DELHI TECHNOLOGICAL UNIVERSITY

Department of Electronics & Communication Engineering

PROJECT REPORT

ELECTROMAGNETICS (EMT) – EE262

TOPIC - THREE PHASE TRANSMISSION LINE FAULT ANALYSIS USING MATLAB SIMULINK

Submitted to : Prof. Anurag Chauhan

Submitted by : Anshul(**2K19/EC/022**) and Abhay Lakhotra(**2K19/EC/006**)

ABSTRACT

The primary aim of this research work is to build up a MATLAB based Simulation model for 3 phase symmetrical and unsymmetrical faults. This paper ways to deal with the MATLAB programming in which transmission line model is composed and different issues has been reenacted utilizing tool compartment(MATLAB Simulink). Fault Analysis for different sorts of faults has been done and it's impacts are appeared in simulation output, for example, voltage, current, control alongside the positive, negative and zero grouping segments of voltage and current output as far as waveforms. By analyzing waveforms we can calculate which fault occurring is maximum and what are the safety measurement that we can include in the power system to overcome this fault.

INTRODUCTION

The fault occurring in power system can be broadly classified into symmetrical and unsymmetrical fault. In case of symmetrical faults, the fault current is same in all three phases and the system remains in balanced even after fault occurrence. Therefore the symmetrical fault condition can be analyzed conveniently. In case of unsymmetrical fault current value are different in each phase. The faults that occur in a power system are

a. Single-line-ground fault

b. Double-line-ground fault

c. Three-line-ground fault

These faults are also called as short circuit fault which are common on transmission lines. These faults occur due to different factors like insulation failure of equipment caused by lightning and switching surges are coming in contact and also when foreign object came in contact with bare power lines. The foreign objects may be falling of trees on line or birds shorting outlines.

In this paper we are using an MATLAB Simulink. MATLAB stands for matrix laboratory. Simulink is a MATLAB-based graphical programming environment for modeling, simulating and analyzing multidomain dynamical systems. Its primary

interface is a graphical block diagramming tool and a customizable set of block libraries.

BLOCK LIBRARIES

MATLAB/SIMULINK tool compartment comprises of:
a. Mat Power Tool compartment
b. Power System Analysis Tool kit and
c. Voltage Stability Tool kit.

The PSB is a realistic device that permits building schematics and recreation of force frameworks in the SIMULINK environment. The block set uses the SIMULINK environment to speak to basic segments and networks found in electrical power systems. It comprises of a block library that incorporates electrical models, for example, RLC branches and loads, transformers, lines, surge arrester, electric machines, control devices, and so on. Outlines can be gathered just by utilizing snap and drag strategies into SIMULINK windows. The Power system Block set utilizes a similar drawing and intelligent discourse boxes to enter parameters as in standard SIMULINK pieces. The Machines groups contain simplified and detail models of synchronous machine, asynchronous machine, a permanent magnet synchronous machine, a model of hydraulic turbine governor, and an excitation system. Every machine block has a SIMULINK output returning estimations of inside factors. The PSB graphical interface (Powergui) incorporates an intuitive instrument to set introductory conditions. This permits reproduction with beginning conditions, or to begin the recreation with enduring state. A heap stream computational motor permits instating three-stage circuits containing synchronous and

asynchronous machine, so that the recreation specifically begins in enduring state. Reproduction results can be envisioned with SIMULINK scopes associated with yields of estimation pieces accessible in the PSB library. This estimation block goes about as an interface between the electrical pieces and the SIMULINK squares. The voltage and current estimation blocks can be utilized at chose focuses as a part of the circuit to change over electrical signs into SIMULINK signals.

1. **Three phase source** : The Three-Phase Source block implements a balanced three-phase voltage source with an internal R-L impedance. The three voltage sources are connected in Y with a neutral connection that can be internally grounded or made accessible. You can specify the source internal resistance and inductance either directly by entering R and L values or indirectly by specifying the source inductive short-circuit level and X/R ratio.

2. **Three phase breaker** : The Three-Phase Breaker block implements a three-phase circuit breaker where the opening and closing times can be controlled either from an external Simulink® signal (external control mode), or from an internal control timer (internal control mode). The Three-Phase Breaker block uses three Breaker blocks connected between the inputs and the outputs of the block. You can use this block in series with the three-phase element you want to switch. The arc extinction process of the Three-Phase Fault block is the same as for the Breaker block. See the Breaker block reference pages for details on the modeling of the single-phase breakers.

3. **Three phase V-I measurement** : The Three-Phase V-I Measurement block is used to measure instantaneous three-phase voltages and currents in a circuit. When connected in series with three-phase elements, it returns the three phase-to-ground or phase-to-phase peak voltages and currents.

4. **Three phase fault,** which will be induced in this circuit before load

5. **Three phase series RLC load**

6. **Step-function** : actuates the fault mechanism. We have taken step time equal to 0.1 second. When t=0.1 sec, a pulse will be generating from step function and it enters the three-phase fault and the fault will occur.
   Its initial and final values always 0 and 1 respectively.

7. **Scope –** The scope block displays its input w.r.t simulation time. It allows us to adjust the amount of time and the range of displayed input values.

8. **Demux –** 1 input and 3 outputs. Also, we can change the number of outputs.

9. **Powergui** : The powergui block allows you to choose one of these methods to solve your circuit :
   Continuous, which uses a variable-step solver from Simulink.
   Discretization of the electrical system for a solution at fixed time steps.
   Continuous or discrete phasor solution. The powergui block also opens tools for steady- state and simulation results analysis and for advanced parameter design.
   This block is necessary for simulation of any Simulink Model containing SimPower Systems blocks.

TRANSMISSION LINE FAULTS

As discuss above in three-phase transmission line of power system mainly two types of fault occurs, balance fault which is also called symmetrical fault and unbalance fault called as unsymmetrical fault. But this paper only deals with the unsymmetrical fault which mainly occurs between two or three conductors of the three-phase system or some time in between conductor and ground.
Contingent on this the unsymmetrical faults can be characterized into fundamental three sorts:-

- Single Line to Ground fault.
- Double Line fault.
- Double Line to Ground fault.

The frequency of occurrence of the single line to ground fault is more in the three phase system followed by the L-L fault, 2L-G fault and three phase fault. During electrical storms these types of fault occurs which may result to insulator flashover and ultimately affect the power system. To study and analyze the unsymmetrical fault in MATLAB there is a need of developing a network of positive, negative and zero sequence. In this project we analysed positive, negative and zero sequence voltage and current at different fault situation. In addition to this we analyzed the active and reactive power and rms bus current and voltage of the system at various fault condition.

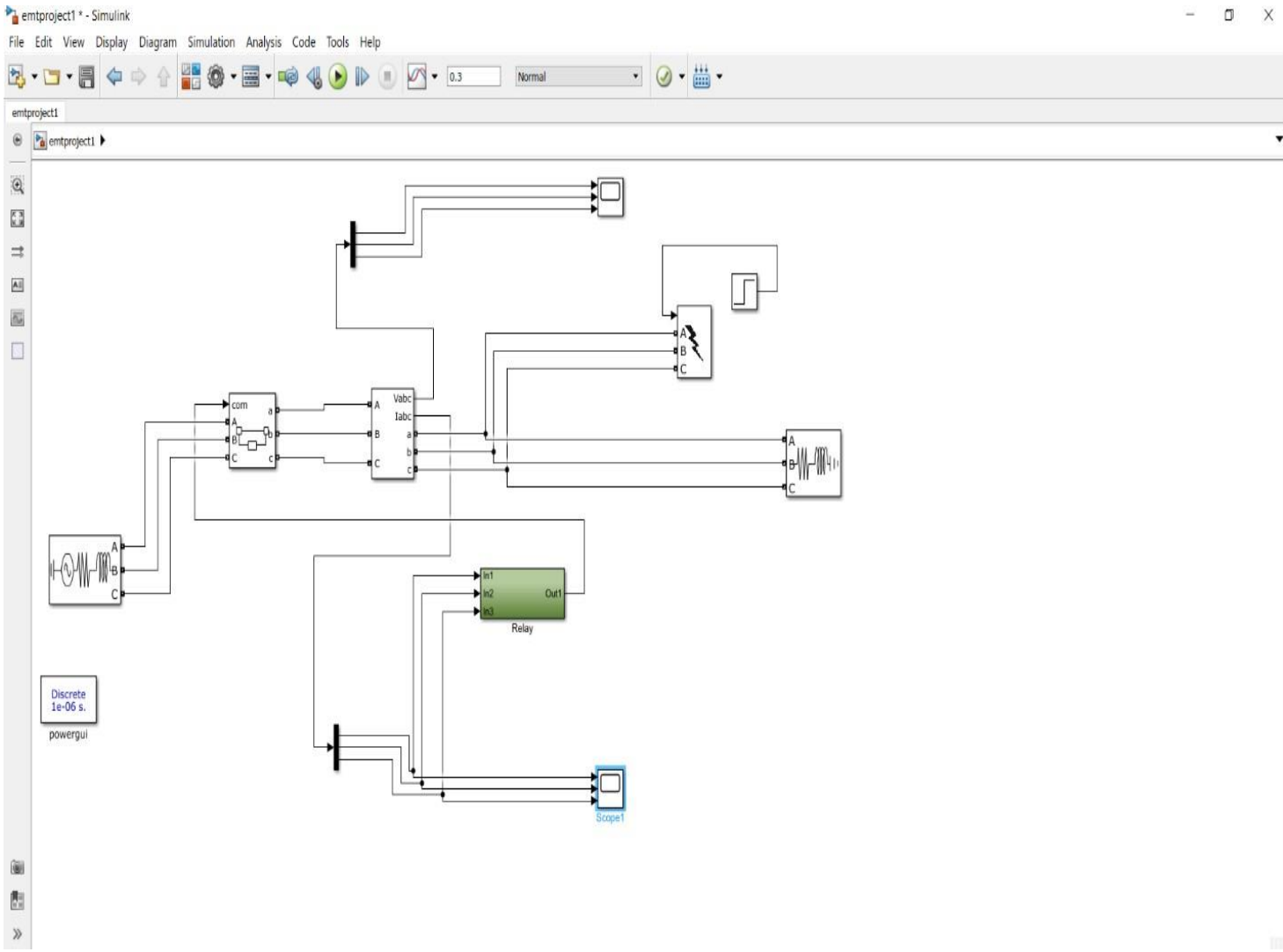
PROTECTIVE RELAYS

A **protective relay** is a relay device designed to trip a circuit breaker when a fault is detected.

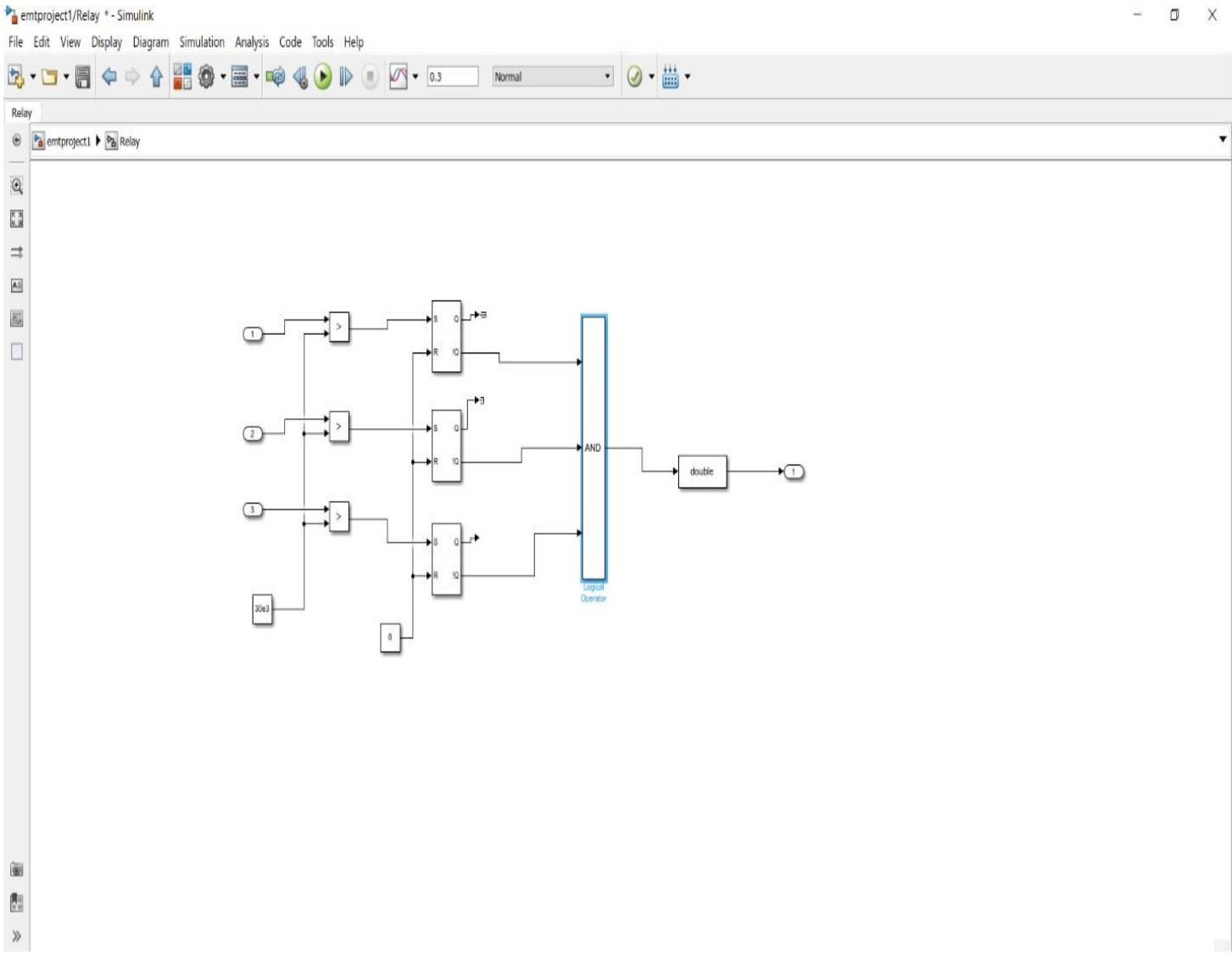
Types according to construction :
1. *Electromechanical Relays*: They are the first generation of relays. They use the principle of electromechanical conversion. They are rugged & immune to electromagnetic interference. But with recent advancements, they have been turned obsolete in most areas.
2. *Solid State Relay*: They make use of transistors, op-amps, etc. They are more flexible with a self-check facility, consuming less power and having improved dynamic performance than the electromechanical relays. They also were smaller in size requiring less panel space.
3. *Numerical Relays*: **Numerical relays** are the evolved form of a static and electromagnetic relay. They are basically a device used for measuring electric parameters in an electrical network and convert them into numerical data which undergoes mathematical and logical analysis to decide on tripping an electrical network.

The main purpose of a numerical relay is to protect the electrical network from unexpected fault currents. Numerical relays are mostly preferred because of their versatile characteristics. A **single Numerical relay can monitor multiple parameters like current, voltage, Frequency, onset time, offset time, etc**. And the same relay can be used for analysing and monitoring multiple faults such as over current, over fluxing, different current and more.

SIMULATION MODEL



RELAY SUBSYSTEM

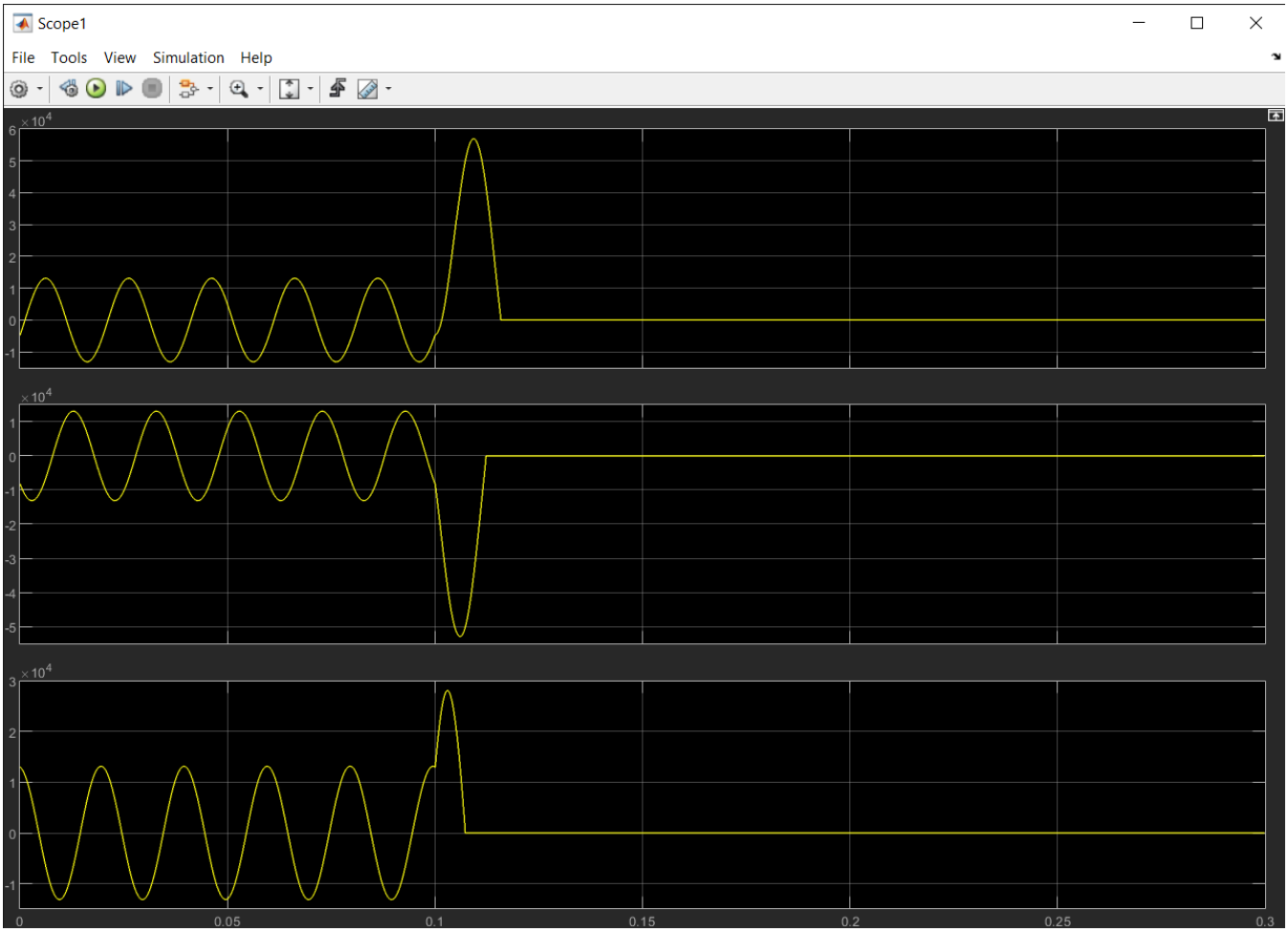


STEP BY STEP PROCEDURE ON DEVELOPMENT OF CIRCUIT MODEL

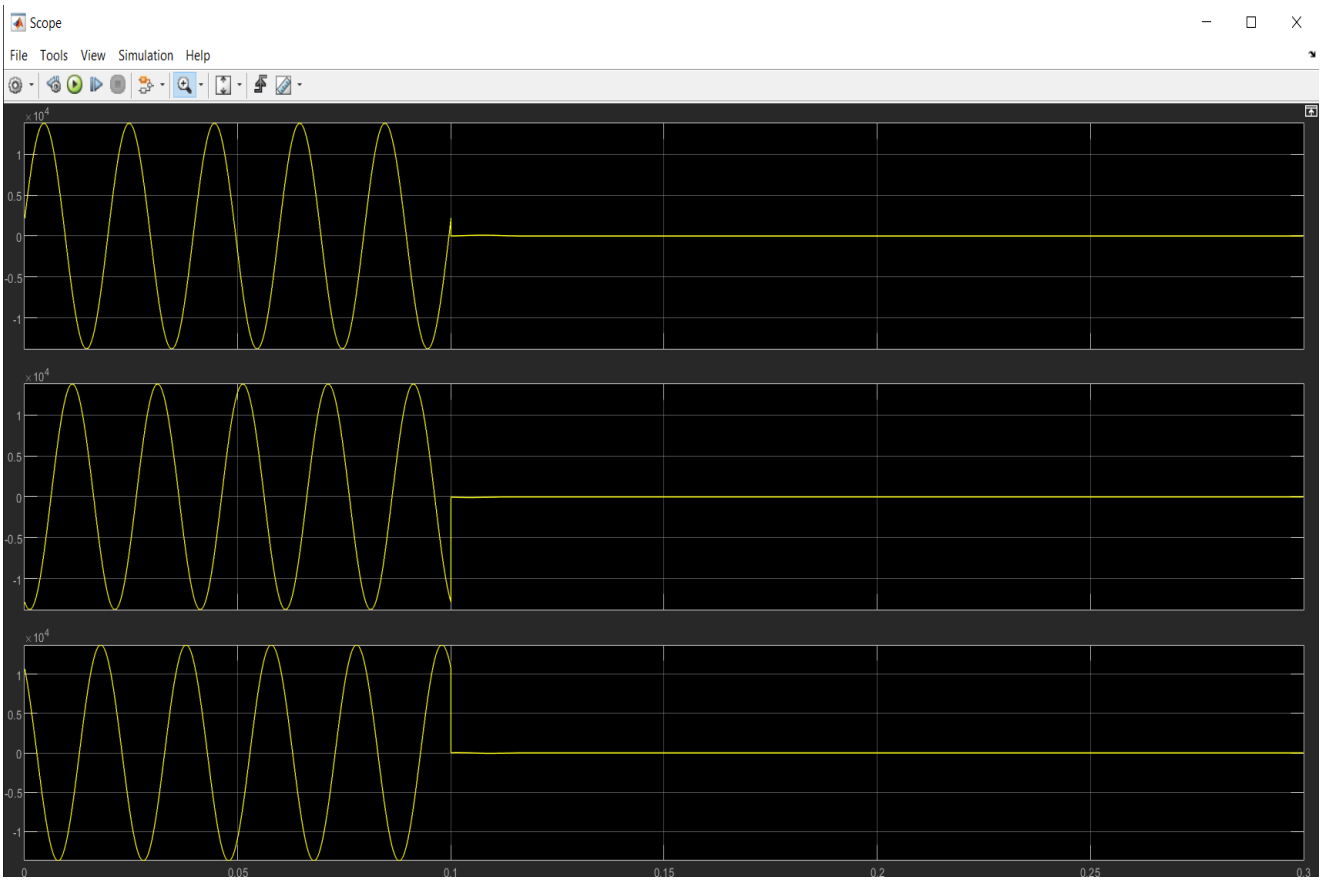
- Open MATLAB Simulink (Blank Model).
- Select the required blocks from the library(SimPower Systems Library).
- Then connect the blocks as per the above simulation model.
- Run Test.
- Create user defined Current & Voltage waveform.
- Save the generated plots.

SIMULATION RESULTS

In this particular case, the Distribution system model runs for a Three Phase to Ground Fault. The simulation is done for 0.3 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 50Hz. The system voltage is taken as 11 kV and the line length is taken as 10 kms. Fault is started at 0.1 secs and cleared at 0.3 secs as shown in Figure. These parameters have been kept constant for other test cases as well. The proposed matlab model can be ran standalone or on the GUI to view the plots.



Three phase fault current waveform



Three phase fault voltage waveform

FUTURE EXTENSIONS IN THE PROJECT

In this proposed project work is extended by simulating the unsymmetrical fault such as Double Line to Ground fault, Line to Line fault and Single Line to ground fault.

INDIVIDUAL CONTRIBUTION

Work done by Anshul (2K19/EC/022)

- MATLAB Simulink
- Basics of three phase system and transmission line faults
- Designed the basic diagram of simulation model
- Verified the output plots
- Preparation of Report

Work done by Abhay Lakhotra (2K19/EC/006)

- MATLAB Simulink
- Basics of three phase system and transmission line faults
- Performed the simulation model and resolved the errors
- Verified the output plots
- Preparation of PPT

References

1. **https://www.ijsr.net/conf/NCKITE2015/13.pdf**
2. **https://en.wikipedia.org/wiki/Transmission_line#:~:text=In%20electrical%20engineering%2C%20a%20transmission,must%20be%20taken%20into%20account.**
3. **https://en.wikipedia.org/wiki/Protective_relay#:~:text=In%20electrical%20engineering%2C%20a%20protective,when%20a%20fault%20is%20detected.**
4. **https://www.youtube.com/watch?v=dyK_t3NneQc**