ECE473 CONTROL OF POWER SYSTEMS

Lab # 5 – Primary Automatic Load-frequency Control

Refer to the conditions in this week's homework problem 3. The utility in question may be represented by a single unit without re-heat and the following characteristics:

- Governor time constant = 0.2 sec.
- Steam chest time constant = 0.2 sec.
- Angular Momentum, M = 5 pu.

The interconnection may be represented by a single unit without re-heat and the following characteristics:

- Governor time constant = 0.3 sec.
- Steam chest time constant 0.4 sec.
- Angular Momentum, M = 7 pu.
- Tie-line synchronizing power co-efficient, T = 0.1 pu, 0.5 pu, 2 pu and 5 pu.

The values of regulation and load damping are given in the homework problem. All pu quantities are on local base and should be converted to 100 GVA base.

For each of the values of T, model the block transfer function diagram of the interconnected system in Simulink and determine $\Delta f(t)$ and $\Delta P_{12}(t)$ for the loss of the 3 GW station. Using plots of f(t) and $P_{12}(t)$, determine:

i) the maximum, minimum and steady-state values of f(t) and $P_{12}(t)$,

ii) the approximate value of damping co-efficient, ζ, by assuming that the response is second-order dominated ($\zeta = \alpha/\omega_o$),

iii) the frequency of the tie-line oscillations,

iv) how long it will take for the time error to reach 1 sec. if secondary ALFC is ignored, and

v) amount of load shed (if any) by underfrequency load-shedding relays.

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Automatic Load-frequency Control - Homework # 5 Q3

A utility that has a peak demand of 16.5 GW is part of an interconnection with a peak demand of 75 GW. The utility may be modeled as a single unit of 15 GW and the rest of the interconnection may be modeled as a single 60 GW unit.

The utility loses the output of an entire generating station, amounting to 3 GW at the time of peak demand while it is importing 1.5 GW from the interconnection.

All parts of the interconnection have load damping factors of 1.35 pu and overall regulation of 18 %, 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 utility.
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 utility if its individual governors are set at 5% droop.
g) How long it will take for the time error to accumulate to 1 sec. if it was zero at the start of the event? (Ignore the transient component.)