ECE 431 Homework #5 (Due – Wednesday, March 11, 2019)

Problem 5.1

A Y-connected, three phase, 60 Hz synchronous generator produces an open circuit terminal voltage of 11.5kV (line-line rms) when the field current is 750 A. Calculate:

a) Stator-to-rotor mutual inductance, L_{af}.
b) Open circuit voltage (line-line rms) for a field current of 700 A and a reduced generator speed to produce a voltage at a frequency of 50 Hz.
c) An estimated field current needed to maintain the same terminal voltage at 60 Hz under open-circuit conditions if the air-gap is increased by 50%.

Problem 5.2

A balanced, symmetrical, round-rotor, 3-phase, 60 Hz, 2-pole, 100MVA, 11.5kV, synchronous generator is being driven at synchronous speed. During tests, an AFNL (field current required to produced rated terminal voltage under open circuit) of 170A and an AFSC (field current required to produced rated armature current under short circuit) of 120A were obtained. Use a linear model and neglect the armature resistance for the following calculations.

a) What field current is needed to maintain rated terminal voltage when the generator is supplying 100MW power at unity power factor?
b) What power factor would be obtained if the field current were maintained at the AFNL value when the generator supplies 100MW at rated voltage?
c) What field current would be required to obtain a lagging power factor of 0.85 while maintaining the same power and terminal voltage?

Problem 5.3

A 208 Volt (line-line rms) Y-connected, 4-pole, 60Hz synchronous motor is drawing 50 Amps at unity power factor from a 208 Volt (line-line rms) power system. The field current flowing under these conditions is 7 Amps. Its synchronous reactance is 1.5 Ω. Assume a linear open-circuit characteristic.

a) Find the torque angle for this condition.
b) How much field current would be required to make the motor operate at a leading pf of 0.8 while consuming the same amount of real power?
c) What is the new torque angle in part (b)?