ECE571 CONTROL OF POWER SYSTEMS

Test # 1, Winter 2001-2002

Name_____

Box #_____

Attempt all four questions.
No partial credit unless you explain your solution procedure.
Write in the space below the question, and on the page facing the question.

Open Book Open Notes. Time Allowed – 2 Periods

Question #	Possible Points	Awarded Points
1	25	
2	25	
3	30	
4	20	
Total	100	

1.

Four generating units are required to supply a total demand of 1550 MW. The data for each unit is:

Unit 1: P_{min} = 25 MW P_{max} = 150 MW $F_1 = 0.030P_1^2 + 3.0P_1 + 300$

Unit 2: P_{min} = 325 MW P_{max} = 700 MW $F_2 = 0.015P_2^2 + 4.8P_2 + 400$

Unit 3: P_{min} = 100 MW P_{max} = 900 MW $F_3 = 0.010P_3^2 + 8.33P_3 + 500$

Unit 4: P_{min} = 300 MW P_{max} = 850 MW $F_4 = 0.0076P_4^2 + 5.7P_4 + 950$

The transmission losses are given by:

$$P_L = 0.2P_1 + 0.25P_2 + 0.1667P_3 + 0.05P_4$$

a) Load the generators according to an economic dispatch, allowing for transmission losses.
b) Determine the average energy cost.
c) How much power can the utility sell to (purchase from) the interconnection if it is required to withstand the loss of its largest unit?

P_3 = 330 MW, P_4 = 745 MW, AEC = 16.06 $/MWh

2.

A power system has five generating units with the following data:

Unit #	Min(MW)	Max(MW)	Cost Function
1	400	1000	$500 + 3P_1 + 0.003P_1^2$
2	100	500	$600 + 4P_2 + 0.006P_2^2$
3	300	900	$200 + 2P_3 + 0.002P_3^2$
4	150	800	$400 + 6P_4 + 0.001P_4^2$
5	50	400	$100 + 5P_5 + 0.005P_5^2$

a) Construct a priority list for these generators and use the list to develop a commitment scheme for a load that varies from 1000 MW to 3500 MW.

b) Based on the priority list, determine an economic dispatch for a system load of 1300 MW.

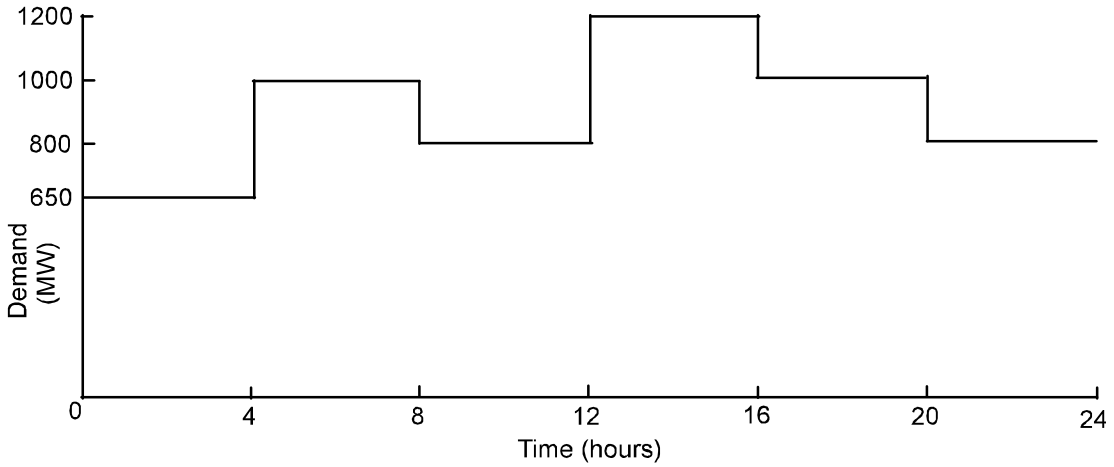
$P_1 = 420$ MW, $P_3 = 880$ MW

3.

a) Given the data in the following tables, find the optimum unit commitment schedules covering the 24 hour period with the load profile shown. The starting conditions are: units 1 & 2 are up, units 3 & 4 have been down for three (3) hours.

Unit #	Max MW	Min MW	Start-up Cost ($)	Minimum uptime	Minimum downtime
1	550	150	4000	2	3
2	300	125	3000	2	2
3	250	100	2000	2	2
4	200	75	1000	2	1

Combination	Unit 1	Unit 2	Unit 3	Unit 4	Operating Costs ($/hr) Load 650	Load 800	Load 1000	Load 1200
A	1	1	0	0	7150	8000	X	X
B	1	1	1	0	7800	8800	10000	X
C	1	1	1	1	8450	9600	11000	12000



b) Determine the average energy cost for the day.

Optimum schedule cost = 225.6 k$/day, AEC = 10.35 $/MWh

4.

a) Two 800 MW generating units, each with 5% droop, are supplying 1000 MW of load. The economic dispatch requires 600 MW from unit 1 and 400 MW from unit 2, when the frequency is 60 Hz. Determine the output of each unit when the frequency is:

   i) 59.94 Hz.

   ii) 60.09 Hz.

ii) $P_1 = 576$ MW, $P_2 = 376$ MW

4.

b) A utility with a peak demand of 12 GW is exporting 144 MW to its only interconnected neighbor. The tie-line trips suddenly and the frequency increases from 60 Hz to 60.4 Hz. Determine the load damping co-efficient (D) in MW/Hz and pu based on peak load and 60 Hz.

D = 1.8 pu