EE 303, Quiz 5, Spring 2017, Dr. McCalley; Name:_____
Time: 20 minutes, closed book, closed notes

1. (34 pts) A generator is connected to a transmission line through a transformer having a rated turns ratio (ratio of line-to-line voltages) of 20kV (generator side) to 100kV (transmission line side). The generator has a per unit reactance of 0.08 pu on a 19 kV, 50 MVA base. Select the base voltage on the transmission line side to be 110 kV.
   a. Compute the base voltage on the generator side.
   Solution:

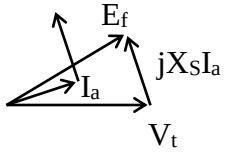
$$V_{basegen} = 110kV \cdot \left[\frac{20kV}{100kV}\right] = 22kV$$

   b. Compute the pu reactance of the generator using a 100MVA system power base.
   Solution:

$$X_{pu2} = X_{pu1} \cdot \left[\frac{V_{base1}}{V_{base2}}\right]^2 \cdot \left[\frac{S_{base2}}{S_{base1}}\right] = 0.08 \cdot \left[\frac{19kV}{22kV}\right]^2 \cdot \left[\frac{100MVA}{50MVA}\right] = 0.11934$$

2. (32pts) A large capacitor is connected in parallel with a resistive load, and both of them are directly connected to a synchronous generator. Draw the phasor diagram corresponding to the operation of the synchronous generator. Show phasors corresponding to $\bar{V}_t$, $\bar{E}_f$, $\bar{I}_a$, $jX_S\bar{I}_a$. Also show the power angle δ. Assume the phasor $\bar{V}_t$ is the reference.
   Solution:

   The angle δ is between $\bar{E}_f$ and $\bar{V}_t$.



3. (34 pts) A three-phase, 60 Hz synchronous generator has a synchronous reactance of 0.95 per-unit and negligible resistance. The terminal voltage of the generator is $\bar{V}_t = 1.0\angle 0°$, and the internal voltage of the generator is $\bar{E}_f = 1.514\angle 30.45°$. The magnitudes of both voltages given are in per-unit on bases consistent with the given synchronous reactance. The three-phase power base is 100MVA. Compute the real power out of the machine in (a) per-unit (24 pts) and (b) three-phase MW (10 pts).
   Solution:
   (a) The per-unit power is given by:

$$P = \frac{|V_t||E_g|}{X_g}\sin(\delta) = \frac{|1.0||1.5136|}{0.95}\sin(30.45) = 0.8076$$

   (b) The 3-phase power is given by 100*0.8076=80.76MW.