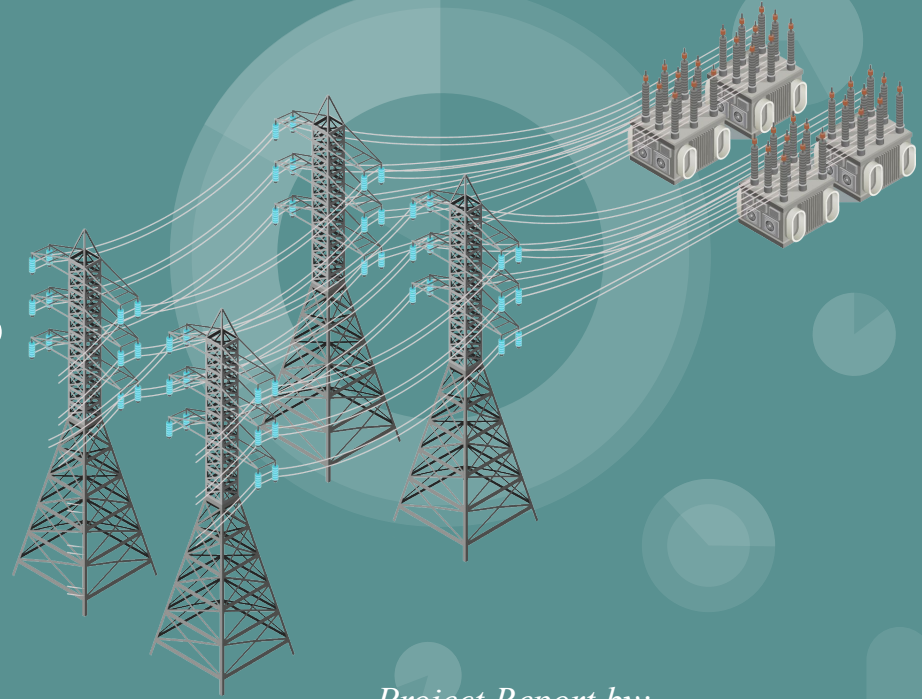


EE-308 Power Systems

Behaviour of a Power System during
transient events



Project Report by:

Harsh Bardhan (200002037)
Prathmesh Verma (200002061)
Udit Patel (200002075)



Introduction

Power system dynamics is the study of how a power system responds to changes in its operating conditions. Transient events refer to disturbances that occur in the power system, such as faults, switching operations, and sudden changes in load or generation. During such events, the system experiences rapid changes in voltage, current, and frequency, which can affect the stability and reliability of the power system.

One of the main goals of power system dynamics is to ensure that the power system remains stable during transient events. Stability refers to the ability of the power system to maintain a steady state of operation despite disturbances. This is achieved by controlling the power system through various means, such as adjusting the output of generators, using protective devices, and coordinating the operation of different components.



Overview of the project

As mentioned in the introduction, Transient events refer to disturbances that occur in the power system, such as faults, switching operations. We have taken faults to explain the power system dynamics in our project.

We have taken different types of symmetrical and unsymmetrical faults like LLL, LG, LL, LLG and calculated the subtransient currents for choosing the circuit breakers and analysed transient stability

We calculated the value of critical time for a 3 phase symmetrical fault.

Finding subtransient fault currents in different symmetrical and unsymmetrical faults



Taking this power system for computing all the fault currents (LLL, LG, LL, LLG).

3-phase Symmetrical Fault at Bus 4

Fault Definitions

Single Fault

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

Y-Bus Matrices

Options

Sequence Data

Single Fault

Calculate

Clear

Clear/Close

Choose the Faulted Bus

Sort by ☐ Name ☒ Number

1 (Bus 1) [13.80 kV]

2 (Bus 2) [138.0 kV]

3 (Bus 3) [138.0 kV]

4 (Bus 4) [13.80 kV]

Fault Location

☒ Bus Fault

☐ In-Line Fault

Location %

Fault Impedance

R :

X :

Fault Type

☐ Single Line-to-Ground

☐ Line-to-Line

☒ 3 Phase Balanced

☐ Double Line-to-Ground

Fault Current

Scale Current By:

If Magnitude: p.u.

If Scaled Mag: p.u.

If Angle: deg.

Units ☒ p.u. ☐ Amps

Subtransient Phase Current

p.u. deg.

A

B

C

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

Y-Bus Matrices

Records

Geo

Set

Columns

Options

1

2

3

4

Number

Name

Phase Volt A

Phase Volt B

Phase Volt C

Phase Ang A

Phase Ang B

Phase Ang C

1 Bus 1

2 Bus 2

3 Bus 3

4 Bus 4

0.67034

0.45057

0.21977

0.00000

0.67034

0.45057

0.21977

0.00000

0.67034

0.45057

0.21977

0.00000

-0.00

-0.00

-0.00

180.00

-120.00

-120.00

-120.00

120.00

120.00

120.00

-63.43

Auto Insert...

Load Data...

Save Data...

Close

Help

LG Fault at Bus 4

Fault Definitions

Single Fault

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

Y-Bus Matrices

Options

Sequence Data

Run Faults

Abort

Single Fault

Calculate

Clear

Clear/Close

Choose the Faulted Bus

Sort by ☐ Name ☒ Number

1 (Bus 1) [13.80 kV]

2 (Bus 2) [138.0 kV]

3 (Bus 3) [138.0 kV]

4 (Bus 4) [13.80 kV]

Fault Location

☒ Bus Fault

☐ In-Line Fault

Location %

0

Fault Impedance

R : 0.00000

X : 0.00000

Fault Type

☒ Single Line-to-Ground

☐ Line-to-Line

☐ 3 Phase Balanced

☐ Double Line-to-Ground

Fault Current

Scale Current By: 1.00000

If Magnitude: 5.612 p.u.

If Scaled Mag: 5.612 p.u.

If Angle: -90.00 deg.

Units ☒ p.u. ☐ Amps

Subtransient Phase Current

p.u. deg.

A 5.612 -90.00

B 0.000 90.00

C 0.000 90.00

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

Y-Bus Matrices

Records

Geo

Set

Columns

Options

	Number	Name	Phase Volt A	Phase Volt B	Phase Volt C	Phase Ang A	Phase Ang B	Phase Ang C
1	1	Bus 1	0.81683	0.96676	0.96676	-0.00	-114.99	114.99
2	2	Bus 2	0.70236	0.94419	0.94419	-0.00	-111.84	111.84
3	3	Bus 3	0.58215	0.92372	0.92372	-0.00	-108.37	108.37
4	4	Bus 4	0.00000	1.12295	1.12295	-0.00	-128.66	128.66

LL fault at Bus 4

Run Faults

Abort

Single Fault

Calculate

Clear

Clear/Close

Choose the Faulted Bus

Sort by ☐ Name ☒ Number

1 (Bus 1) [13.80 kV]

2 (Bus 2) [138.0 kV]

3 (Bus 3) [138.0 kV]

4 (Bus 4) [13.80 kV]

Fault Location

☒ Bus Fault

☐ In-Line Fault

Location %

0

Fault Impedance

R : 0.00000

X : 0.00000

Fault Type

☐ Single Line-to-Ground

☒ Line-to-Line

☐ 3 Phase Balanced

☐ Double Line-to-Ground

Fault Current

Scale Current By: 1.00000

If Magnitude: 6.087 p.u.

If Scaled Mag: 6.087 p.u.

If Angle: -180.00 deg.

Subtransient Phase Current

p.u.

deg.

A

0.000

0.00

B

6.087

-180.00

C

6.087

0.00

Units

☒ p.u.

☐ Amps

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

Y-Bus Matrices

Records

Geo

Set

Columns

Options

	Number	Name	Phase Volt A	Phase Volt B	Phase Volt C	Phase Ang A	Phase Ang B	Phase Ang C
1	1	Bus 1	1.02219	0.76412	0.76412	0.00	-131.98	131.98
2	2	Bus 2	1.02262	0.63813	0.63813	0.00	-143.25	143.25
3	3	Bus 3	1.02308	0.54438	0.54438	0.00	-160.00	160.00
4	4	Bus 4	1.02351	0.51175	0.51175	0.00	-180.00	-180.00

Auto Insert...

Load Data...

Save Data...

Close

Help

LLG fault at Bus 4

Fault Definitions

Single Fault

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

> Y-Bus Matrices

Options

> Sequence Data

Run Faults

Abort

Single Fault

Calculate

Clear

Clear/Close

Choose the Faulted Bus

Sort by ☐ Name ☒ Number

1 (Bus 1) [13.80 kV]

2 (Bus 2) [138.0 kV]

3 (Bus 3) [138.0 kV]

4 (Bus 4) [13.80 kV]

Fault Location

☒ Bus Fault

☐ In-Line Fault

Location %

Fault Impedance

R :

X :

Fault Type

☐ Single Line-to-Ground

☐ Line-to-Line

☐ 3 Phase Balanced

☒ Double Line-to-Ground

Fault Current

Scale Current By:

If Magnitude: p.u.

If Scaled Mag: p.u.

If Angle: deg.

Units ☒ p.u. ☐ Amps

Subtransient Phase Current

	p.u.	deg.
A	<input type="text" value="0.000"/>	<input type="text" value="0.00"/>
B	<input type="text" value="6.570"/>	<input type="text" value="158.66"/>
C	<input type="text" value="6.570"/>	<input type="text" value="21.34"/>

Bus Records

Lines

Generators

Loads

Switched Shunt Buses

Y-Bus Matrices

Records

Geo

Set

Columns

Sort

f(x)

Options

	Number	Name	Phase Volt A	Phase Volt B	Phase Volt C	Phase Ang A	Phase Ang B	Phase Ang C
1	1	Bus 1	0.94428	0.74076	0.74076	-0.00	-129.60	129.60
2	2	Bus 2	0.89596	0.58982	0.58981	-0.00	-139.42	139.42
3	3	Bus 3	0.84520	0.46218	0.46218	0.00	-156.12	156.12
4	4	Bus 4	1.19532	0.00000	0.00000	0.00	90.00	135.00



Transient Stability

Transient stability refers to the ability of a power system to maintain synchronism and continue to operate stably after experiencing a large and sudden disturbance, such as a fault or loss of generation.

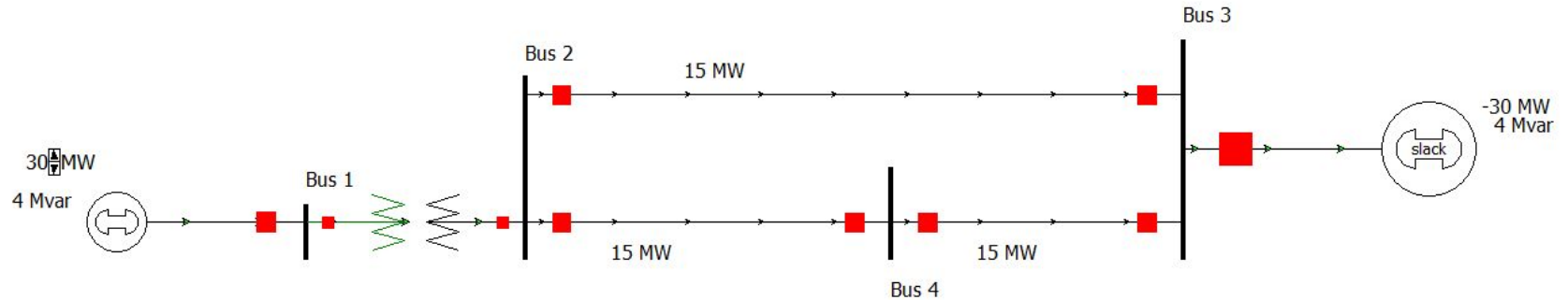


Critical Time

The critical time or maximum time needed by the synchronous generator to maintain the condition of the generator remains in synchronization.

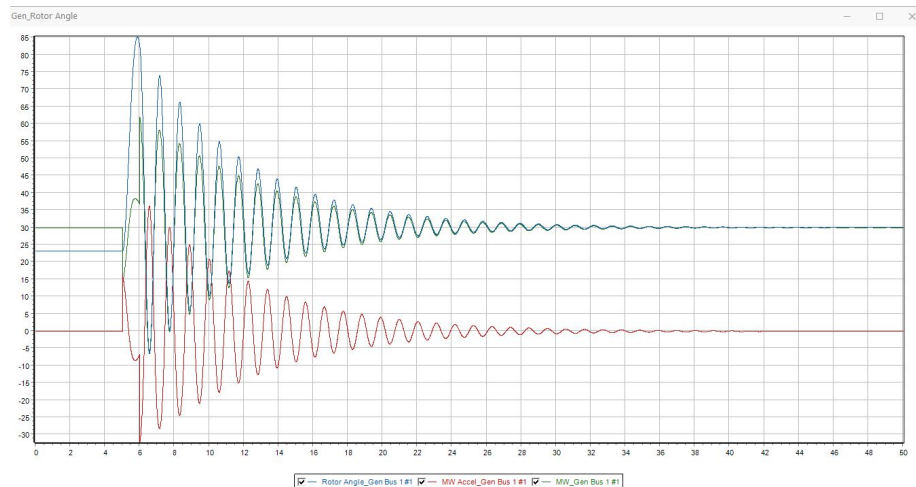
We assumed that three phase symmetrical fault occur at bus 4 at $t=5$ seconds.

GENCC model of synchronous generator is used for analysis

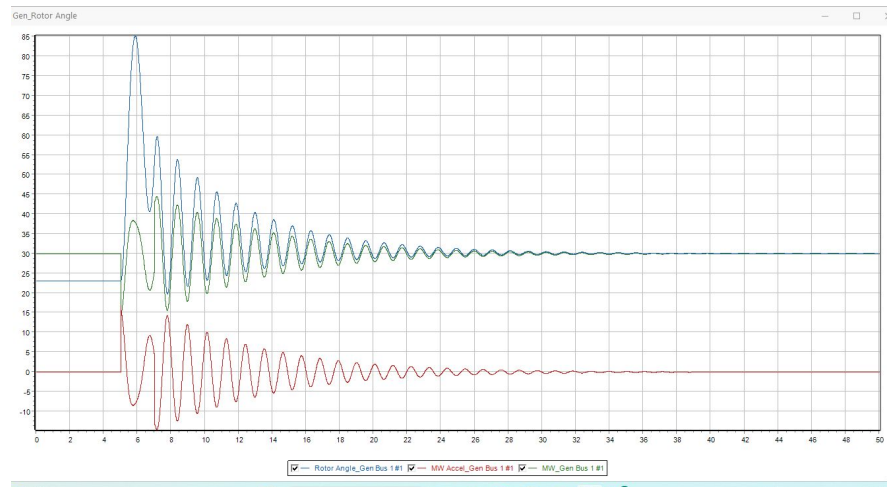




Fault time = 5 sec
Fault clearing time = 7 sec

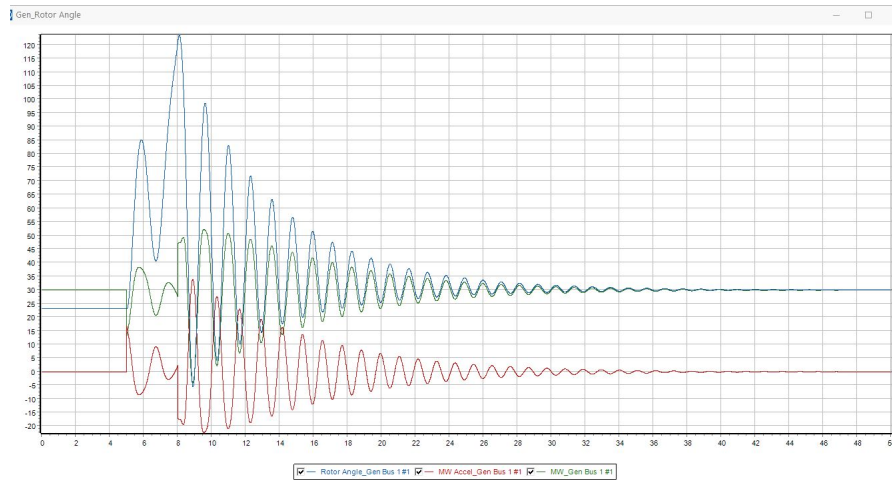


Fault time = 5 sec
Fault clearing time = 8 sec

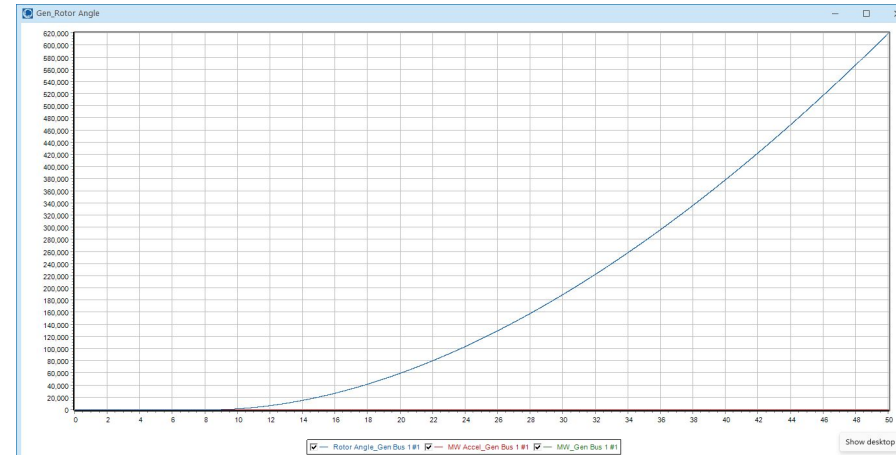




Fault time = 5 sec
Fault clearing time = 8 sec



Fault time = 5 sec
Fault clearing time = 9 sec





Conclusion & Analysis

Power generated	Max. No. of cycles to clear the fault	Fault occurring time(sec.)	Fault clearing time(sec.)	System Status
30 MW	180	5	8	Stable
	Above 180	5	Above 8	Unstable
40 MW	36	5	5.6	Stable
	Above 36	5	Above 5.6	Unstable
50 MW	18	5	5.3	Stable
	Above 18	5	Above 5.3	Unstable

Thank You