National Institute of Technology, Tiruchirappalli

FAULT ANALYSIS IN POWER SYSTEMS USING MATLAB

Prepared by

107124043 - Harshavardhini

107124052- Keerti A.C

107124057- Lakshana S

107124068- Vani Sri M

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INTRODUCTION

A power system is a complex network consisting of generation, transmission, and distribution components. For reliable and safe operation, it is essential to analyse abnormal conditions that may occur during system operation. One such abnormal condition is a fault, which can result from insulation failure, lightning strikes, equipment malfunction, or human error. Faults cause excessive currents and voltage disturbances that can damage equipment and disrupt power supply.
Fault analysis is an important study in power system engineering as it helps in designing protective devices such as relays and circuit breakers. MATLAB is a powerful simulation tool widely used for modelling and analysing power systems due to its flexibility, accuracy, and ease of visualization. This project focuses on analysing different types of faults in a power system using MATLAB simulation.

FAULTS IN POWER SYSTEMS

Faults in power systems are broadly classified into symmetrical and unsymmetrical faults.

i. **Symmetrical Fault**
   A symmetrical fault occurs when all three phases are short-circuited simultaneously. Although it is rare, it is the most severe type of fault because it results in very high fault currents.

ii. **Unsymmetrical Faults**
   Unsymmetrical faults are more common and include:
   - Single Line to Ground (LG) Fault
   - Line to Line (LL) Fault
   - Double Line to Ground (LLG) Fault

A short circuit or fault occurs when the insulation of a system fails at any location due to one or more of the following reasons:

- Lightening or switching surges
- Wind damage
- Trees falling across lines
- Birds shorting the lines
- Small animals entering switchgear
- Breakage of conductor caused by wind and ice loading.

When a short circuit occurs, a heavy current flows through the network to the point of the fault, and the voltage at the fault point is reduced, reaching o. These faults cause unbalanced currents and voltages in the system and are more complex to analyse.

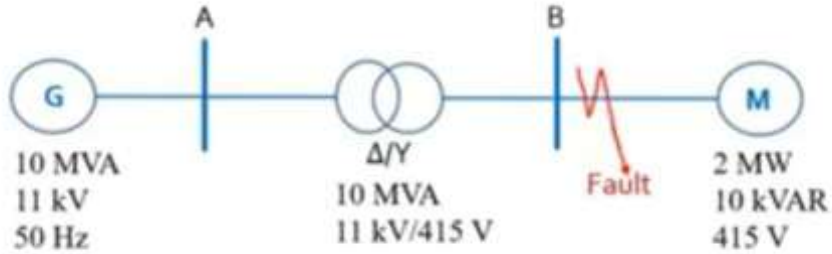
OBJECTIVE

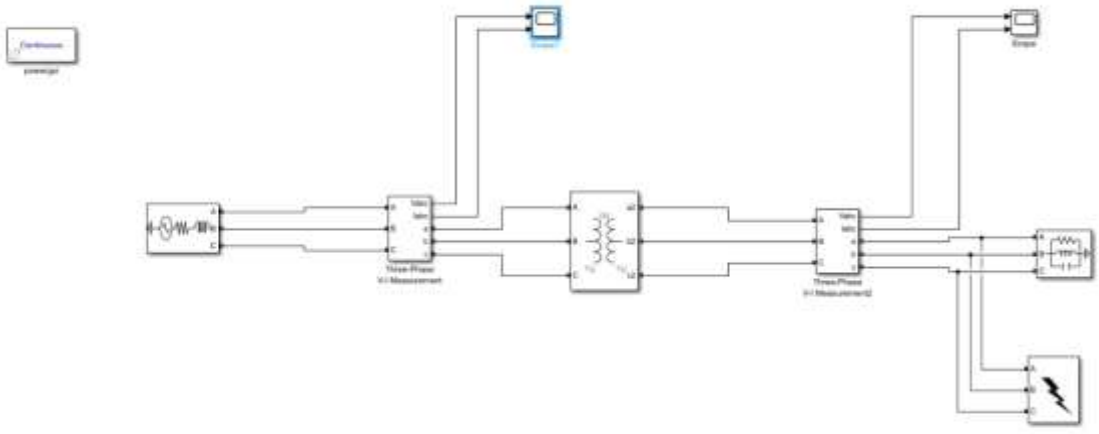
The main objectives of this project are:

- To model a power system using MATLAB
- To simulate different types of faults
- To analyse fault currents and voltages
- To understand the behaviour of the system during fault conditions

MATLAB MODELLING AND SIMULATION

MATLAB along with Simulink is used to simulate the power system. The model consists of a 11Kv,10 MVA,50 Hz three-phase power source block feeding through an 11Kv/415 V, 10 MVA delta/wye transformer to a load consisting of a 2 MW active power and a 10 KVAR reactive power. MATLAB provides built-in blocks for fault simulation, allowing easy configuration of fault type, fault location, and fault duration.
This simulation is used to simulate faults caused by both symmetrical and unsymmetrical conditions.





FAULT ANALYSIS USING MATLAB

i) **Normal Condition**
Under normal operating conditions, the three-phase voltages and currents are balanced and sinusoidal. The system operates within safe limits.

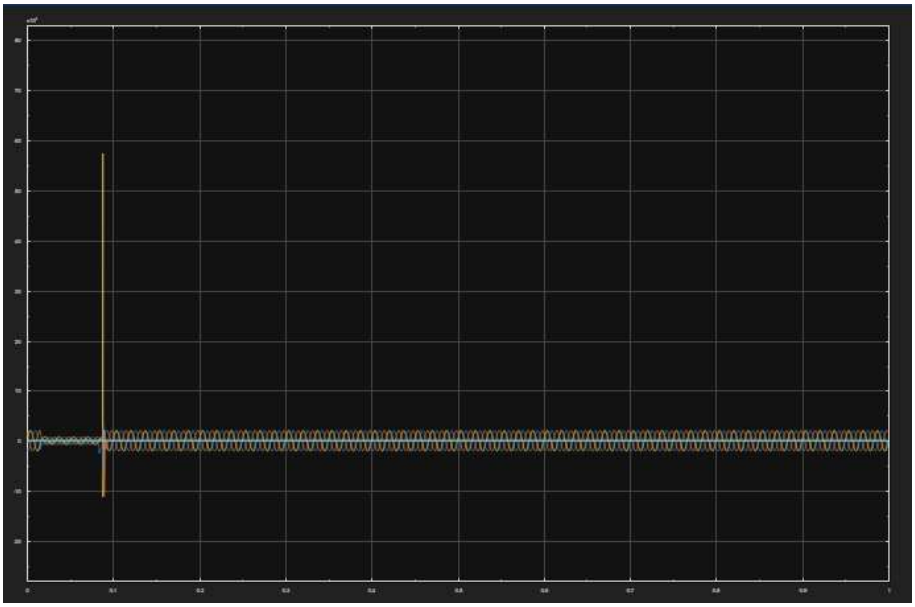
ii) **Single Line to Ground Fault**
When an LG fault is introduced, the current in the faulty phase increases significantly, while the other phases are affected due to imbalance. MATLAB waveforms clearly show distortion in voltage and current of the affected phase.

iii) **Line to Line Fault**
In an LL fault, two phases are short-circuited. High currents flow in the faulty phases, and voltage drops are observed. MATLAB simulation helps visualize these variations effectively.

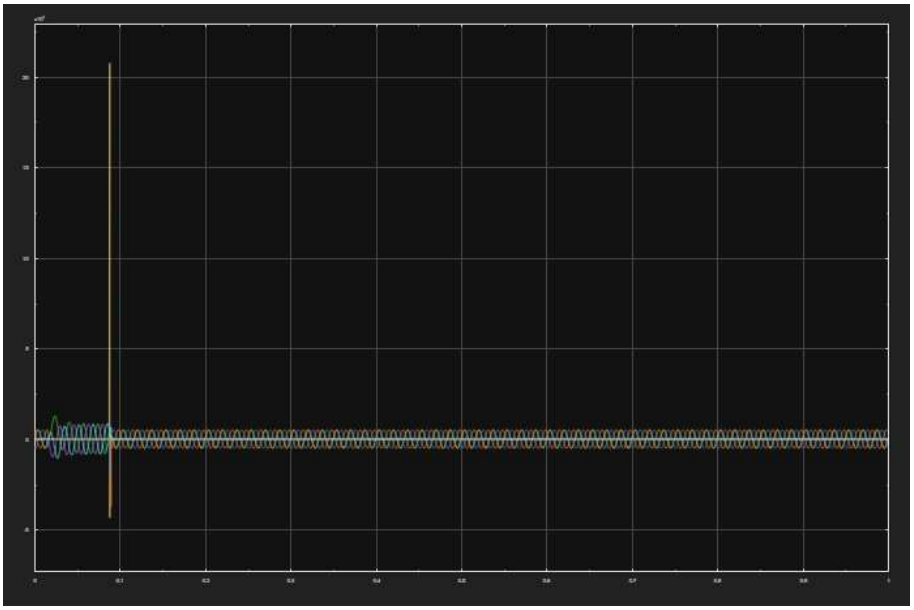
iv) **Three-Phase Fault**
A three-phase fault results in a sudden and severe rise in current in all phases. MATLAB simulation shows symmetrical high-magnitude fault currents, indicating the most critical fault condition.

RESULTS

The simulation results demonstrate that fault currents are much higher than normal operating currents. The severity of the fault depends on the type of fault and system parameters. Three-phase faults produce the highest fault currents, while single line-to-ground faults are the most common in real systems.
MATLAB proves to be an efficient tool for fault analysis as it allows real-time observation of system behaviour, helping engineers design appropriate protection schemes.



V-I characteristics without fault



V-I Characteristics with fault

APPLICATIONS OF FAULT ANALYSIS

1. Design of protective relays and circuit breakers
2. Power system stability analysis
3. Equipment rating and safety assessment
4. Fault detection and isolation

CONCLUSION

This project successfully demonstrates fault analysis in a power system using MATLAB. By simulating different fault conditions, the behaviour of voltages and currents during faults was analysed. MATLAB provides a flexible and accurate platform for understanding power system faults and plays a crucial role in modern power system studies. Fault analysis is essential for ensuring reliability, safety, and efficient operation of power systems.

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