

# ECE571 CONTROL OF POWER SYSTEMS

Test # 2, Winter 2001-2002

Name \_\_\_\_\_

Box # \_\_\_\_\_

Attempt both 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 hours.

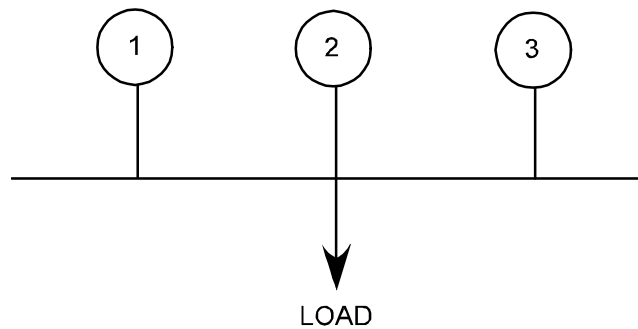
Question #	Possible Points	Awarded Points
1	30	
2	35	
3	35	
Total	100	

1. In the three generator system shown below, the generators are configured as:

Unit #	Rating (MVA)	Initial Load (MW)	Speed Droop (R) (% on unit base)
1	250	200	5
2	500	400	8
3	750	600	6

The load damping,  $D = 2.1$  pu on the initial load base. A 100 MW load increase occurs when the frequency is exactly 60 Hz. Work on a base of 500 MW and determine:

- The steady-state frequency following the load increase but prior to any secondary ALFC.
- The output of each generating unit for the conditions in part (a).



- 59.77 Hz
- $P_3 = 647.7$  MW

2. A control area which has a peak demand of 20 GW is part of an interconnection with a peak demand of 95 GW. The control area may be modeled as a single unit of 20 GW and the rest of the interconnection may be modeled as a single 75 GW unit.

A neighboring utility (part of the interconnection) loses the output of an entire generating station, amounting to 2 GW at the time of peak demand while it is importing 2 GW from a utility in the control area.

The control area has a load damping factor of 1.6 pu and overall regulation of 25%, while the interconnection has a load damping factor of 1.5 pu and overall regulation of 20%, all quantities are based on individual peak demand.

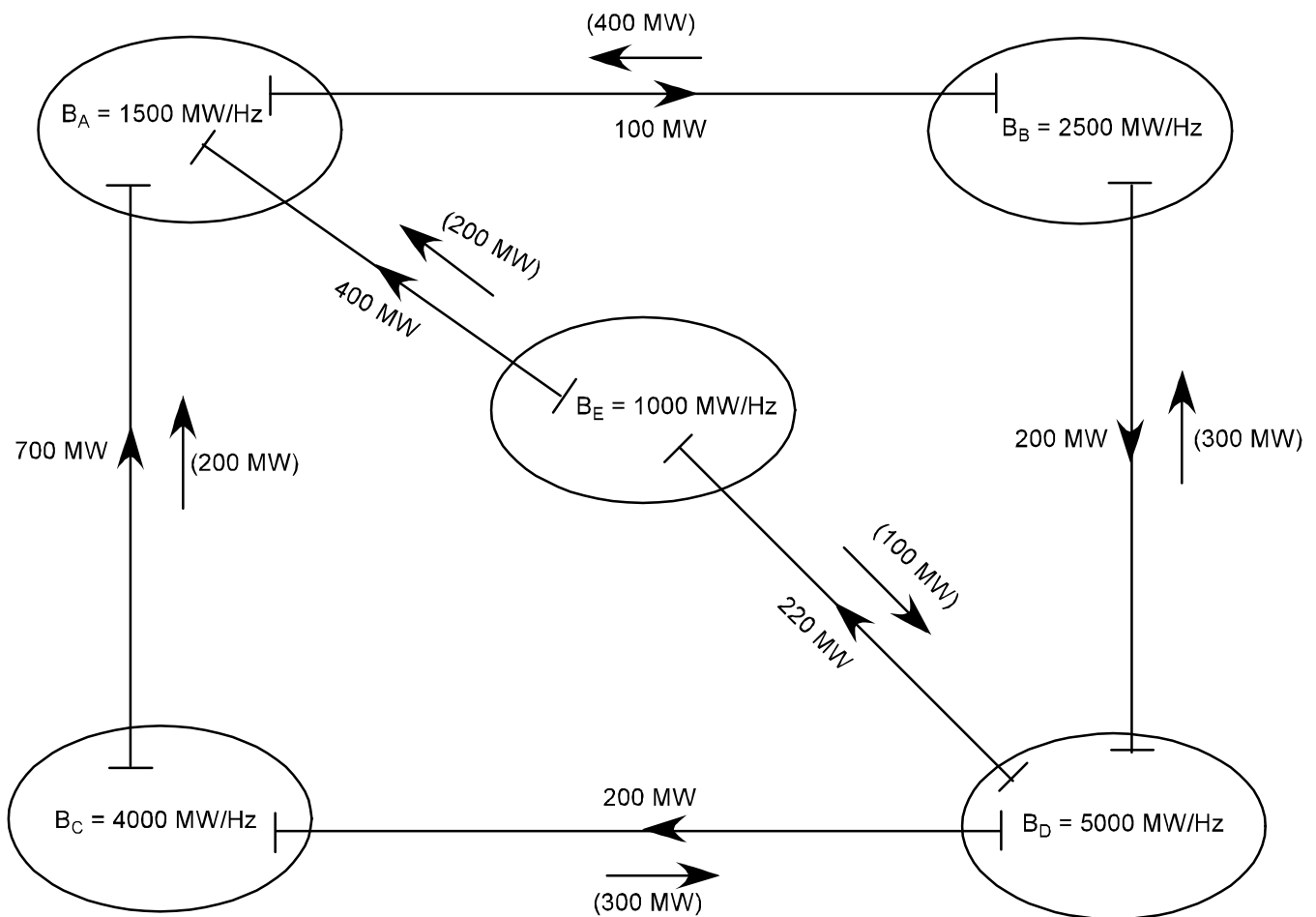
Work on a base of 100 GVA and determine:

- a) Steady-state frequency before any secondary ALFC.
- b) Steady-state tie-line flow before any secondary ALFC.
- c) Frequency Bias Factor (MW/Hz) of the control area.
- d) Frequency Bias Factor (MW/Hz) of the rest of the interconnection.
- e) Frequency Bias Factor (MW/Hz) of the overall interconnection.
- f) Percentage of generating capacity under governor control in the control area if its individual governors are set at 5% droop.
- g) How long it will take for the time error to accumulate to 2 sec. if it was zero at the start of the event? (Ignore the transient component.)

- a) 59.8 Hz
- b) 2374 MW
- f) 20%
- g) 10 min

3. Five utilities are interconnected as shown below. Actual exchanges are indicated, with scheduled exchanges in parentheses. The frequency has been measured at 60.12 Hz.

- Work on a system base of 5 GVA and standard frequency of 60 Hz to calculate the Area Control Error (ACE) for each of the utilities.
- State what control action is necessary at each utility to bring the frequency back to 60 Hz and put each interchange back on schedule.
- What is the Frequency Bias Factor of the overall interconnection?
- If a 20 mHz frequency off-set is required to correct the accumulated time error, what would be the new control action. (i.e., re-work part (a) with a standard frequency of 59.98 Hz.)
- How long will the off-set in part (d) be required if the accumulated time error was 2 sec when the off-set was enacted?



- a) & b) P<sub>A</sub> 20 MW raise P<sub>B</sub> 300 MW lower      d) P<sub>A</sub> 10 MW lower P<sub>B</sub> 350 MW lower  
 e) 100 min.