EE 303, Quiz 6, Spring 2017, Dr. McCalley; Name:_____
Time: 20 minutes, closed book, closed notes

1. (32 pts) A transmission line having R=0.005 pu and X=0.05 pu (charging capacitance is negligible) is operating so that the voltage magnitudes and angles at its terminals are given by the data below:

Voltage Magnitude for p-bus (pu)	**Voltage Angle for p-bus (deg)**	**Voltage Magnitude for q-bus (pu)**	**Voltage Angle for q-bus (deg)**
1.15	10	0.95	0

All per unit values are given on a 100 MVA base. A relation that may be helpful to you is this:

$$P_{pq} = V_p^2 G - V_p V_q G \cos\left(\varphi_p - \varphi_q\right) + V_p V_q B \sin\left(\varphi_p - \varphi_q\right)$$

Compute:

(a) (22 pts) the real power flowing into and out of the line, in MW;

Solution:

$$P_{pq} = V_p^2 G - V_p V_q G \cos\left(\varphi_p - \varphi_q\right) + V_p V_q B \sin\left(\varphi_p - \varphi_q\right)$$

$$= 1.15^2(1.98) - (1.15)(0.95)(1.98)\cos(10^\circ) + (1.15)(0.95)(19.80)\sin(10^\circ) = 4.2445$$

So real power into line = 100(4.245) = **424.5 MW**

$$P'_{pq} = -P_{qp} = -\left[V_q^2 G - V_q V_p G \cos\left(\varphi_q - \varphi_p\right) + V_q V_p B \sin\left(\varphi_q - \varphi_p\right)\right]$$

$$= -[.95^2(1.98) - (0.95)(1.15)(1.98)\cos(-10^\circ) + (1.15)(0.95)(19.8)\sin(-10^\circ)] = 4.0996$$

So real power out of the line = 100(4.0996) =**409.96 MW**

(b) (10 pts) the real power absorbed by the transmission line impedance.

Solution:

$P_{loss} = P_{pq} - P'_{pq} = 424.5 - 409.96 =$ **14.49 MW**

2. (36 pts) Short answers on transmission lines:

(a) If a transmission line is bundled so that it requires a total of 12 conductors, how many conductors per phase are being used?

Solution: 4

(b) Which is larger for a transmission circuit: capacitance between the phases or capacitance between phases and ground?

Solution: Capacitance between the phases.

(c) What is the range for the ratio X_L/R for a typical conductor?

Solution: About 10. I would accept any number or range between 2 and 20.

(d) If a transmission line has impedance of $Z = R + jX = 2 + j5$, is it true that G=Re*{Y}=1/R=0.5?*

Solution: No, it is not true.

G=Re{Y}=Re{1/Z}=Re{1/(2+j5)}=Re{0.69-j0.1724]=0.69

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3. (32 pts) True/false on the power flow problem.

_____a. In the power flow problem, the engineer inputs the flows on all of the circuits, and MW and MVAR generation and load values are computed for all buses in the network.

_____b. A generator capability curve, which specifies a boundary for operating a synchronous generator in terms of MW and MVAR output, is approximated within a power flow program as a rectangular region specified by Q_{max}, Q_{min}, and P_{max} for each generator.

_____c. A bus "k" with load but no generator would satisfy: $P_{inj,k} \leq 0$.

_____d. All buses with loads only are type "PV."

Solutions:

a. F
b. T
c. T
d. F