Name (5 pts):____

EE 303, Quiz 6, Spring 2019, Dr. McCalley
20 minutes, closed book, closed notes, no calculator allowed

1. A synchronous generator having synchronous reactance of X_S=2 ohms is operating with an 18.0kV line-to-line terminal voltage. The power out of the machine terminals is P_{out}=140 MW, Q_{out}=0.

a. (40pts) Show how to compute magnitude $|E_f|$ and angle $\angle\delta$ of the internal voltage.

i. Using power expressions $3|E_f||V_t|\sin\delta/X_S$ and $3|E_f||V_t|\cos\delta/X_S-3|V_t|^2/X_S$

Solution:

$$V_t = \frac{18\times10^3}{\sqrt{3}} = 10,392 volts,$$

$$P_{out} = \frac{3V_t\,|E_f|\sin\delta}{X_s} \Rightarrow \qquad |E_f|\sin\delta = \frac{P_{out}X_s}{3V_t} = \frac{(140\times10^6)(2)}{3(10392)} = 8961.2$$

$$Q_{out} = 0 = \frac{3V_t\,|E_f|\cos\delta}{X_s} - \frac{3V_t^2}{X_s} \Rightarrow |E_f|\cos\delta = V_t = 10,392$$

$$\frac{|E_f|\sin\delta}{|E_f|\cos\delta} = \tan\delta = \frac{8961.2}{10392} = 0.8642 \Rightarrow \delta = 40.84^\circ$$

ii. Using power expression $3|V_t||I_a|\cos\theta$

$$P_{out} = 3V_t I_a \cos\theta \Rightarrow 140E6 = 3(10.392)I_a(1) \Rightarrow I_a = 4490.6$$

Because we know operation is at unity power factor➔ $\bar{I}_a = 4490.6\angle0°$

$$\bar{E}_f = \bar{V}_t + jX_s\bar{I}_a = 10392\angle0° + j2(4490.6\angle0°)$$

$$= 10392 + j8981.2 = 13735\angle40.83° \Rightarrow \delta = 40.83^\circ$$

b. (15 pts) A large shunt capacitor is suddenly connected in parallel with the load R_L, and the field current is adjusted. Indicate what would happen to each of the below by checking the appropriate space:

Field current:	increase______	decrease__√___	
Reactive power out of the generator:	increase______	decrease___√__	no change____
Current:	lead____√____	lag_________	neither______

2. A transmission line has impedance of Z=R+jX=2+j5.

a. (10 pts) Show how to compute the admittance Y=G-jB.

Solution:

Y=1/Z=1/(2+j5)=0.69-j0.1724

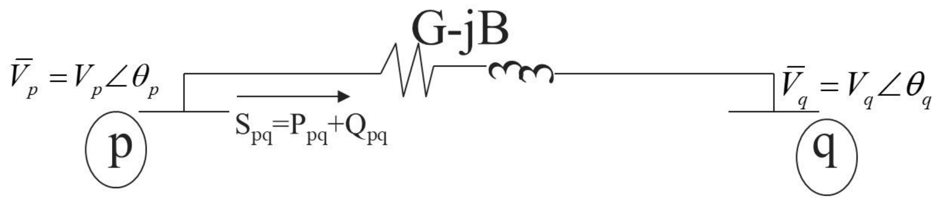
G=0.69; B=0.1724

b. (10 pts) Is G=1/R=1/2=0.5?

Solution:

No. G=Re{Y}=0.69.

3. (20 pts) Consider the following model of a transmission line containing only the series elements (i.e., shunt capacitance is neglected). Observe that V_p and V_q indicate the magnitude of the corresponding voltage phasor.



We showed that P_{pq} and Q_{pq} may be approximated by

$$P_{pq} = V_p V_q B(\theta_p - \theta_q); \qquad Q_{pq} = V_p B(V_p - V_q)$$

The following table gives voltage magnitudes and voltage angles for three separate operating conditions (Cases 1, 2, and 3) of the above transmission line.

1. Relative to Case 1, which case, 2 or 3, has the largest change in P_{pq}?____3_____

2. Relative to Case 1, which case, 2 or 3, has the largest change in Q_{pq}?____2_____

	V_p	θ_p (deg)	V_q	θ_q (deg)
Case 1	1.03	30	1.03	10
Case 2	1.06	30	1.03	10
Case 3	1.03	50	1.03	10