

Two-area Load Frequency Control using MATLAB Simulink

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The change in frequency with change in load demand in a two area system with PI controllers is observed using MATLAB software

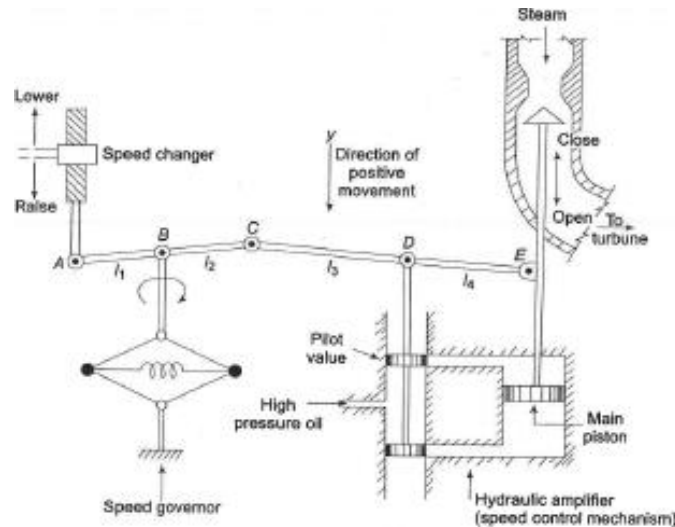


Fig 1 Turbine speed governing system

Fig. 1 shows schematically the speed governing system of a steam turbine. The system consists of Fly ball speed governor, Hydraulic amplifier, Linkage mechanism and speed changer.

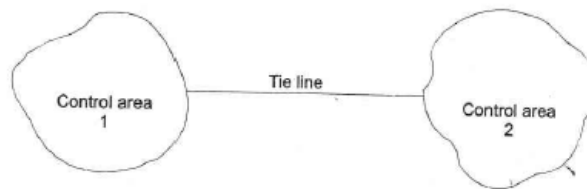


Fig 2 Two interconnected control areas (single tie line)

Consider two interconnected control areas through a single tie line as shown in Fig 2. The steam valve setting equation for each area is described by equations 1 and 2 in terms of commanded increase in power, change in frequency, regulation of speed governor, gain and time constant of speed governor of each area.

$$\Delta Y_{E1}(s) = [\Delta P_{c1}(s) - \frac{1}{R} \Delta F_1(s)] * \left[\frac{K_{sg1}}{1 + sT_{sg1}} \right] \quad (1)$$

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$$\Delta Y_{E2}(s) = [\Delta P_{c2}(s) - \frac{1}{R} \Delta F_2(s)] * \left[\frac{K_{sg2}}{1 + sT_{sg2}} \right] \quad (2)$$

The change in power generated for changes in steam valve settings of each area I described in equations 3 and 4 in terms of turbine gain and time constants.

$$\Delta P_{G1}(s) = \frac{K_{t1}}{1 + sT_{t1}} * \Delta Y_{E1}(s) \quad (3)$$

$$\Delta P_{G2}(s) = \frac{K_{t2}}{1 + sT_{t2}} * \Delta Y_{E2}(s) \quad (4)$$

The changes in frequency of each area of the two area system are described by the equations 5 and 6 in terms of changes in generated power, load demand, tie line power and gain and time constants of the power system of each area

$$\Delta F_1(s) = [\Delta P_{G1}(s) - \Delta P_{D1}(s) - \Delta P_{tie,1}(s)] * \frac{K_{ps1}}{1 + sT_{ps1}} \quad (5)$$

$$\Delta F_2(s) = [\Delta P_{G2}(s) - \Delta P_{D2}(s) - \Delta P_{tie,2}(s)] * \frac{K_{ps2}}{1 + sT_{ps2}} \quad (6)$$

Area Control Error in each area in terms of changes in tie line power and frequency are described in equations 7 and 8.

$$ACE_1(s) = \Delta P_{tie,1}(s) + b_1 * \Delta F_1(s) \quad (7)$$

$$ACE_2(s) = \Delta P_2(s) + b_2 * \Delta F_2(s) \quad (8)$$

The changes in tie line power in terms of changes in frequency and synchronizing coefficient of each area are described in equations 9 and 10.

$$\Delta P_{tie,1}(s) = \frac{2 * pi * T_{12}}{s} * [\Delta F_1(s) - \Delta F_2(s)] \quad (9)$$

$$\Delta P_{tie,2}(s) = \frac{-2 * pi * a_{12} * T_{12}}{s} * [\Delta F_1(s) - \Delta F_2(s)] \quad (10)$$

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The block diagram of the two area load frequency control is represented in Fig.3.

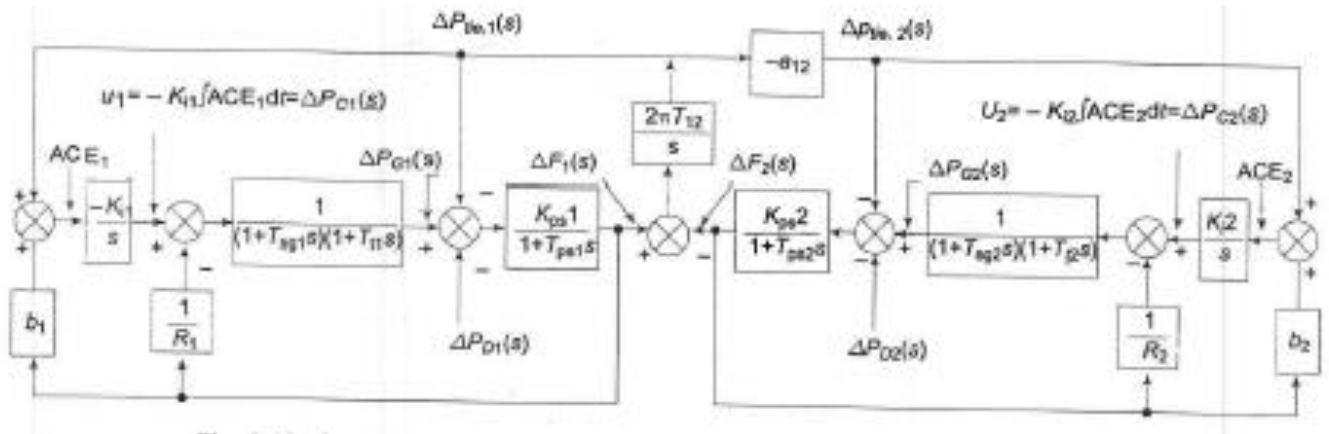


Fig. 3 Block diagram of two area load frequency control

Input data:

The two areas are assumed to be identical with system parameters given by

Time constant of speed governor:

$$T_{sg1}=T_{sg2}=0.4$$

Time constant of speed turbine

$$T_{t1}=T_{t2}=0.5$$

Time constant of power system

$$T_{ps1}=T_{ps2}=20$$

Gain of the power system

$$K_{ps1}=K_{ps2}=100$$

Regulation of the speed governor

$$R1=R2=3$$

System bias

$$b1=b2=0.425$$

Integrator time constant

$$K_{i1}=K_{i2}=0.09$$

Synchronizing coefficient

$$T_{12}=0.05/(2*\pi)$$

Change in load demand in each area

$$\Delta P_{d1}=0.01$$

$$\Delta P_{d2}=0$$

constant

$$a_{12}=1$$

SIMULINK MODEL

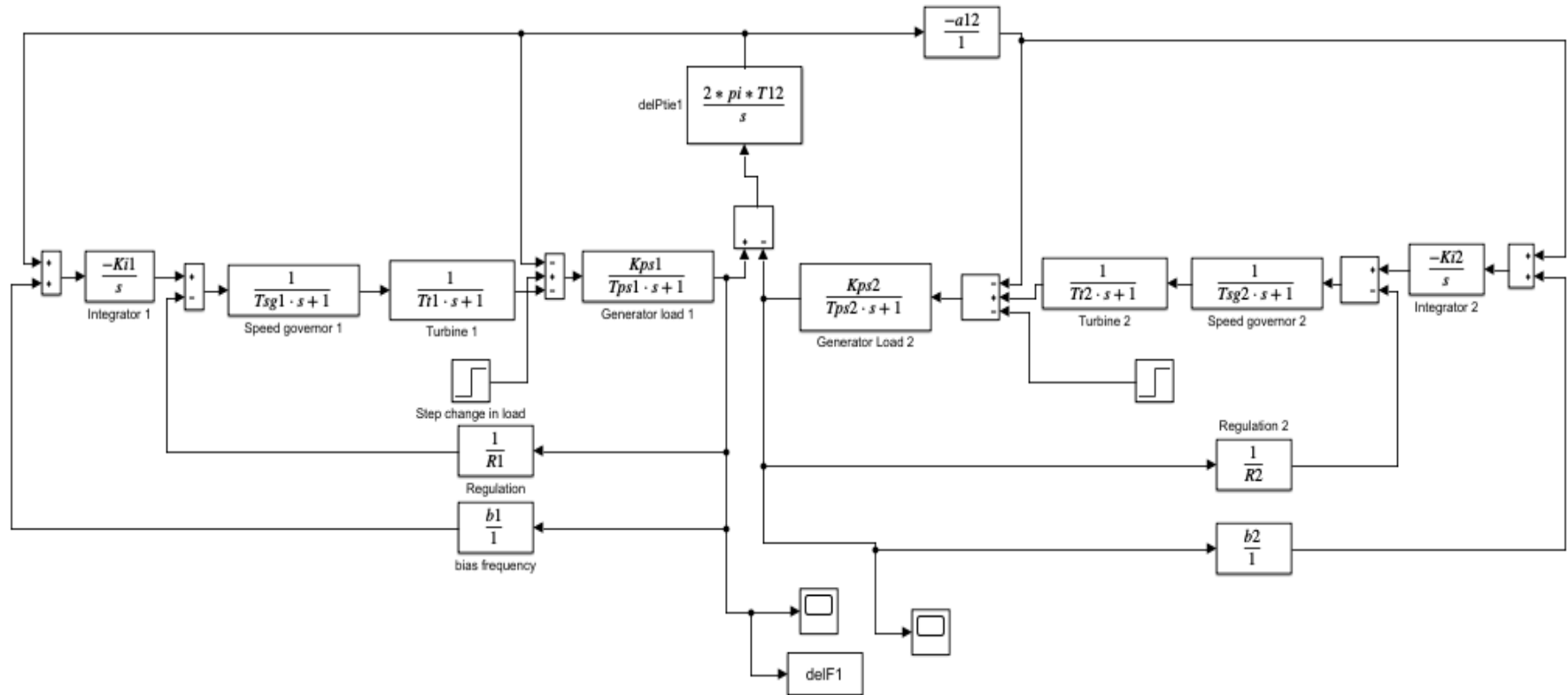


Fig. 4 MATLAB Simulink block diagram of two area load frequency control

EXPECTED GRAPH

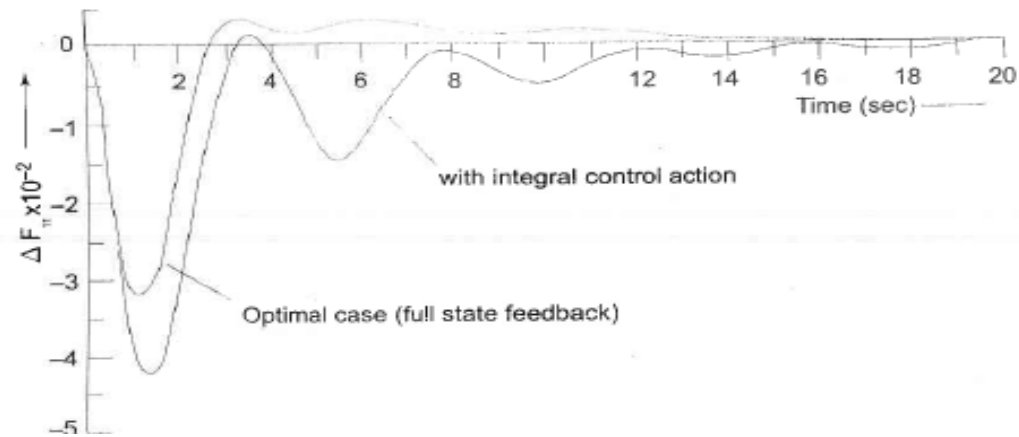


Fig. 5 Change in frequency of area 1 due to step change in load of area 1

The change in frequency with change in load demand in a two area system with PI controllers was observed

Reference

1. D.P.Kothari and I.J.Nagrath, Modern Power Systems Analysis, 3rd Edition, Tata McGraw Hill, 2004

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Subject: Power System Operation and Control

Demonstration of Load frequency Control (Power System Operation and Control) using Matlab Simulink

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