
- $X_{trans} = X_5$
- $X_{sub} = X_5$

- $P = X_1 X_2 X_3$
- $X_1 = X_2 = X_3 = X_4$
- $X_{trans} = 0.5 X_5$
- $X_{sub} = 0.5 X_5$
- $X_{trans} = 0.5 X_5$
- $X_{sub} = 0.5 X_5$

- $X_6 = X_7$
- $X_8 = X_9$
- $X_{trans} = X_5$
- $X_{sub} = X_5$
- would need to be finished new
- November 2
- Tentative exam available
- 3 days
- Take home exam

Exam 1
Then other Z

- One phase different impedance

- Two single pole open

1 phase different than other 2

Series fault

E 2a - 3b

Z 3A = Z2

E C

Z 1A

E Z 2B

T 1A

Z 2B

Z 3A

T (E 2a - 3b)
\[ V_{AB} = Z_4 \cdot I_4 \]
\[ I_B = I_C = 0 \]
\[ Z_B = Z_C = 0 \]

ABC Domain Constraints

2 phase open - Greener Failure

Circuit must work where that Special Case Where That
In series circuit

\[ I_0 = I_1 = I_2 = \frac{V}{R} \]

\[ \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{1}{R} & \frac{1}{R} & \frac{1}{R} \end{bmatrix} \]
\[ 0 = (I_2 \cdot V_Z - 2,000 \cdot \Lambda) + (I_1 \cdot V_Z - 1,500 \cdot \Lambda) + (0.1 \cdot V_Z - 0,000 \cdot \Lambda) \]

Recurrent equation grouping terms:

- \((7 + 1 + 0.1) \cdot V_Z = 2,000 \cdot \Lambda + 1,500 \cdot \Lambda + 0,000 \cdot \Lambda\)

- Voltage equation mapped to sequence domain:
  - Result in continuous is similar to that for a SLG Feule.
  - Transient boundary conditions in sequence domain:
    - \(V_{\text{Z}} = \Lambda\)
    - \(I = 0\)
  - Boundary conditions in ABC domain:
    - \(Z_{\infty} = 0\)

Two-phase open sequence connections

EE 523, Lecture 14
\[ I_1 = \frac{V_o}{R_{\text{eq}}} = I_0 = I \]

\[ I_2 = \frac{Z_1}{Z_2 + \text{Z_{eff}}} \]
\[ 3 \approx 1.3 \quad \text{deg} = 1 \quad \text{deg} \quad m_{d} = 1 \quad \text{deg} \quad n_{d} = 1 \quad \text{deg} \quad \text{V} = 3 \quad \text{V} \]

**Generator Terminal Voltage:**

\[ 6.0 = |Z_{e}| \]

\[ 0.42 = 0.68 - 0.42 \]

\[ \frac{V_{a}}{S_{a}} = \frac{V_{b}}{S_{b}} \]

\[ 0.18 = 0.85 \]

\[ P_{r} = 0.85 \quad \text{kW} \]

\[ \text{mW} = 80 \quad \text{kVA} \]

**Determine Internal Source Voltages:**

No change of base calculations need for this system.

\[ V_{b} = 20 \quad \text{kV} \]

\[ \left( \frac{V_{a}}{V_{b}} \right) \]

\[ \left( \frac{V_{a}}{V_{b}} \right) \]

\[ V_{b} = 34.5 \quad \text{kV} \]
Now solve the two-phase open circuit below for the sequence currents:

\[ Z_a = 0 \]

\[ I_1 = \frac{V_{\text{equiv}}}{Z_{\text{FP}} + Z_{\text{DP}} + Z_{\text{PF}}} \]

\[ I_2 = I_1 \]

\[ I_0 = 1 \]

\[ |I_1| = 0.23 \text{ pu} \]

\[ \arg(I_1) = -31.79^\circ \]

\[ |I_2| = 0.69 \text{ pu} \]

\[ |I_0| = 1 \]

\[ \text{arg}(I_0) = 81.87^\circ \]

[Image of a circuit diagram with labels and calculations]
Now solve for the single phase open circuit currents and voltages:

\[ I_1 = \frac{Z_{OFP}}{Z_{OFO}} I_0 \]

\[ Z_{OFP} = Z_{OFO} + Z_{0} \times \text{Yield} + Z_{1} \times T + Z_{2} \times \text{Yield} \]

Find total impedance counter clockwise around loop from F to P.
2. How will the effect of 2 pola open narrative?

3. Will I pola open narrative? How will this effect?
Now solve the two phase open circuit below for the sequence currents:

$$I_1 = 0$$

$$I_2 = I_I$$

$$I_I = 0$$
Solve using Zbus method. First get the Zbus matrices for the positive, negative and zero sequence networks.
\[ \frac{\frac{d \phi}{d \psi}}{Z} + \frac{d \phi}{d \psi} Z \]

\[ \frac{1}{1 - \frac{d \phi}{d \psi}} \]

Find the sequence currents based on the per-unit load current.

\[ Z_{0, \text{pu}} = 1 \text{pu} \]

Same as calculated above

\[ Z \rightarrow 0.711 \text{pu} \]

From above: \[ \frac{1}{1 - \frac{d \phi}{d \psi}} \]

Notice that the denominator has the transmission impedance at the bus on either side of the open condition and

\[ Z \rightarrow 0.711 \text{pu} \]

Equivalent impedances looking into the network: From the open section, see section 6.4.4 in the text.
Asynchronous Fault and Series Fault
Use both a series fault and a separate equal to
Electromagnetic Transient Simulations
<table>
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<td><strong>Why Analyze Transients?</strong></td>
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- Protection decisions before transients do not rely on transient behavior.
- Transients include faults and response to clearing faults.
- Sudden changes cause large voltage and current variations.
- Steady-state disturbances are not present.
- Power systems operate in sinusoidal conditions.

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- RLC response to changes in voltage or current:
  - Large voltage and currents are possible.
  - Generally dies out rapidly (higher freq).
- Response frequencies from DC to MHz:
  - Switching, operations, faults, lighting, etc.
- Allows use of RMS phasors in steady-state:
  - OR quasi-steady-state
- Power systems normally in steady-state.