Homework #4 – ECEN 667 Fall 2025

Due Thursday, October 30th, 2025, at 8 AM.

1. Using the Example 7_4 PowerWorld Case, determine the critical clearing time for a self-clearing fault at bus 9. Then determine the sensitivity of this clearing time to KA value for the exciter at the bus 3 generator and the bus 3 generator initial real power output (when varying the bus 3 generator MW output assume the change in generation is made up at the system slack).

   Answer: Original critical clearing time is 0.21 seconds. Changing KA does not have significant impact on critical clearing time. Increasing real power output significantly reduces critical clearing time. (Specific results may vary based on different values tried.)

2. A 60 Hz generator is supplying 400 MW (and 0 Mvar) to an infinite bus (with 1.0 per unit voltage) through two parallel transmission lines. Each transmission line has a per unit impedance (100 MVA base) of 0.1j. Assume the generator represented with a GENSAL model with the following parameter values (all per unit, 400 MVA base): H =5, D = 0, R_s=0, X_d=2.1, X_q=1.5, X'_d =0.3, X''_d=X''_q=0.18, X_ℓ=0.12, T'_{do}=7, T''_{do} =0.035, T''_{qo}=0.05; you may ignore saturation. The GENSAL block diagram is given in the slides. At time t= 0 one of the transmission lines experiences a balanced three phase short to ground half way down the line from the generator to the infinite bus (i.e., model the line with 1/2 its original impedance on both sides of the fault. The fault is cleared at t=0.02 seconds by opening the faulted line. Using Euler's method with a time step of 0.01 seconds determine the generator's internal angle and per unit speed over the first 0.04 seconds.

   Answer:

Time	delta	omega	Eqp	Psidp	Psiqpp
0	1.0390723	0.0000000	0.9379872	0.7828391	-0.6692666
0.01	1.0390723	0.0005957	0.9369054	0.7825145	-0.2135957
0.02	1.0413182	0.0009462	0.9727312	0.7821890	-0.2328787
0.03	1.0448854	0.0008906	0.9832749	0.7823098	-0.4730487
0.04	1.0482428	0.0010336	0.9939236	0.7824426	-0.5565921

3. In the HW4_2025_Prob3 case the generator 2 exciter Ka value has been modified to give an unstable response. Using the SMIB tool, plot the eigenvalues with positive real parts as the value of Ka is decreased. Give several points in your plot. At what value does SMIB indicate the system becomes stable? Be sure to Re-Initialize the case between each SMIB solution with different parameters. How well does the time-domain simulation confirm this result?

   Answer: (Exact plot may vary) when Ka is reduced to 125, the SMIB indicates that the system becomes stable. The time-domain simulation does confirm this result, since the response appears to stabilize when Ka goes below 125.