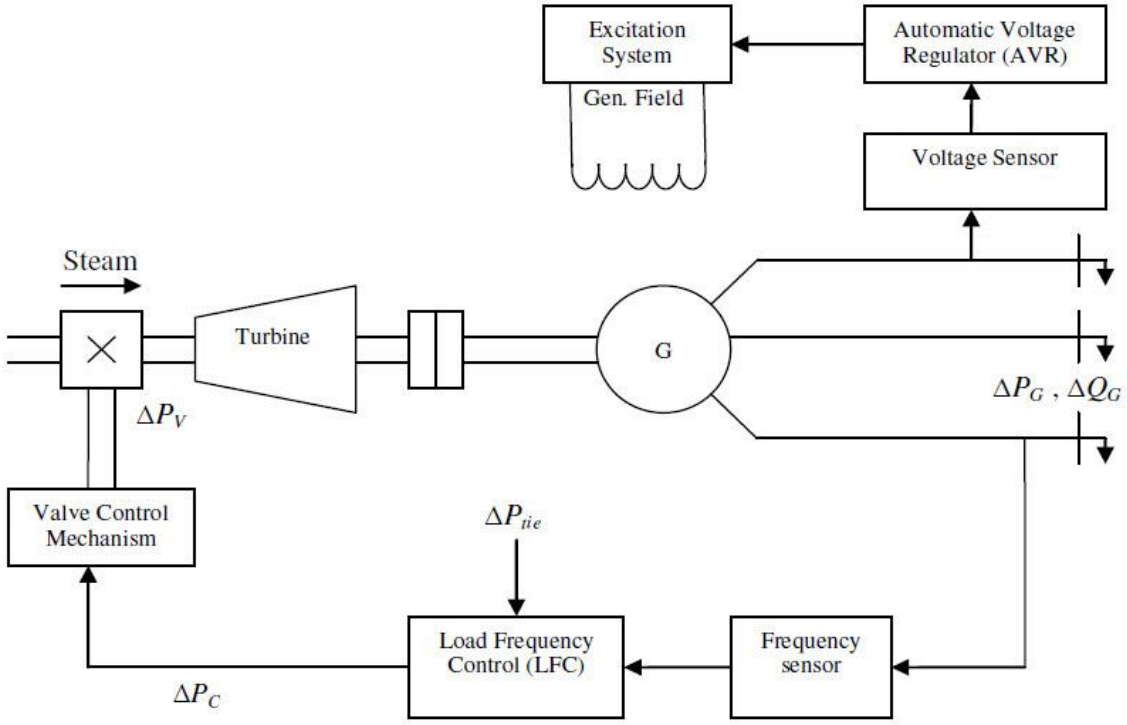
Power System Control

Introduction

The power systems control refers to the interconnection of more than one control areas through tie lines.

- The load Frequency Control (LFC) Loop: that controls real power and frequency
- The Automatic Voltage Regulator (AVR): that regulates the reactive power and voltage magnitude



The Load Frequency Control (LFC)

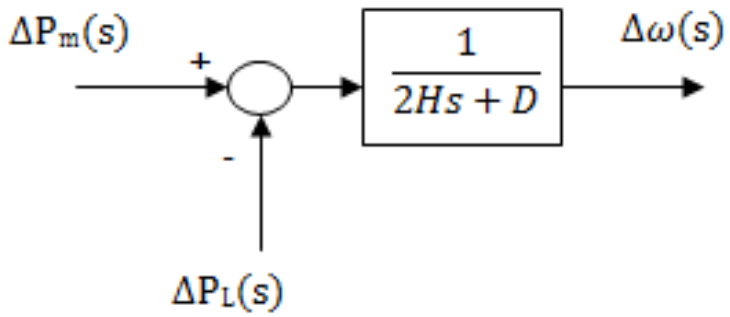
Load Frequency Control has a very important role in power system operation and control, The main objective of Load Frequency Control is to keep the frequency deviation and tie line power deviation within acceptable limit when a load change occurs in that power system.

To model a Load Frequency Control model, it is necessary to model:

- Generator and load model.
- Prime mover model.
- Governor model.

Generator and load model

The block diagram of a simple generator and load model can be represented by:



Where:

- D (Load Damping coefficient) : represented as percent change in load divided by percent change in frequency. (Frequency sensitive load change).
- H (Generator Inertia constant).
- ΔPL: is the per unit change in load demand (non-frequency sensitive load change)
- ΔPM: is the mechanical power change.
- ΔΩ: is the frequency change.

Prime mover model

The prime mover is the source of mechanical power, the block diagram of a simplest prime mover model for a steam turbine can be represented by:

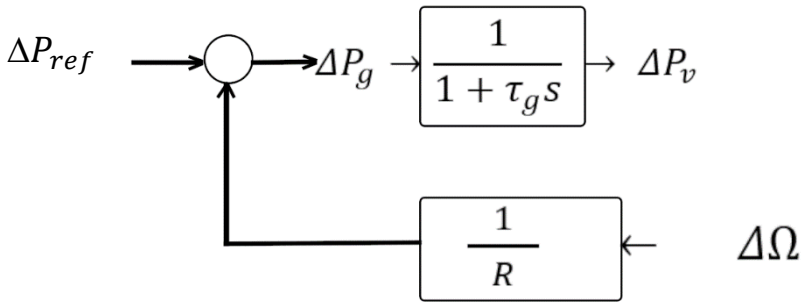
$$\Delta P_v \rightarrow \boxed{\frac{1}{1+\tau_T s}} \rightarrow \Delta P_m$$

Where:

- ΔPv : is the change in steam valve position.
- τ_T : is the turbine time constant and it is generally is the range 0.2 to 20 seconds.

Governor model

The steam turbine governor is a component of turbine control system that regulates rational speed in response to changing load condition, the block diagram of a speed governing system for steam turbine represented by:

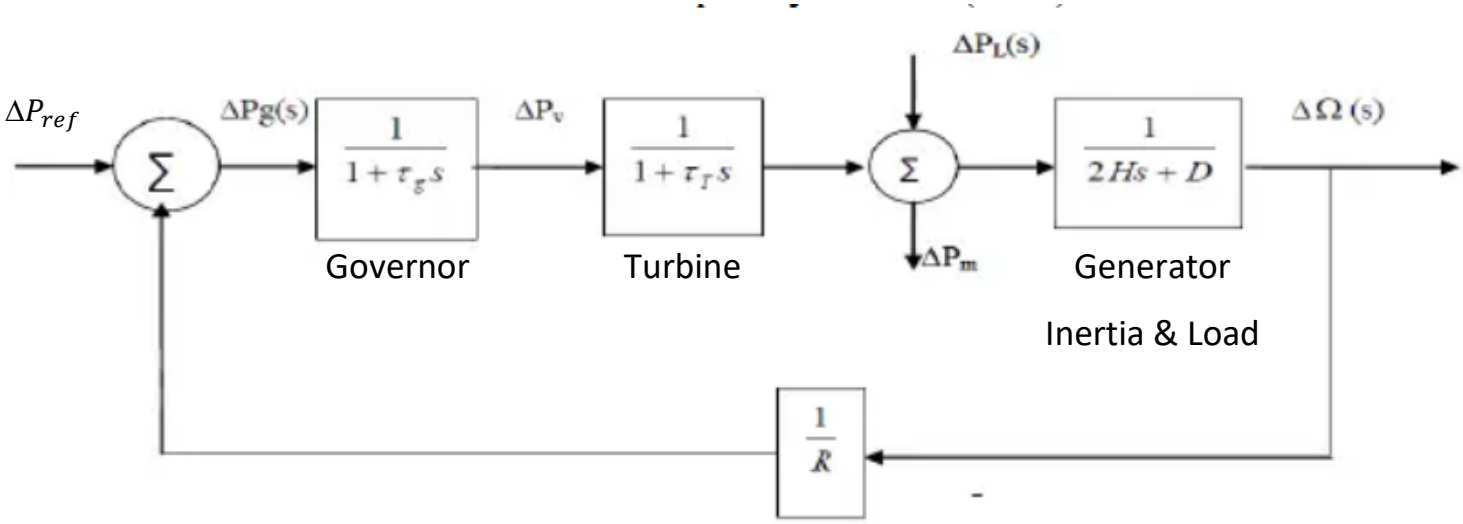


Where:

- ΔP_{ref} : is the reference set power.
- ΔPg : is the difference between ΔP_{ref} and the power ($\Delta\Omega$/R).
- R: is the speed regulation of governor measured generally in Hz/MW.
- τ_g : is the governor time constant.

The Load Frequency Control (LFC)

The block diagram of the load frequency control loop for steam turbine power system can be represented by:



Example:

A power station has the following parameters:

Turbine time constant τ_T =0.3 sec

Governor time constant τ_g =0.2 sec

Generator inertia constant H=6 sec

Generator speed regulation =0.02 per unit

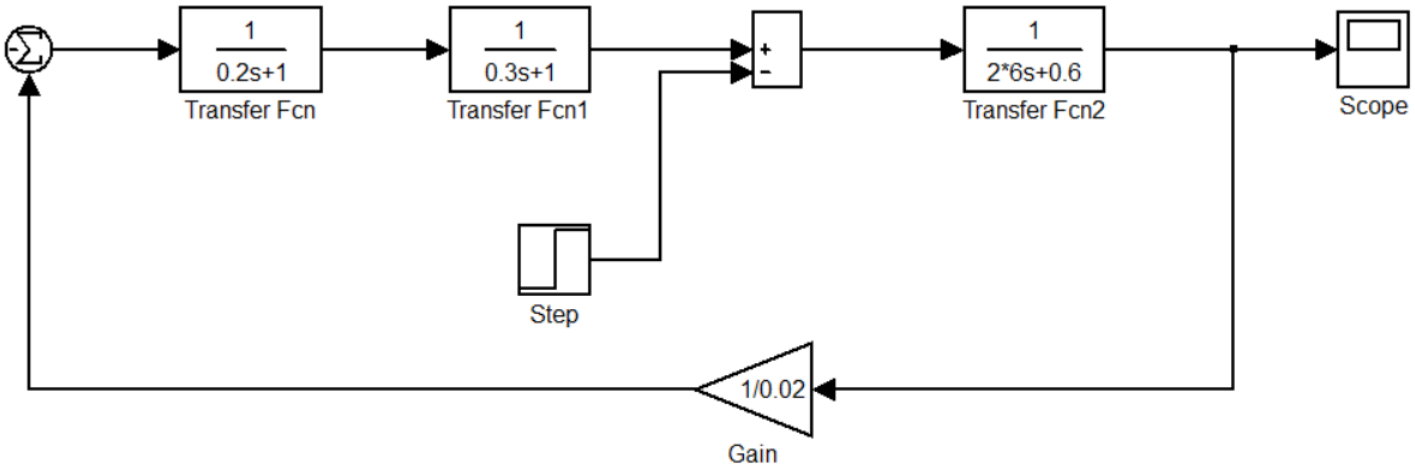
The load varies by 0.6% for 1% change in frequency.

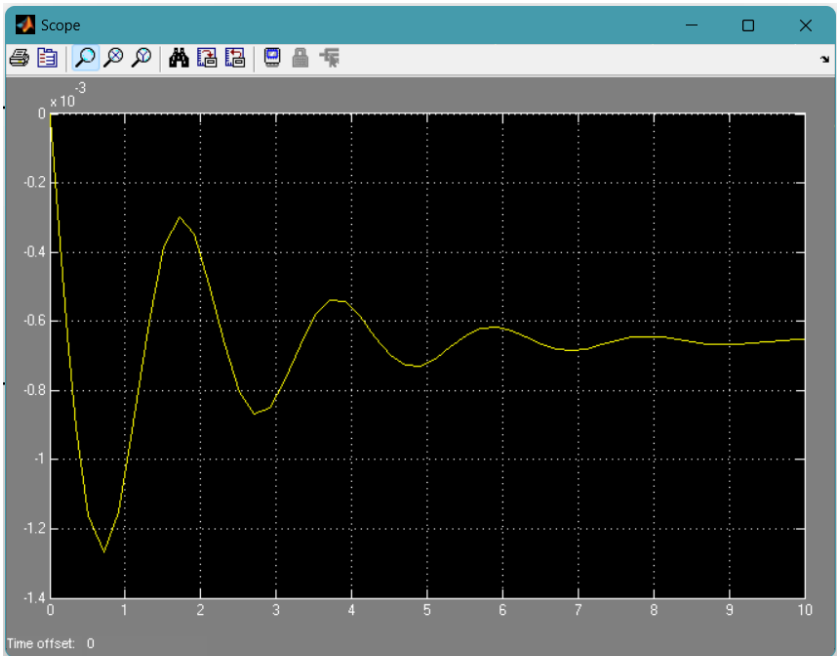
The Turbine rated output is 600MW at a nominal frequency of 50Hz.

A sudden load change 20MW.

Construct a SIMULINK block diagram to simulate the LFC

Value	Parameter
Gain	
1/0.02	Gain
Step	
0	Step time
0	Initial value
20/600	Final value
Sum	
round	Icon shape
|-	List of signs
Sum1	
rectangular	Icon shape
|+-	List of signs
Transfer	
[1]	Numerator coefficients
[0.2 1]	Denominator coefficients
Transfer1	
[1]	Numerator coefficients
[0.3 1]	Denominator coefficients
Transfer2	
[1]	Numerator coefficients
[2*6 0.6]	Denominator coefficients


1
0.2s+1
Transfer Fcn
1
0.3s+1
Transfer Fcn1
+
-
1
2*6s+0.6
Transfer Fcn2
Scope
Step
1/0.02
Gain


Scope
x 10^-3
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
1
2
3
4
5
6
7
8
9
10
Time offset: 0