Name: ___________________________

ECE 530

Exam #1
Thursday, October 24, 2013
75 Minutes

Closed book, closed notes
One 8.5 by 11 inch note sheet allowed
Simple calculators allowed

1. _________ / 26

2. _________ / 20

3. _________ / 24

4. _________ / 30

Total _________ / 100

1. (26 points total)

A generator bus (with a 1.0 per unit voltage) supplies a load through a transmission line with per unit (100 MVA base) impedance of 0.05 + j0.1 and no line charging. Rather than assuming a constant power load, assume that the load varies linearly with the load bus voltage. At 1.0 per unit voltage the load is 150 MW, 50 Mvar. Starting with an initial voltage guess of **$1.0\angle 0°$**, do two complete iterations using the Newton-Raphson power flow method, giving the load bus voltage (magnitude and angle) and the mismatches at the end of the second iteration.

2. (20 points total) (True/false)

Two points each. Circle T if statement is true, F if statement is False.

T F 1. When using the Newton-Raphson approach to solve a set of nonlinear equations, the Jacobian is always invertible

T F 2. Adding a load-tap-changing (LTC) transformer with a off-nominal turns ratio breaks the symmetry of the Y-matrix

T F 3. For a dense matrix (all values non-zero), storing the matrix as a linked list requires less space than storing it as an array in memory.

T F 4. The Fast Decoupled Power Flow (FDPF) can be solved analytically (i.e. does not need to be solved iteratively using Newton Raphson)

T F 5. The Y-matrix for a large power system, such as the North America Eastern Interconnection, is usually singular

T F 6. For per-unit analysis, the impedance base is always the same everywhere in the system.

T F 7. Trying to have a PV generator regulate a bus that is not its terminal will result in a singular Jacobian.

T F 8. The maximum reactive power output limit of a generator tends to increase with increasing real power output.

T F 9. Phase shifting transformers are often used in a power system to control the amount of reactive power flowing through the transformer.

T F 10. When solving a large case with the power flow with no areas on AGC, any increase in the assumed real power output of one generator tends to get absorbed by nearby generators.

3. (Short Answer: 24 points total – four points each)
(note problem continues on next page)

Your answers to not need to be more than 4 or 5 sentences at max, and for some problems less is required.

1. Give two reasons why the slack (reference) bus is needed for the power flow problem.

2. Assume a 3ϕ 230/138 kV transformer has a per unit reactance of 0.1 using a 300 MVA base. What is the transformer's per unit reactance on a 100 MVA base?

3. As shown in class MISO posts a contour of its LMPs. Explain what is meant by the term LMP. Also, please tell whether these values could ever be negative.

3. Continued

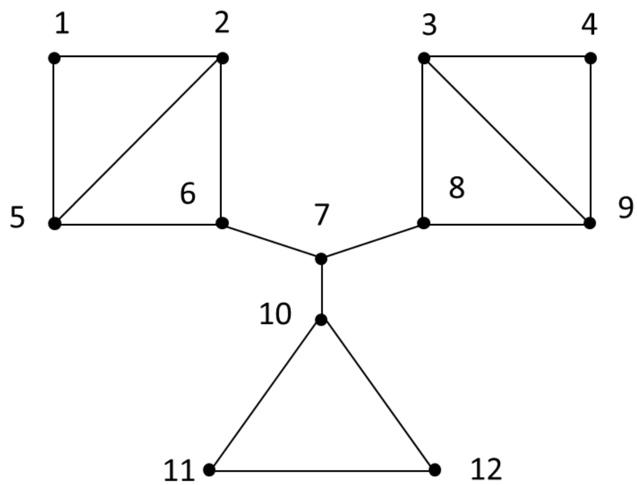
4. In the power flow the load is usually represented by a constant power model. Yet much of the load appears to be constant impedance, such as electric heaters and incandescent lighting. Why is a constant power model used?

5. In power flow analysis the term “island” is commonly used. What is meant by an electrical island? How are islands determined? What is required for an island to be viable?

6. What are three of the key assumptions in developing the fast decoupled power flow? Explain why these assumptions are often reasonable for a high voltage power grid.

4. (30 points total – ten points each) (note problem continues on next page)

1. The below network is initially numbered as shown. Use the Tinney Scheme 2 algorithm to determine a new ordering to reduce fills. Break tie numerically; that is, ordering the lower bus number first. Give the total number of fills added (i.e., twice the number of new lines).



2. Using the dc power flow approach, the inverse of the **B** matrix for a five bus power system is given below, with bus 1 the slack bus. All data is per unit on a 100 MVA base. Assume the only non-slack bus power injections are 800 MW of load at Bus 2 and 520 MW of generation at Bus 3. If the per unit reactance of the line joining Buses 4 and 5 is 0.025, what is the magnitude of the MW flow on this line? There is extra space on the next page if needed

	1	**2**	**3**	**4**	**5**
1	1.0	0	0	0	0
2	0	-0.056	-0.027	-0.027	-0.02
3	0	-0.027	-0.051	-0.041	-0.02
4	0	-0.027	-0.041	-0.041	-0.02
5	0	-0.02	-0.02	-0.02	-0.02

4. continued

(extra space for 2)

3. The sparsity structure for an ordered sparse matrix is given in the below table. As discussed in Tinney's 1985 Sparse Vector Methods paper, draw the Path Graph.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	X						X	
2		X	X					
3		X	X	X		X		X
4			X	X		X		
5					X	X		
6			X	X	X	X		X
7	X						X	X
8			X			X	X	X