ECE 431 Homework #6 (Due – Wednesday, April 1, 2020)

Problem 6.1

A two pole synchronous generator with synchronous reactance of 0.5 pu is connected to an infinite bus at rated voltage. The generator delivers rated VA at 0.95 power factor lagging.

a) Find the per unit internal voltage and the load angle.
b) A circuit breaker opens to isolate the generator from the infinite bus. Find the critical clearing angle.
c) Suggest two changes to the machine that can help increase the critical clearing *time*.

Problem 6.2

A synchronous motor is connected to the grid at rated voltage, driving a load of 0.9 p.u. A fault occurs and causes the load to suddenly decrease. The terminal voltage and excitation remained constant throughout the fault. How much can the load decrease before the motor starts operating as a generator? Using the 'equal area criterion', sketch the power versus load angle curves associated with this scenario and mark out the areas and angles that need to be evaluated.

Problem 6.3

The following differential equation characterizes the electromechanical dynamics of a synchronous motor connected to a load. Assume the motor has no damping torque. $\boldsymbol{T}_m$ is initially 0.6.

$$d^2\delta/dt^2 = -2\sin(\delta) - \boldsymbol{T}_m$$

a) Express this in the standard state-space form
b) Compute the equilibrium points and identify the steady state load angle, δ, and rotor angular velocity, ω.
c) At time t=0, $\boldsymbol{T}_m$ is changed to 1.0. Choose a time step of 1 ms, and compute δ and ω at 5 ms using the forward Euler method.