Laboratory Experiment 11

AGC using *Simulink* and Economic Dispatch using *PowerWorld*

Objectives: Study the dynamic interaction between two control areas using *Simulink* modeling and economic dispatch using *PowerWorld*.

Laboratory Tasks and Report:

1. Study the dynamic interaction between two control areas using Simulink modeling. The MATLAB file for this is **AGC_Data.m**, which is located in this Folder. First launch MATLAB and open this file through it, and then execute it. Then double click on the *Simulink* file **AGC.mdl** located in this folder. Look at the various waveforms and comment on them. Adapted from Reference 6 in Chapter 12. See video clip# 15.

2. To run the simulation, first go to the Matlab workspace and enter AGC_Data which runs this simple bit of code to enter all the parameters into the workspace. Then run AGC and click on the arrow to run it.

    a. First run the simulation and capture a copy of each "scope" in the simulink window by double clicking on the scope and then clicking on the "binoculars" icon.

    b. Next you are to run the simulation with the ACE1 and ACE2 connections broken. This means that only the governors are controlling frequency. Again capture all the scope plots and compare them to those found in part a above.

    c. In parts a and b the generators are identical. You are now going to change the rotating mass of the lower generator. Left click on the box having 1/M1s+D1 for the lower generator and change the M1 parameter to M2, (Use TransferFcn Parameters) which is 10 times the size. Now rerun the simulation and get the scope plots. Explain the differences.

3. In PowerWorld, assume that the generation at Bus 2 is by two generators with different marginal costs, as shown in **Load_Sharing.pwb**. Justify the load sharing between the generators.

    In this system the generator on the left at bus 2 has a different cost curve from that on the right on bus 2. You can find the cost functions by first clicking on one of the generators, then left clicking and selecting "Generator Information Dialog", and then clicking on "Costs" tab, and then the "Output Cost Model" tab. These generator use a cubic cost model. That is:

    $$Cost(P_i) = A_i + B_i P_i + C_i P_i^2 + D_i P_i^3$$

    However, the value of the D parameter is zero, so they are actually quadratic functions.

The generation is allocated so that the "Incremental Cost" of each generator is equal.

That is: $\dfrac{dCost_1(P_1)}{dP_1} = \dfrac{dCost_2(P_2)}{dP_2}$ or $B_1 + 2C_1P_1 = B_2 + 2C_2P_2$

You are to obtain the values for B and C for each generator on bus 2, note that the generation starts out at 100 MW and 300 MW but this changes.

First open the breaker on the generator at bus 1 so that the generators at bus 2 are the only ones supplying the load. Now start up the PowerWorld simulation and note how it allocates the generation to each generator on bus 2.

Now, while it is running, click on the 500 MW load and change it to 600 MW and again record the generation allocation on bus 2.

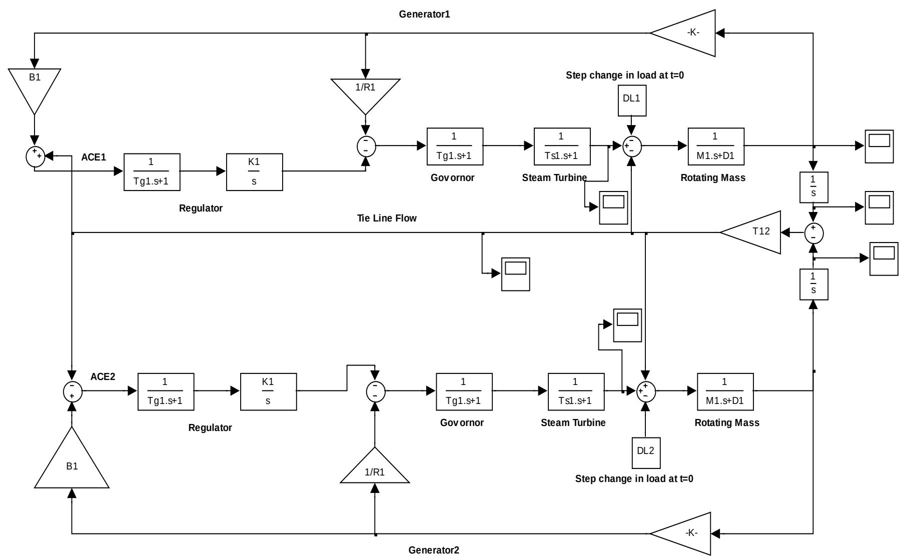
Equal incremental cost means that two equations are solved:

$B_1 + 2C_1P_1 = B_2 + 2C_2P_2$ and $P_1 + P_2 = P_{total}$ where P_{total} is the total generation being supplied by the two generators. Solve these two equations for each case you ran and indicate whether PowerWorld is loading them according to incremental loading.

AGC_Data.m

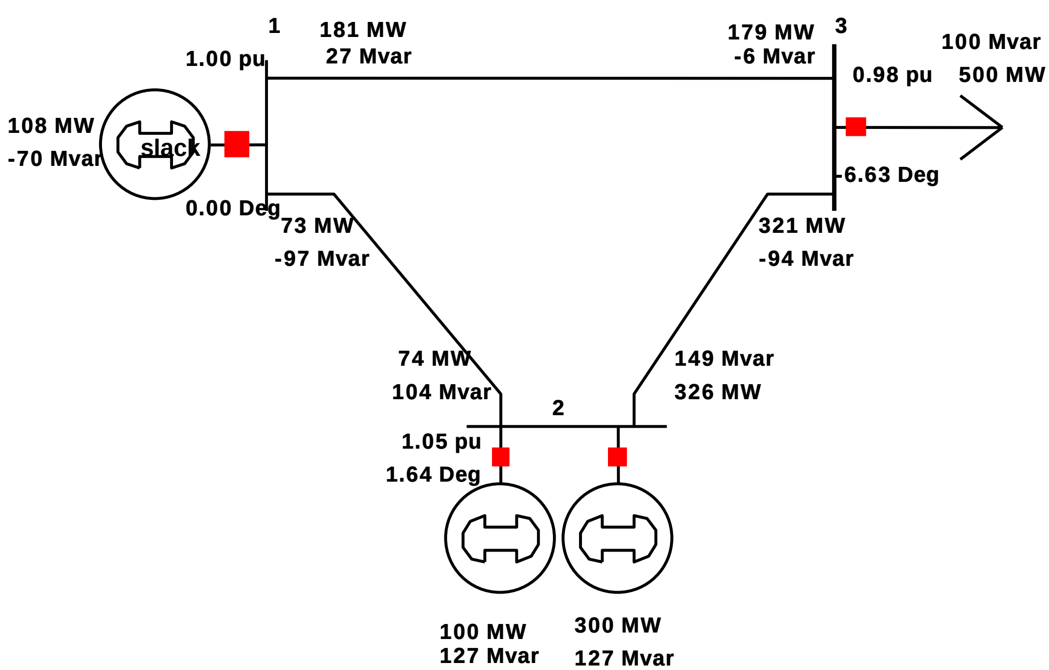
```
% Data for Example 12-3
H1=5.3; % H=5.3 seconds
M1=(2*H1)/(2*pi*60) % 2*pi*60 denotes the
synchronous speed in rad/s
H2=500.
M2=(2*H2)/(2*pi*60)
D1=0.75/(2*pi*60) % D1 is the damping coefficient
T12=0.1;
R1=0.167;
Tg1=.26;
Ts1=.26;
DL1=1; % 1 percent so the results are in per cent
DL2=0;
B1=1/R1+D1;
thetar=0;
K1=0.001*((2*pi*60)); % Controller gain for the ACE
loop
```

AGC.mdl



The above simulation is with D1=0.75/wsyn and K1=0.001/wsyn with timeconstants Tg1,Ts1 in seconds

Load_Sharing.pwb



Problem 5-8
Confirm the MATLAB Results of Example 5-4.