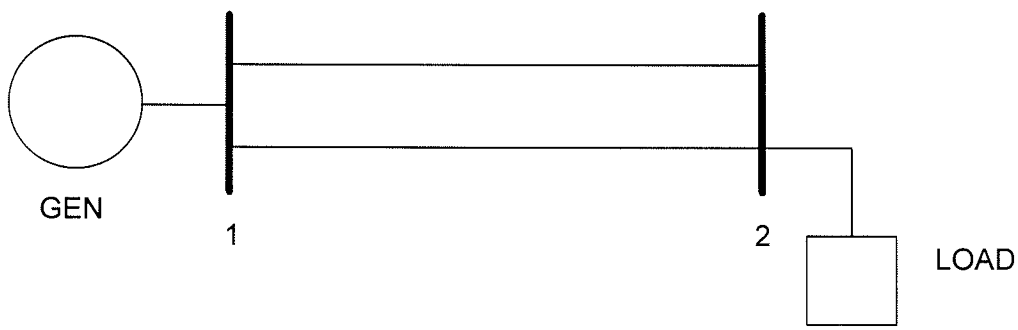
Power Systems Power Electronics Problem

Part a) Power Systems

Given the generator on bus 1 connected to a load bus, bus 2, through a pair of identical transmission lines as shown below:



The load at bus 2 draws 2.5 pu MW and 0 pu MVAR from bus 2

The equivalent impedance of the transmission system from bus 1 to bus 2 with both lines in is 0.1j per unit

The Bus 1 voltage is 1.0 per unit volts at zero degrees phase angle, and bus 1 is the reference bus.

With both transmission lines connected the voltage magnitude and phase angle at bus 2 are:

$V_2 = 0.966$ pu volts and $\theta_2 = -15.00$ degrees

The transmission system now suffers a forced outage of one of the transmission lines. The bus voltage at bus 1 remains at 1.0 pu, and the load at bus 2 stays at 2.5 + 0j

Solve for the voltage magnitude and phase angle at bus 2,(phase angle may be expressed in radians or degrees). You may use any method of solution that is appropriate.

Solution to Part a on Power Systems

The equivalent impedance with only one line is now 0.2j pu

$$P_2 + jQ_2 = V_2((V_2 - V_1)/0.2j)^*$$

Where $P_2 = -2.5$, $Q_2 = 0$, $V_1 = 1$

The net real power and reactive power is known for bus 2 Then:

$$-2.5 = \text{Re}(V_2((V_2 - V_1)/0.2j)^*)$$

$$0 = \text{Im}(V_2((V_2 - V_1)/0.2j)^*$$

This results in two simultaneous equations involving V_2 and θ_2

$$(-2.5 * 0.2)/V_2 = \sin\ \theta_2$$

and

$$0 = V_2 - \cos(\theta_2)$$

Resulting in the solution

$V_2 = \sqrt{0.5}$ and $\theta = -45$ degrees

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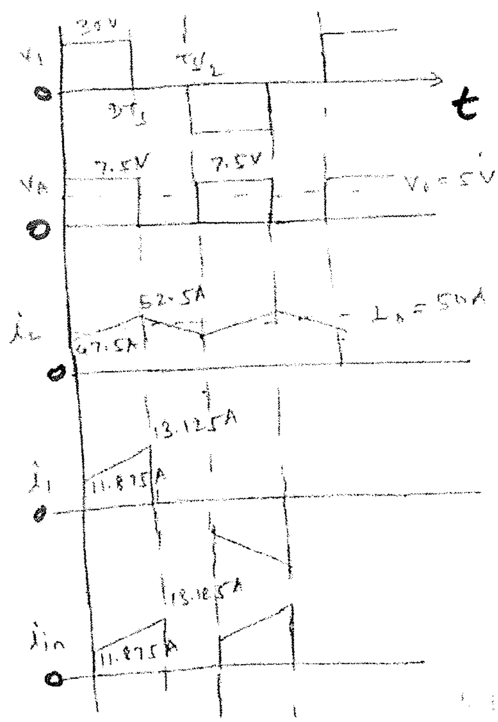
$V_{in} = 30\,V, \quad f_s = 300\,kHz \qquad N_1/N_2 = 4$

$P_o = 250\,W \quad V_o = 5\,V$

$I_o = \frac{P_o}{V_o} = \frac{250}{5} = 50\,A$

$\frac{V_o}{V_{in}} = 2\left(\frac{N_2}{N_1}\right)D \Rightarrow D = \frac{V_o}{V_{in}} \times \left(\frac{N_1}{N_2}\right) \times \frac{1}{2} = 0.33$



$V_A = \frac{N_2}{N_1} V_{in} = \frac{30}{4}$

$V_A = 7.5\,V$ and $0\,V$

$\Delta I_{Lpp} = \frac{(V_A - V_o)\,DT_s}{L}$

$= 0.1 \times I_o$

$\Delta I_{L} = 5\,A$

$\therefore L = \frac{(V_A - V_o)\,DT_s}{5}$

$= \frac{2.5 \times 0.33}{5 \times 300k}$

$L = 0.55\,\mu H$

$i_1 N_1 = i_L N_2$

$i_1 = \frac{i_L N_2}{N_1} = \frac{i_L}{4}$