I. Define the Situation

A salient-pole generator is rotating off-line at synchronous speed and 1.2 pu voltage in steady state. The field voltage is increased by a 10% step at time 1 second. Simulate the response using the generator transient model we have been discussing in class. Compare the simulation of the generator neglecting saturation and including saturation. The values below are in per unit.

\[
P_m := 0 \\
E_a := 1.1 \\
X_{dp} := 0.4 \\
X_d := 1.2 \\
X_q := 0.9 \\
\omega_s := 120 \cdot \pi \text{ rad} / \text{sec} \\
\omega_s = 377 \text{ rad} / \text{sec} \\
\psi_d := 1.2 \\
\psi_d := 1.2 \\
i_d := 0 \\
i_q := 0 \\
E_{qp} := \psi_d - i_d \cdot X_{dp} \\
E_{qp} = 1.2
\]

Use the following equation for \( S_c \) when saturation is not neglected:

\[
S_c := 4 \cdot \frac{(E_{qp} - 9)^2}{E_{qp}} \\
S_c = 0.3
\]

II. Goals

1. Use Simulink/MatLab to graph \( \nu_q \), \( S_c \) & \( i_{fd} \) when saturation is neglected.

2. Use Simulink/MatLab to graph \( \nu_q \), \( S_c \) & \( i_{fd} \) when saturation is modeled using the equation above.

For each case put \( \nu_q \), \( S_c \) on one subplot and \( i_{fd} \) together on another subplot.

Zip and email to Andy by Session #17 (2/21/07 for on-campus students):

(3/7/07 for EO Students)

1. Your Simulink file (ABCHW07p1.mdl)

2. your MatLab file(s)
   - ABCHW07p1.m
   - ABCHW07p2.m
   - ABCHW03p2graph.m <- Can avoid by calling .mdl file from .m file

Replace "ABC" with your initials
\[
\frac{S_{c1.2}}{S_{c1.0}} = \frac{B(E_2-A)^2}{B(E_1-A)^2} \frac{E_1}{E_2}
\]

\[
\Rightarrow \frac{(E_2-A)}{(E_1-A)} = \sqrt{\frac{E_2 S_{c1.2}}{E_1 S_{c1.0}}}
\]

\[
E_2 - A = (E_1 - A) \sqrt{\frac{E_2 S_{c1.2}}{E_1 S_{c1.0}}}
\]

\[
(\sqrt{\lambda} - 1) A = E_1 \sqrt{\lambda} - E_2
\]

\[
A = \frac{E_1 \sqrt{\lambda} - E_2}{\sqrt{\lambda} - 1}
\]
Initial conditions

\[ \tilde{\omega} = \frac{1}{1 + \text{ST} \cdot d_0} \]
For this class
Model Network

\[ X_{\text{ther}} \]

\[ E_{\text{ther}} \] 100

\[ X \gg R \]

large Network
To open a line -
  Increase $X_{Thev}$

To fault
  Calculate New $X_{Thev}$ $\bar{E}_{Thev}$
To run simulation

1st solve network

2^{nd} get \text{ } x = \frac{u}{R_a}

Initial conditions

3^{rd} start simulation

Nothing should change

* Start disturbances @ 4 sec
Solve Network

For our class we'll often start with \( \frac{1}{|V_a|} = \frac{1}{2} P_2 \)
\[ P = \frac{1^2 \|E_{th}\| \sin(\alpha_{gen})}{X_{ther}} \]

\[ x_{th} \]

\[ \alpha_{gen} = \sin^{-1} \left( \frac{P}{\|E_{th}\|} \right) \]

\[ x \text{ if we want} \]

\[ S = V I^* \]
\[ i_a = \frac{V_a - E_{ther}}{jX_{ther}} \]

want \[ i_d + i_2 = i_a \]

\[ e_x = V_a + j\cdot\lambda_a X_q \]

\[ = |e_x| \angle \alpha \text{ rotor} \]
\[ i z s + j 1 d s = l e^{j \phi \text{ rotor}} \]

Scalers vs complex vectors
\[ v_{qs} + jv_{ds} = V_a e^{j\alpha_{rotor}} \]
Let \( n = \rho u \cdot s \)

\( n = \frac{u s}{n} \)

\( n = -\frac{v}{s} n \)

\( n = n \)
\[ e'_g = x_{ds} + \sum L_i \Delta s \]

\[ S_e = f(e'_g) \quad \text{Eq. } e'_g \]

\[ \text{ld. effective } = e'_g + (1 + S_e) 2 \]

\[ \text{ld. effective } = e'_g (1 + S_e) \]
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Initial conditions

\[ \dot{I}_{fd} = e_2' (1+\xi_c) + (L_d - L_d') i_d s \]

\[ V_{fd} = \dot{I}_{fd} \]