EE549 - Power System Dynamics and Control

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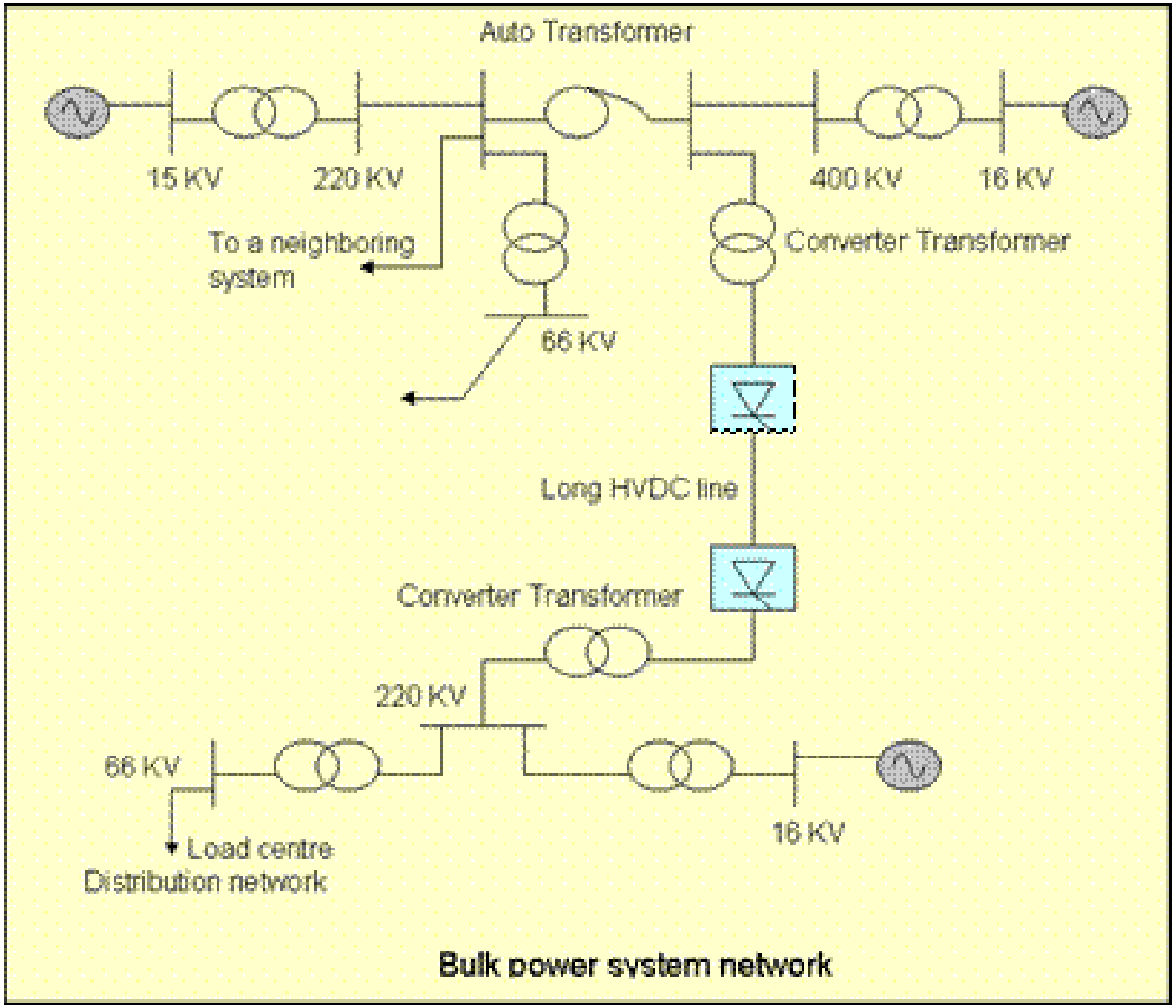
Overview

A Typical Power System



Source : NPTEL

Interconnection

Reasons for interconnections

1. To improve reliability
2. To improve economy

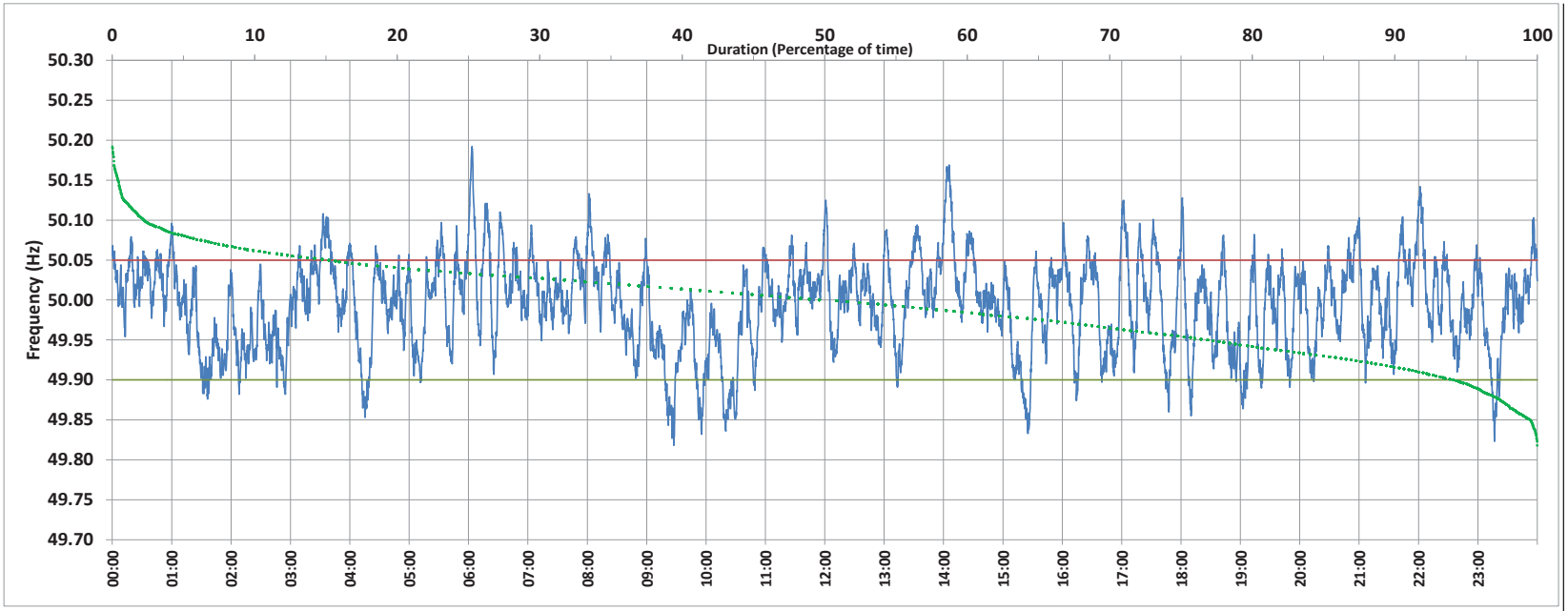
- Several power systems are interconnected to form a grid.
- Several regional grids are interconnected to form a national grid.
- Interconnections are done at Transmission networks.
- In interconnected systems, the frequency of generation must be the same in steady state.

Grid Frequency

POWER SYSTEM OPERATION CORPORATION LIMITED

NATIONAL LOAD DESPATCH CENTRE, NEW DELHI

Frequency profile for 03-Jan-2021 (Sunday)



<49.7	<49.90	<49.97	49.7-49.8	49.8-49.9	49.9-50.0	50.0-50.1	50.1-50.2	49.90-50.05	49.7-50.2	49.97-50.03	50.05-50.1	>50	>50.03	>50.05	>50.2	<49.95	49.95-50.05	49.90-49.95
0.00	5.68	31.72	0.00	5.68	43.50	48.53	2.29	79.13	100.00	40.78	13.45	49.61	27.50	15.19	0.00	22.75	62.06	17.07

Average Frequency : 49.994	Frequency Variation Index : 0.0332	Standard Deviation : 0.0574	Mileage: 51.5	FDI: 20.9

Instantaneous Frequency		
Max	50.192	6:03:20
Min	49.818	9:27:20

15 minute Average Frequency		
Max	50.098	14:15:00
Min	49.873	10:30:00

No. of excursions	
above 50.03 Hz	161
below 49.97 Hz	115
above 50.00 Hz	136
below 50.00 Hz	137

Average time freq per excursion remains	
below 49.97	0:03:58
above 50.03	0:02:28

No. of hours freq outside 49.9-50.05 Hz	5:00:30

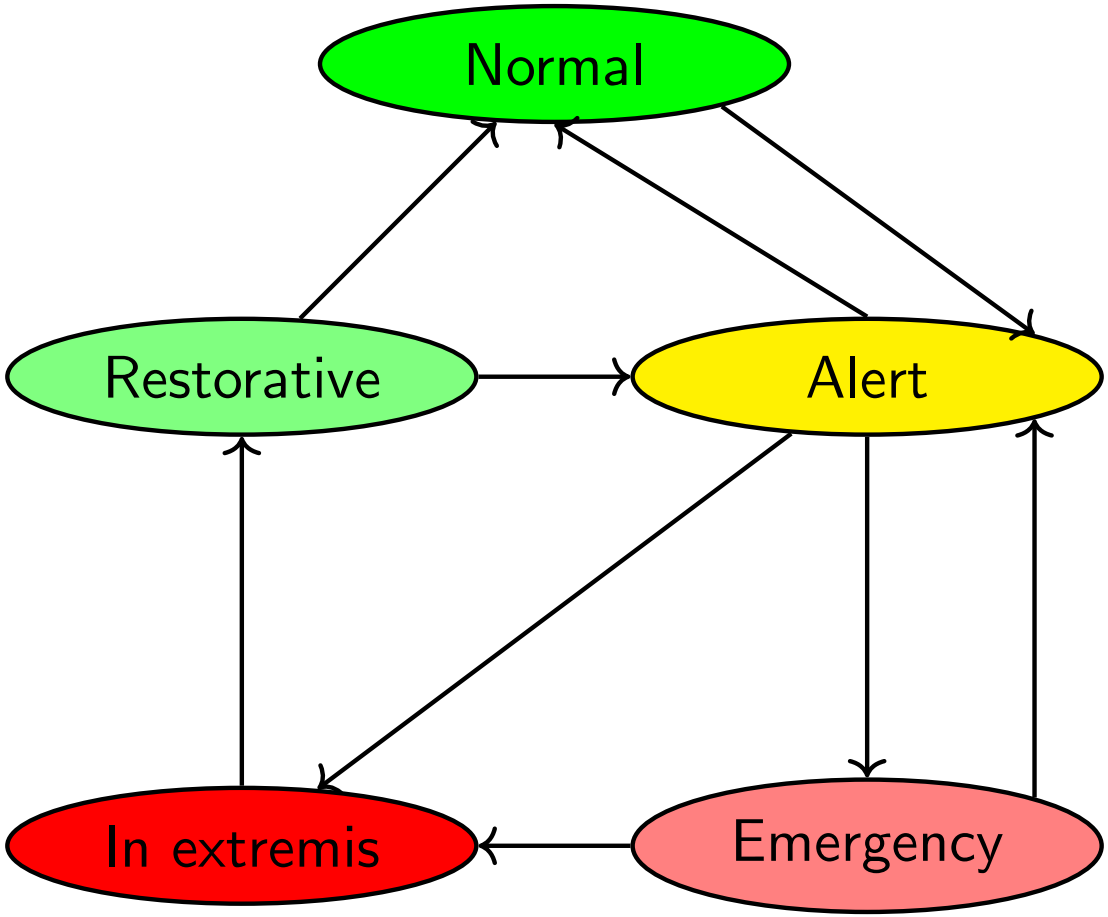
Source : BONGAIGAON:Frequency 10 Sec. (8640 samples)

Source : POSOCO

Requirements of a Power System

1. The system must be able to meet the continually changing load demand.
2. The quality of power supply must meet certain minimum standards with regard to the following factors.
    1. constancy of frequency
    2. constancy of voltage
    3. level of reliability
3. The system should supply energy at minimum cost and with minimum ecological impacts.

Operating States of a Power System



1. Normal State
   - All the system variables are within the normal range.
   - The system is able to withstand a contingency.
2. Alert State
   - All the system variables are within the normal range.
   - But the system is not able to withstand any contingency.
   - Preventive actions will bring back the system to the normal state.
3. Emergency State
   - System variables are not normal.
   - Emergency control actions may bring the system back to the alert state.

4. In extremis State
   - Shut down of a major portion of the system.
   - Load shedding and controlled system separation are done to avoid a complete black out.
5. Restorative State
   - Control actions are taken to restore the system.
   - The system will go to Alert or Normal depending on the system conditions.

Criteria for Stability

1. It is clear that a power system is subjected to a wide variety of disturbances.
2. For reliable service, the system must remain intact and be capable of withstanding disturbances.
3. Therefore, it is essential that the system be designed and operated so that it sustains disturbances with no loss of load.

1. The design of a large interconnected system to ensure stable operation at minimum cost is a very complex problem.
2. Every major component of a system has an effect on system stability.
3. Therefore, their characteristics need to be studied for the understanding and study of power system stability.

Course Contents

What we will study in EE549 are the following.

1. Introduction to Power System Stability
2. Power system stability by classical model
   - Small disturbances
   - Large disturbances
3. Detailed modelling of the following.
   - Synchronous Generator
   - Exciter, Turbine and Load
   - Transformer
   - Transmission line
4. Power system stability using the detailed model
   1. Small disturbances
   2. Large disturbances
5. Voltage Stability

Prerequisites

1. Electrical Machines
2. Power Systems

Reference Books

1. P. Kundur, “Power System Stability and Control ”, Tata McGraw-Hill, 1994.
2. P. W. Sauer and M. A. Pai,” Power System Dynamics and Stability”, Prentice Hall, 1998.

Course Mechanics

The following pattern may be adopted.

- Two Quizzes - 40 %
- Mid Sem Exam - 20 %
- End Sem Exam - 20 %
- Attendance and Sincerity - 10 %
- Seminar - 10 %