PROBLEM SET #35

35.1 A 60Hz, Y-connected generator is rated for an RMS line voltage of 450V. Assume that the field regulator achieves the rated line voltage at the generator terminals. The machine delivers 50Arms to a balanced 3-phase load with a $+30^\circ$ impedance angle. If the stator resistance is $r_S = 0.2\Omega$ and the synchronous reactance $X_S = 3\Omega$, calculate the following:

a. The RMS magnitude of the excitation (generated) voltage, $\tilde{E}_a$ (note for a Y-connection, this is a line-to-neutral voltage)
b. The torque angle δ
c. The number of poles if the prime mover turns at 900rpm
d. The three-phase real power delivered to the load

35.2 A 50Hz, Y-connected, 4-pole generator is rated for an RMS line voltage of 240V. The field regulator maintains the terminal voltage at its rated value. The generator is supplying a balanced 3-phase, Y-connected load at a torque angle of $\delta = 12^\circ$. The magnitude of the excitation (generated) voltage is $\left|\tilde{E}_a\right| = 185V$. The synchronous reactance is $X_S = 2\Omega$ and the stator resistance is negligible. Calculate the following:

a. The per-phase voltage across the load
b. The RMS magnitude of the line current
c. The power factor of the load
d. The speed of the prime mover
e. The torque produced by the generator

35.3 A 60Hz, Y-connected, 4-pole generator is rated for an RMS line voltage of 240V. The field regulator adjusts I_F to maintain the terminal voltage at its rated value. The generator delivers 40Arms to a balanced Y-connected load that operates at a 0.9 (lagging) power factor. The synchronous reactance is $X_S = 1.7\Omega$ and the stator resistance is negligible. If the load increases and draws 50Arms with no change in power factor,

a. By what factor must the field current change to keep the output voltage constant (Hint: recall that the magnitude of the excitation voltage is proportional to the field current)
b. What are the torque angles (δ) before and after