23-9-2020

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Roll No. 26

EXPERIMENT No:7

AUTOMATIC GENERATION CONTROL – TWO AREA SYSTEM

Aim

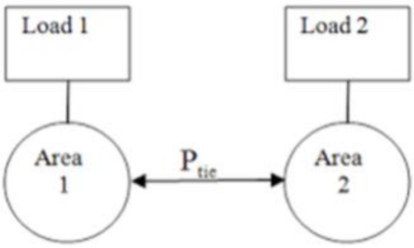
To determine the change in speed, frequency and steady state error corresponding to a load disturbance in a two-area power system, with and without supplementary control using any software.

Software Platform

MATLAB/Simulink

Theory

A large power system can be divided into a number of load frequency control areas which are interconnected by tie lines. For simulation purpose we consider a two-area system. Each area contains an equivalent turbine, generator, load and governor system.



Consider the two area representation by an equivalent generating unit interconnected by a lossless tie-line with reactance X_{tie}. During normal operation, the real power transferred through tie-line is given by,

$$P_{12} = \frac{|E_1||E_2|}{X_{12}} \sin \delta_{12}$$

where, $X_{12} = X_1 + X_{tie} + X_2$ and $\delta_{12} = \delta_1 - \delta_2$

for small deviation, $\Delta P_{12} = P_s \Delta \delta_{12}$. The quantity P_s is the slope of the power angle curve at the initial operating angle $\delta_{12_0} = \delta_{1_0} - \delta_{2_0}$

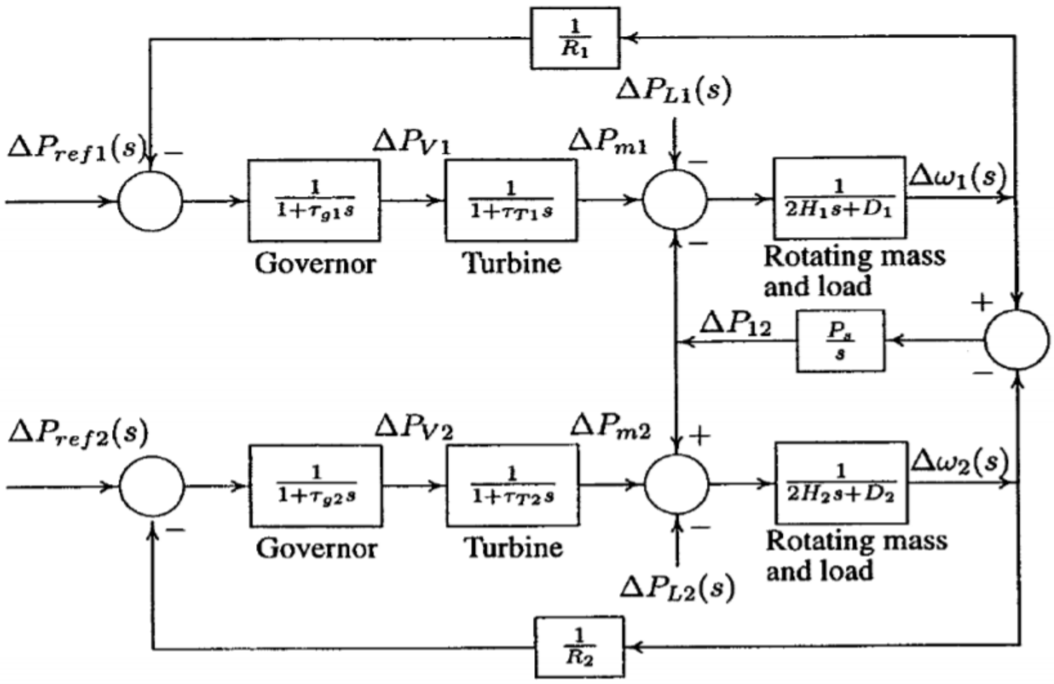
Thus, $P_s = \frac{|E_1||E_2|}{X_{12}} \cos \Delta \delta_{12_0}$

The tie-line power deviation is given by $\Delta P_{12} = P_s\left(\Delta\delta_1 - \Delta\delta_2\right)$

Depending on the direction of the flow, the tie-lie power flow appears as a load increase in one area and a load decrease in the other area. If $\Delta\delta_1 > \Delta\delta_2$, the power flows from area 1 to 2.

Case1: Obtain the frequency deviation response and the change in tie line flow deviation with only primary LFC control

Consider a load change ΔP_{L1} in area 1. In the steady-state, both areas will have the same steady-state frequency deviation, $\Delta\omega = \Delta\omega_1 = \Delta\omega_2$ and $\Delta P_{m1} - \Delta P_{12} - \Delta P_{L1} = \Delta\omega D_1$, $\Delta P_{m2} - \Delta P_{12} = \Delta\omega D_1$



Two-area system with only primary LFC loop

Case 2: With Tie-line bias control

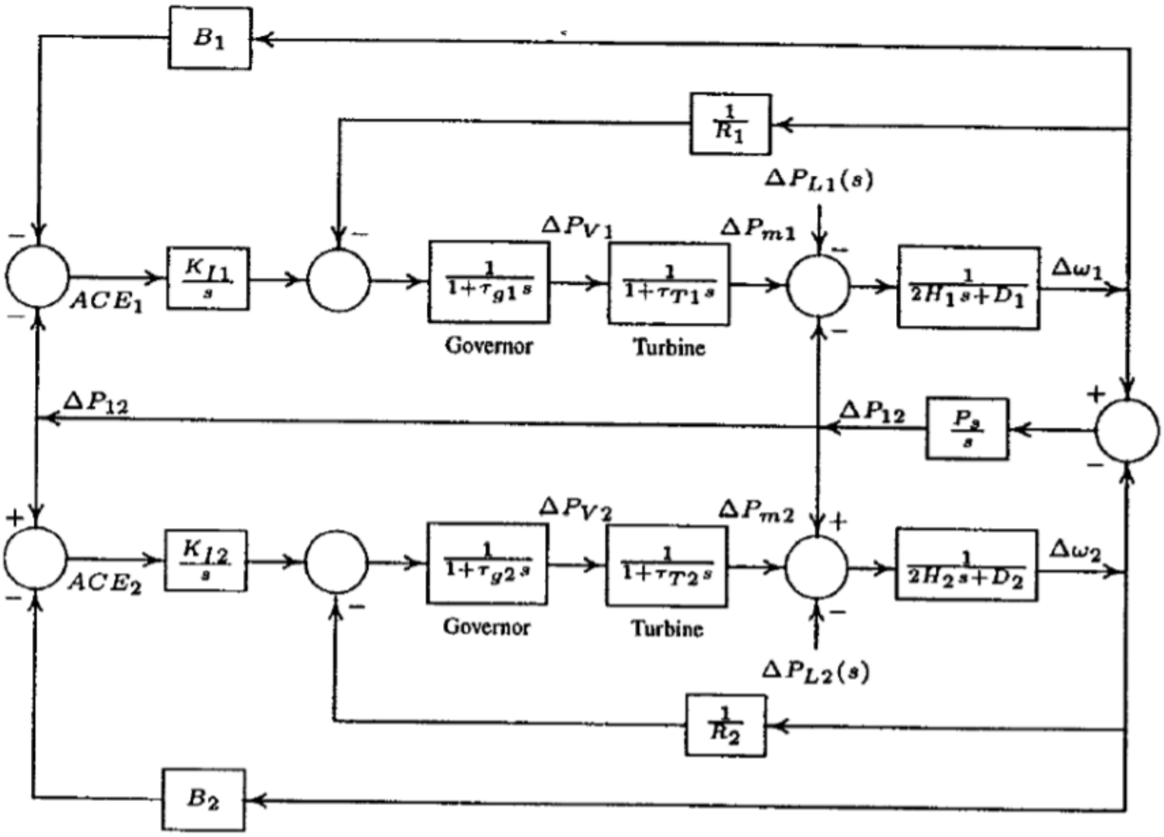
In Conventional LFC each area tend to reduce the area control error (ACE) to zero (tie-line bias control).

$$ACE_i = \sum_{j=1}^{n} \Delta P_{ij} + K_i \Delta\omega$$

The overall satisfactory performance is achieved when K_i (area bias) is selected equal to the frequency bias of that area

$$ACE_1 = \Delta P_{12} + B_1\Delta\omega_1 \text{ and } ACE_2 = \Delta P_{21} + B_2\Delta\omega_2$$

$$B_i = \frac{1}{R_i} + D_i$$



Two-area system with tie-line bias control

Exercise1:

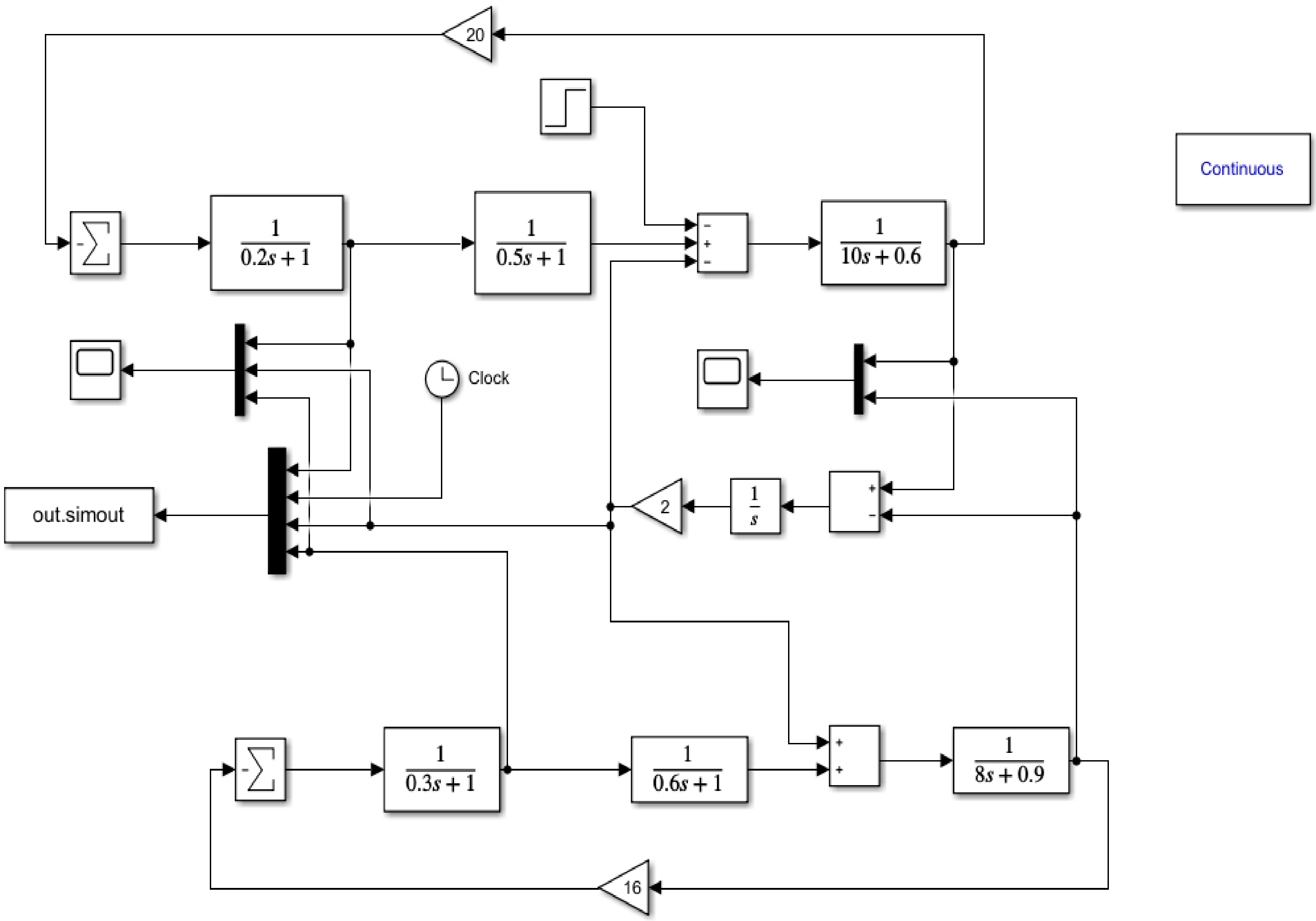
A two-area system connected by a tie-line with following parameters on 1000 MVA base

Area	1	2
Governor speed regulation	$R_1 = 0.05$ pu	$R_2 = 0.0625$pu
Load damping constant	D_1=0.8	D_2=0.9
Generator inertia constant	H_1=5 sec	H_2=4 sec
Governor time constant	τ_{g1}=0.2sec	τ_{g2}=0.3sec
Turbine time constant	τ_{T1}=0.5sec	τ_{T2}=0.6sec

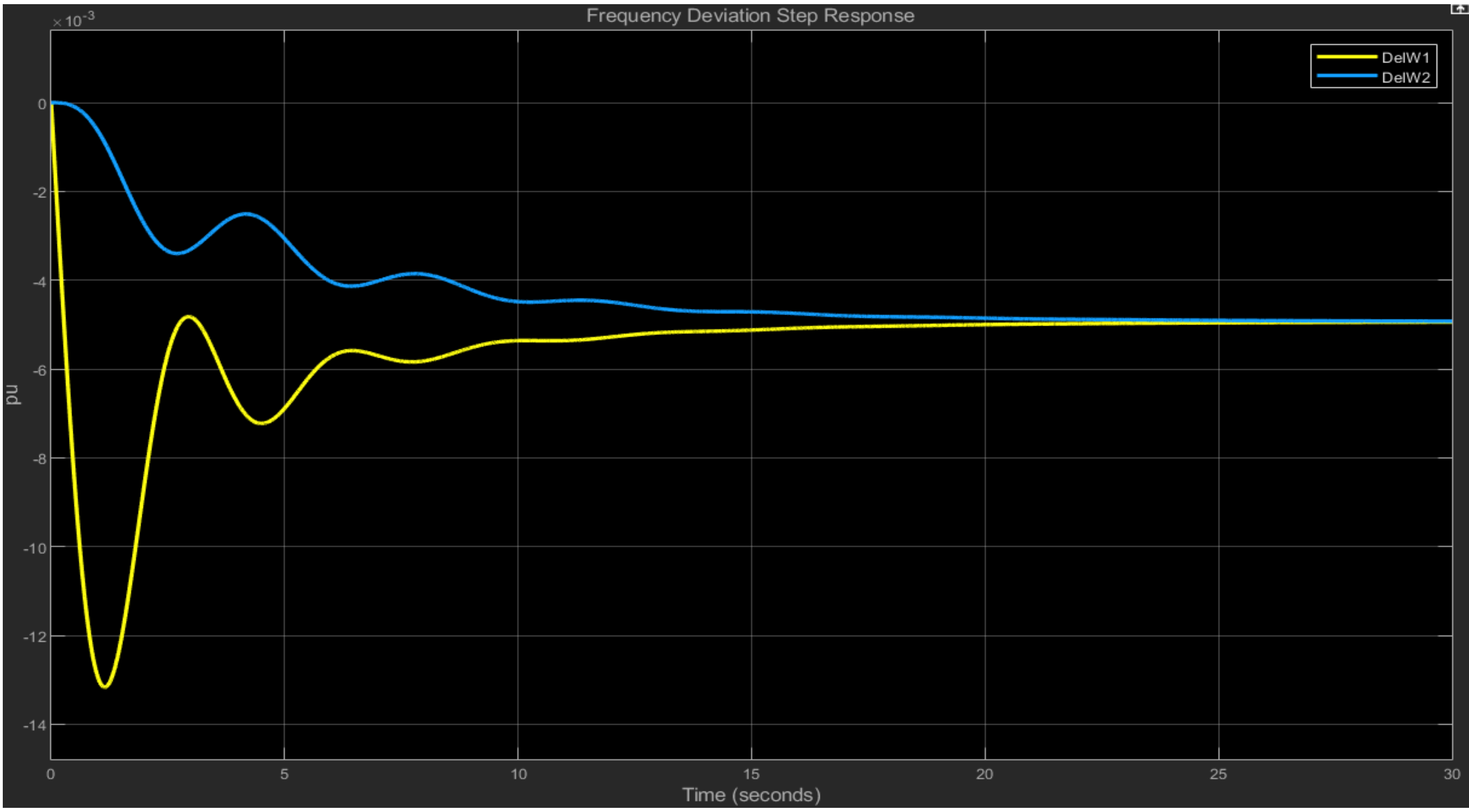
The unit are operating in parallel at nominal frequency of 60 Hz. The synchronizing power coefficient is computed from the initial operating condition, given by P_s=2pu. A load change of 187.5 MW occurs in area 1.

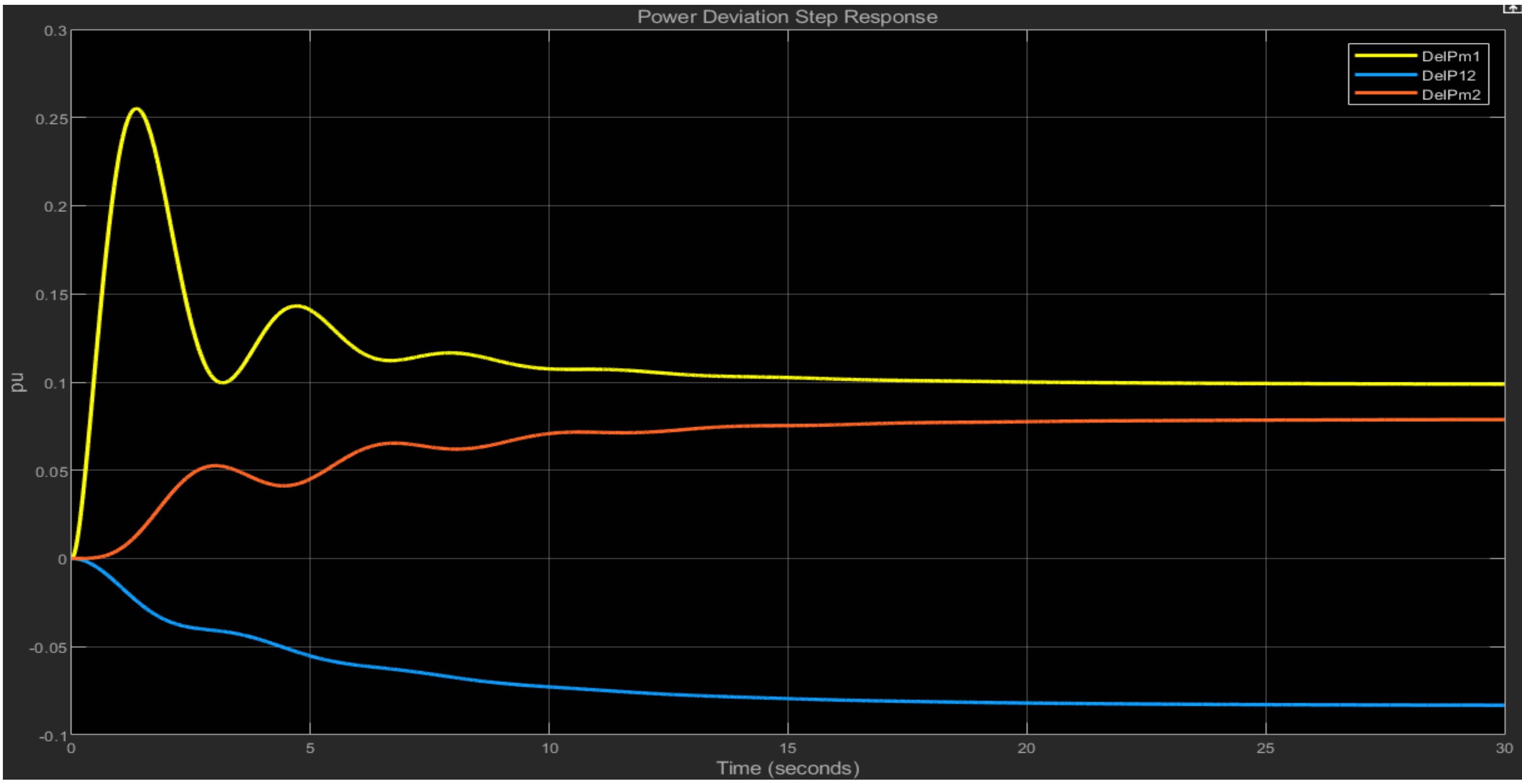
Case1: Obtain the frequency deviation response and the change in tie line flow deviation with only primary LFC control

Simulation Diagram



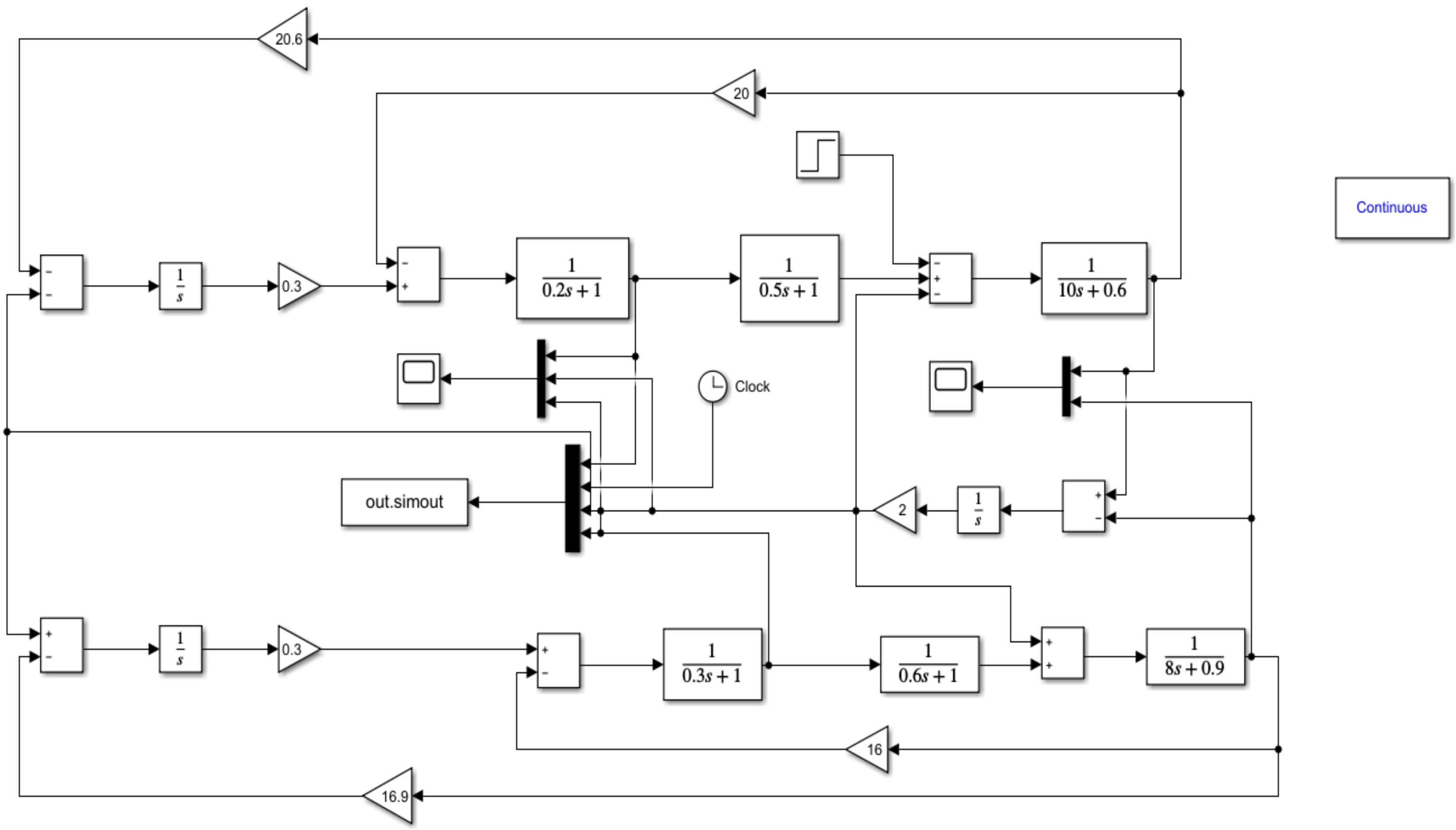
OUTPUT


Frequency Deviation Step Response
× 10^-3
DelW1
DelW2
0
-2
-4
-6
-8
-10
-12
-14
pu
0
5
10
15
20
25
30
Time (seconds)

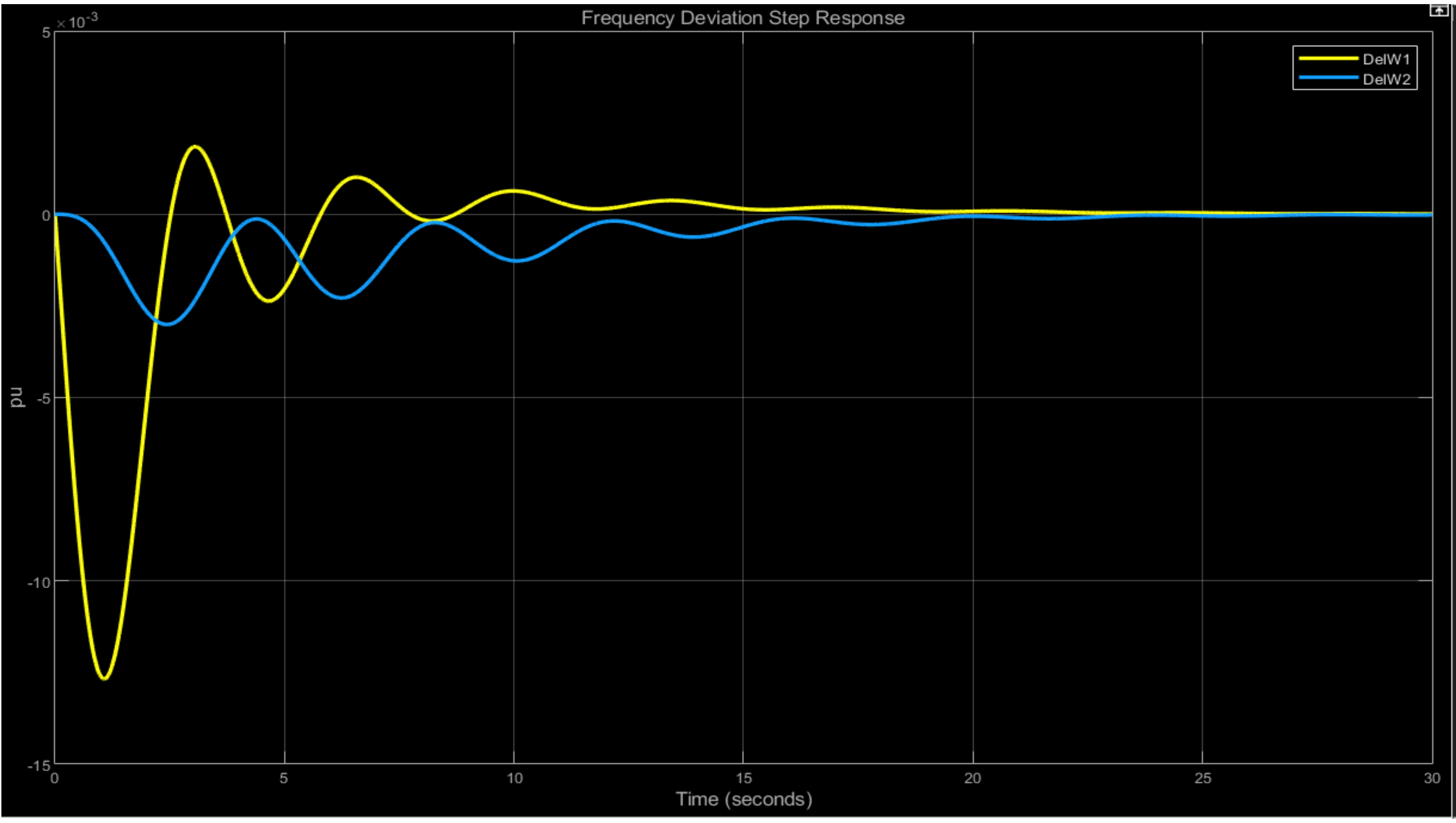

Power Deviation Step Response
DelPm1
DelP12
DelPm2
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
pu
0
5
10
15
20
25
30
Time (seconds)

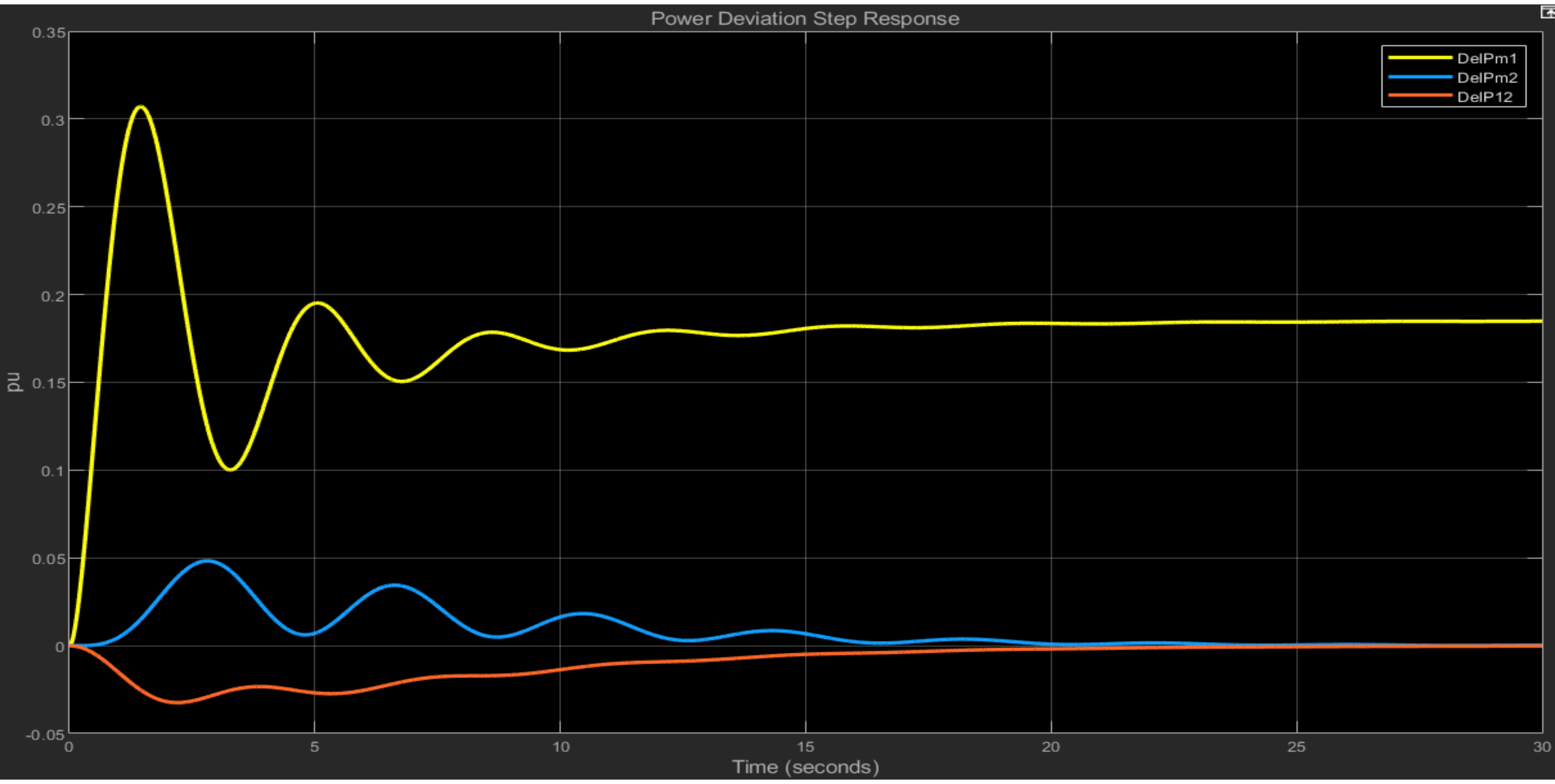
Case2: Obtain the frequency deviation response and the change in tie line flow with tie-line bias control

Simulation Diagram



Output


Frequency Deviation Step Response
× 10^-3
5
0
-5
-10
-15
pu
0
5
10
15
20
25
30
Time (seconds)
DelW1
DelW2


Power Deviation Step Response
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
pu
0
5
10
15
20
25
30
Time (seconds)
DelPm1
DelPm2
DelP12

Result

Two area power system is simulated using MATLAB and the waveforms are plotted.