DELHI TECHNOLOGICAL UNIVERSITY
EE-304: POWER SYSTEM ANALYSIS

SUBMITTED TO PROF. RACHNA GARG
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TOPIC : DETECTION AND ANALYSIS OF FAULT IN THE TRANSMISSION LINE

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CERTIFICATE

This is to certify that Simulink project titled "DETECTION AND ANALYSIS OF FAULT IN THE TRANSMISSION LINE" is the record of work done by Arun Nair and Azim Faruki , students of B.Tech (Electrical Engineering), Delhi Technological University as a part of their Innovative project for the 6th semester . This simulink project was carried out under my guidance and supervision.

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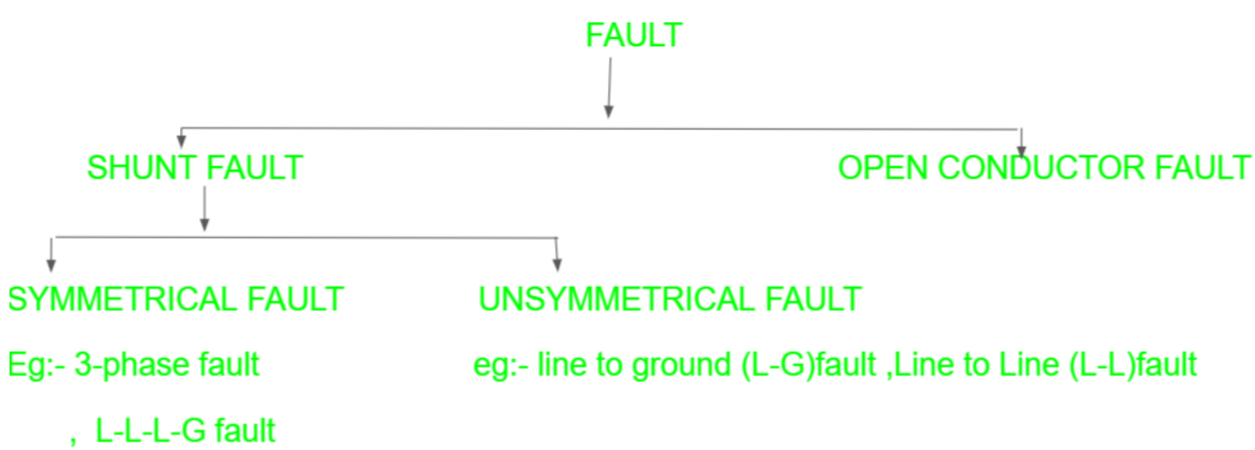
1. FAULT AND ITs TYPE

- The main purpose of is to properly design a switchgear
- The most common fault occurs in a power system is transmission line fault because it is exposed to wide number of natural phenomena
- The main key points or quality that show that which type of phenomena is fault

1) Fault is high current
2) Low voltage
3) High frequency
4) Low power factor
5) Highly lagging
6) D-axis phenomena



Symmetrical fault :- it is a type of fault in which system become stable before and after fault eg:- 3-phase fault,L-L-L-G

Unsymmetrical fault :- it is a type of fault in which a balanced system will unbalanced after fault eg :- line-ground , L-L , L-L-G

- Fault current has two part (component)

  Ac fault current and Dc offset current but due to soe irregularity and to ease the calculation or finding method we can ignore the dc offset current hence

  Fault current = rms value of ac fault current

- The fault study are divided into three state

1) Subtransient state
2) Transient state
3) Steady state

2) MATHEMATICAL CALCULATION TO FIND OUT THE FAULT CURRENT WHICH WAS DETECTED IN THE TRANSMISSION LINE

Here we are calculated different fault current with their respected method as we already discuss there are three state of fault in the fault
1)subtransient state
2)transient state
3)steady state

A derived mathematical formula to calculate resultant ac fault current for all three type of state of fault used for all type of fault

Iac(t)=sqrt(2)*Eg[((1/Xd”)-(1/Xd’))*exp(-t/Td”)+((1/Xd’)-(1/Xd))*exp(-t/Td’)+(1/Xd)]Sin(wt+B)

Where Eg = prefault phase to neutral voltage of machine , Xd”=direct axis subtransient reactance
Xd’=direct axis transient reactance , Xd=direct axis steady state reactance
Td”=direct axis short circuit subtransient time constant , Td’=direct axis transient time constant

Here we know that Td”<< Td’ (rate”>>rate’)

If”=Eg/Xd” (subtransient fault current or initial sysm. Rms current) at (t=0+)

$I_f' = E_g/X_d'$ (transient fault current) between ($T_d'' < t < T_d'$)
$I_f = E_g/X_d$ (sustain fault current) at ($t > T_d'$)

Due to sudden change in current in the transmission line reluctance gose increase and attain a very high value therefore the inductance at subtransient state is goes very low ($L \propto 1/\text{reluctance}$)hence the reactance is very low therefore as the time increases reluctance decreases and inductance increases hence reactance increases($X_d'' < X_d' < X_d$).

The procedure to calculate L-L-L-G , L-L , L-G , fault are nearly same but with very minimum change which is held due to the unbalance network in unsymmetrical fault.

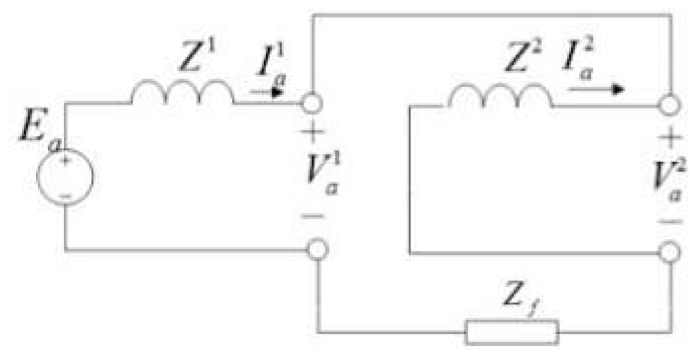
#Steps to calculate the symmetrical 3-Φ fault

1) Draw the per phase per unit equivalent circuit of the system
2) Find thevenin equivalent circuit between faut point and neutral
3) If solid fault occurs the short circuit the equivalent circuit and calculate the amount of current (I = Vth/Zth)

- Before discussing about unsymmetrical fault let as know about C.L Fortescue method to resolve 3-Φ unbalance system to 3- component namely positive component , negative component and zero component
- Positive component is same as balanced system and negative component has

 # Step calculation to calculate the unsymmetrical 3-Φ fault

1) Draw the positive negative and zero sequence network of the unbalanced system
2) Find the thevenin equivalent circuit between fault point and ground for all three sequence network(+ve , -ve , zero)



$I_a^1 = -I_a^2$ $\qquad$ $I_a^1 = \dfrac{E_a}{(Z^1 + Z^2 + Z_f)}$

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Fig: Thevenin Equivalent Circuit diagram of line to line fault

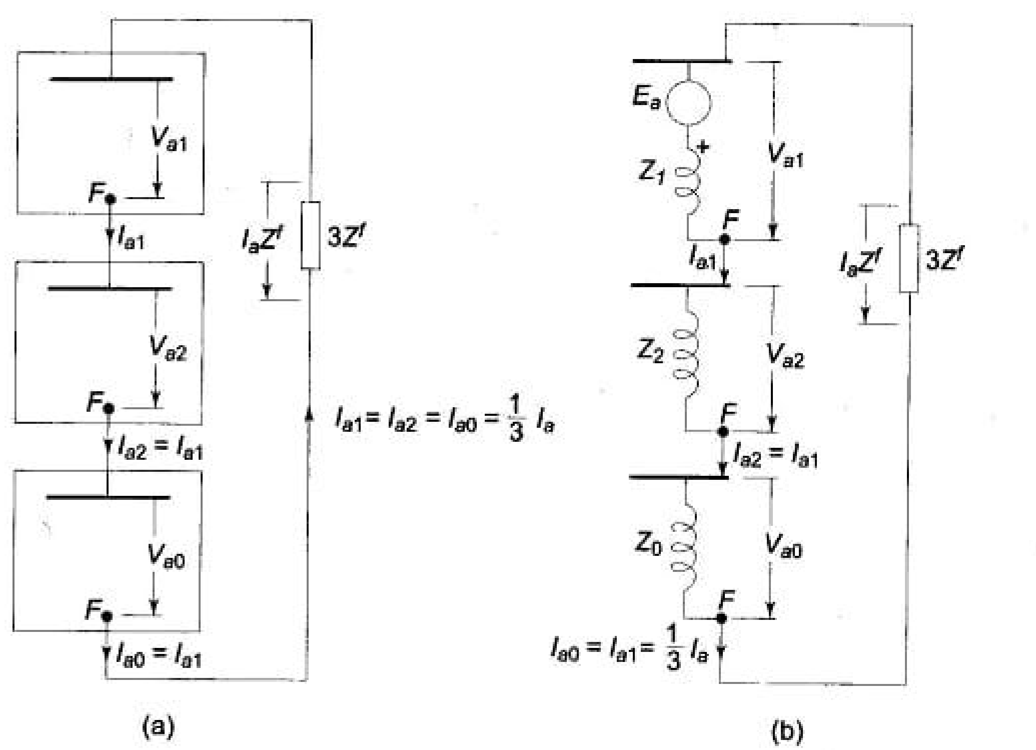


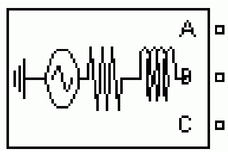
Fig. 11.5 Connection of sequence network for a single line-to-ground (LG) fault

3) Connect the 3 thevenin equivalent circuit according to the type of fault and solved the complete fault analysis.

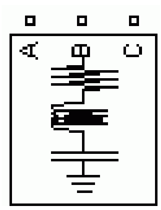
3) Components Required in Simulink Model

1) **Discrete Measurement :** It allows us to solve the electric discretization of the electrical system for a solution at fixed time steps.

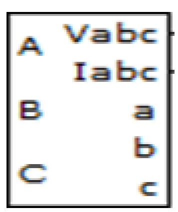
2) **Three phase Source:** This block implements a balanced three-phase voltage source with an internal R-L impedance.



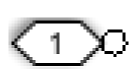
3) **Three Phase RLC load:** It implements three balanced branches consisting each of a resistor, an inductor, or a capacitor or a series combination of these.



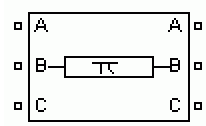
4) **Three Phase VI Measurement:** This block is used to measure instantaneous three phase voltages and currents in a circuit.



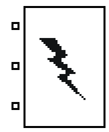
5) **Connection Port:** The Connection Port block transfers a physical connection or signal across subsystem boundaries.

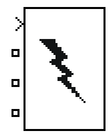


6) **Three-Phase PI Section Line:** The Three-Phase PI Section Line block implements a balanced three-phase transmission line model with parameters lumped in a PI section.

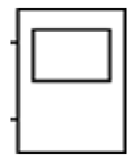


7) **Three-Phase Fault:** The Three-Phase Fault block implements a three-phase circuit breaker where the opening and closing times can be controlled either from an external Simulink signal, or from an internal control timer.

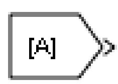




8) **Scope:** This block displays time domain signals with respect to simulation time.

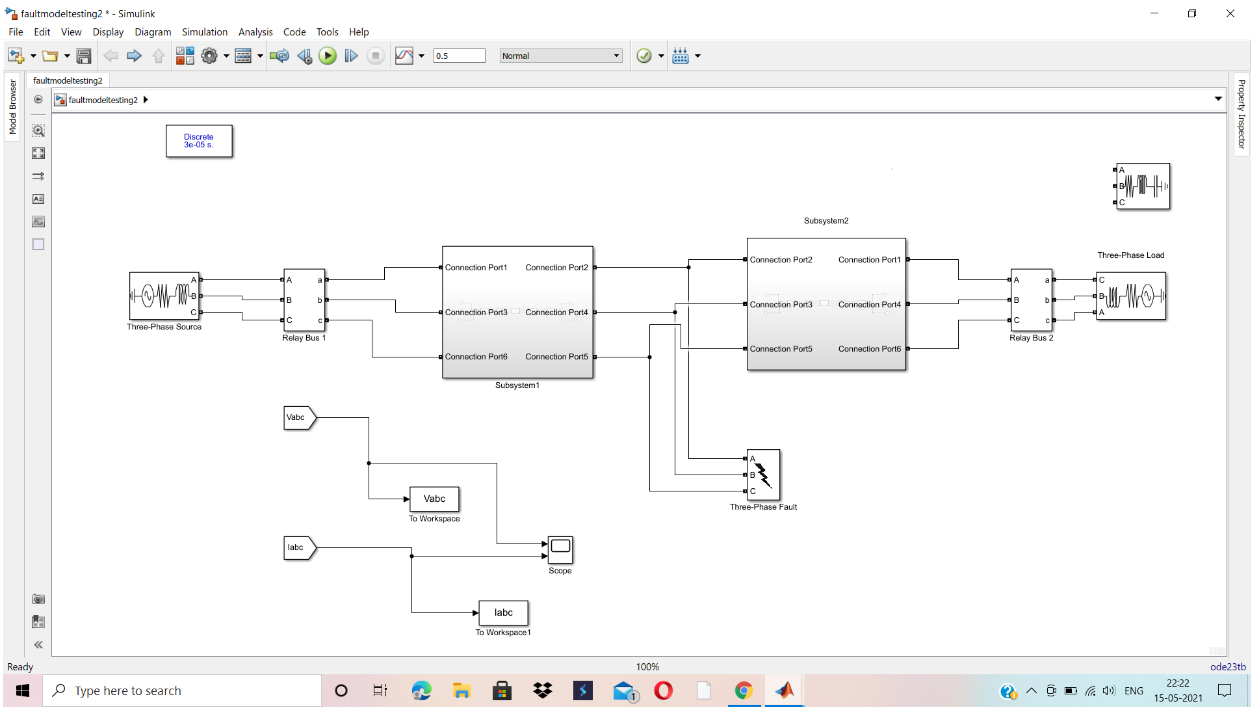


9) **From:** The From block accepts a signal from a corresponding Goto block, then passes it as output. The data type of the output is the same as that of the input from the Goto block.

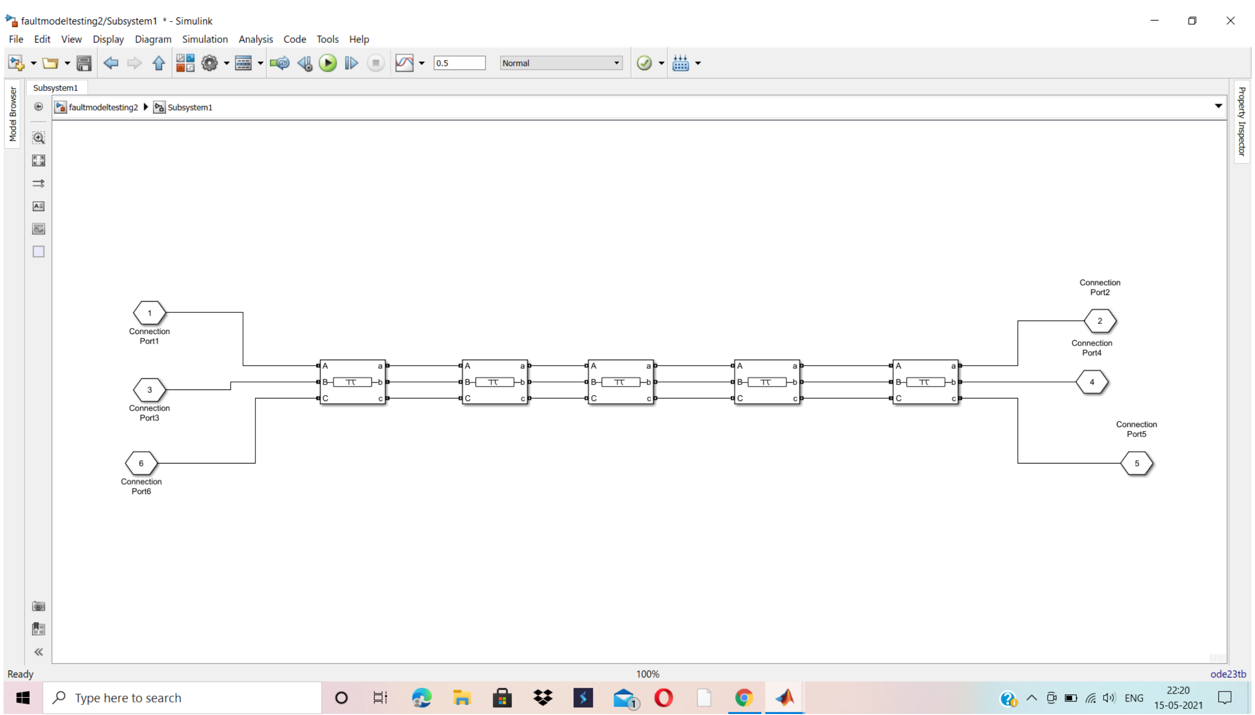


10) To Workspace: The To Workspace block writes input signal data to a workspace. During simulation, the block writes data to an internal buffer. When you pause the simulation or the simulation completes, that data is written to the workspace. Data is not available until the simulation pauses or stops.

4) Simulink Model



Subsystem



5) Output Waveforms

1) Output of the simulink was shown in two graphs in which the upper graph is between voltage vs time and lower graph was between current vs time.

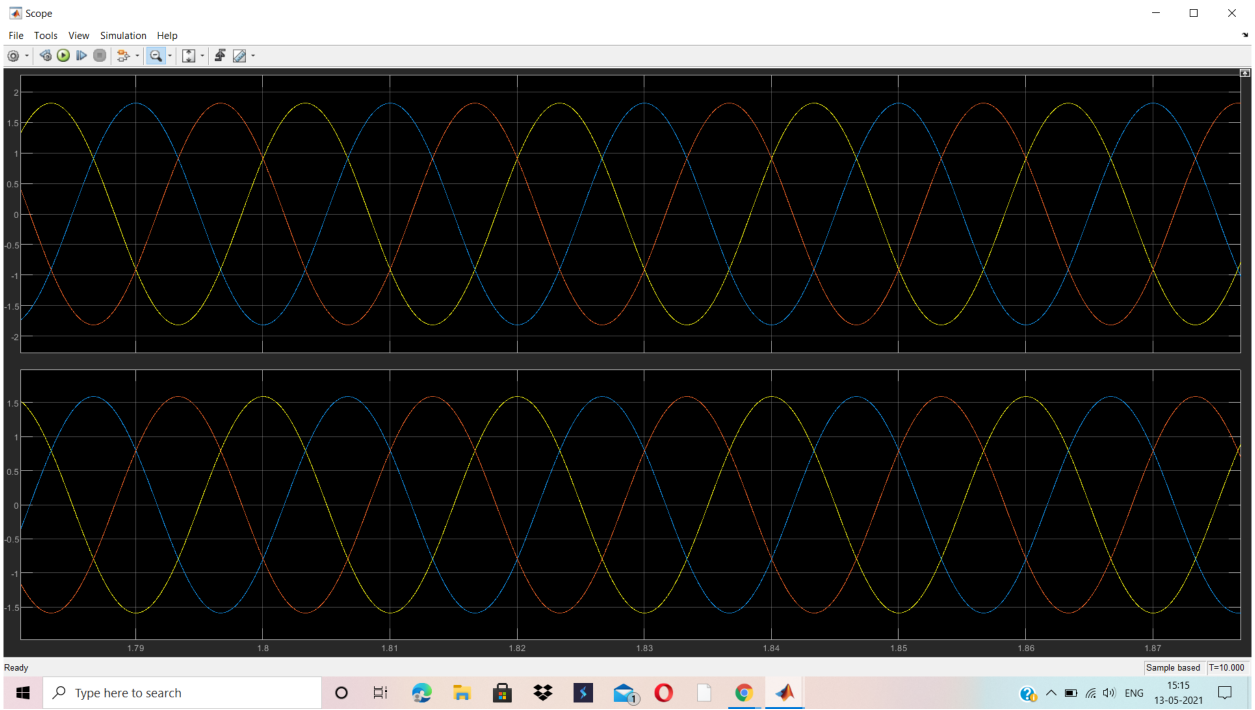
2) As we all discussed above that fault is a low voltage and high current phenomenon, hence we found visual disturbance in the current vs time graph.

3) Due to the fault the current amplitude of the respected phase in which fault occurs goes high and shows disturbance for a time period Td'' and then reduces slightly and then comes to original amplitude after Td' time.

Four types of output waveforms are shown below :-

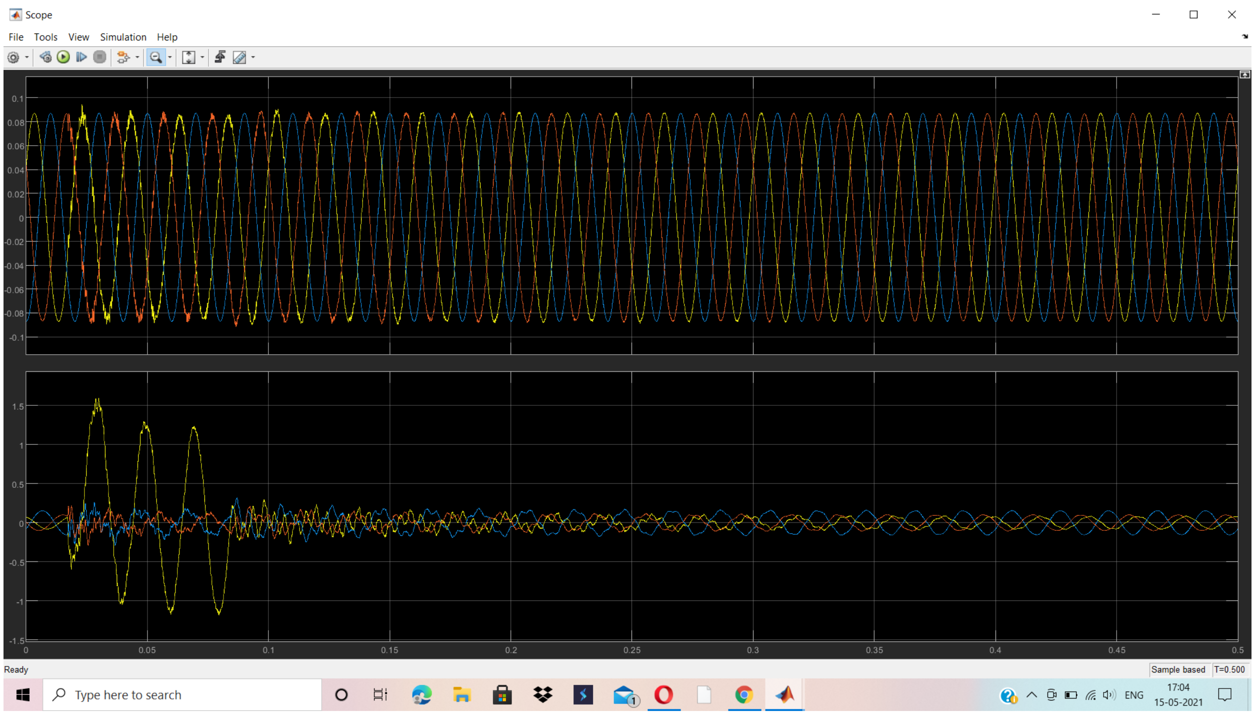
1) Output without any fault
2) Line-Ground fault
3) Line to Line fault
4) Line-Line-Line-Ground fault

1) Output without any fault



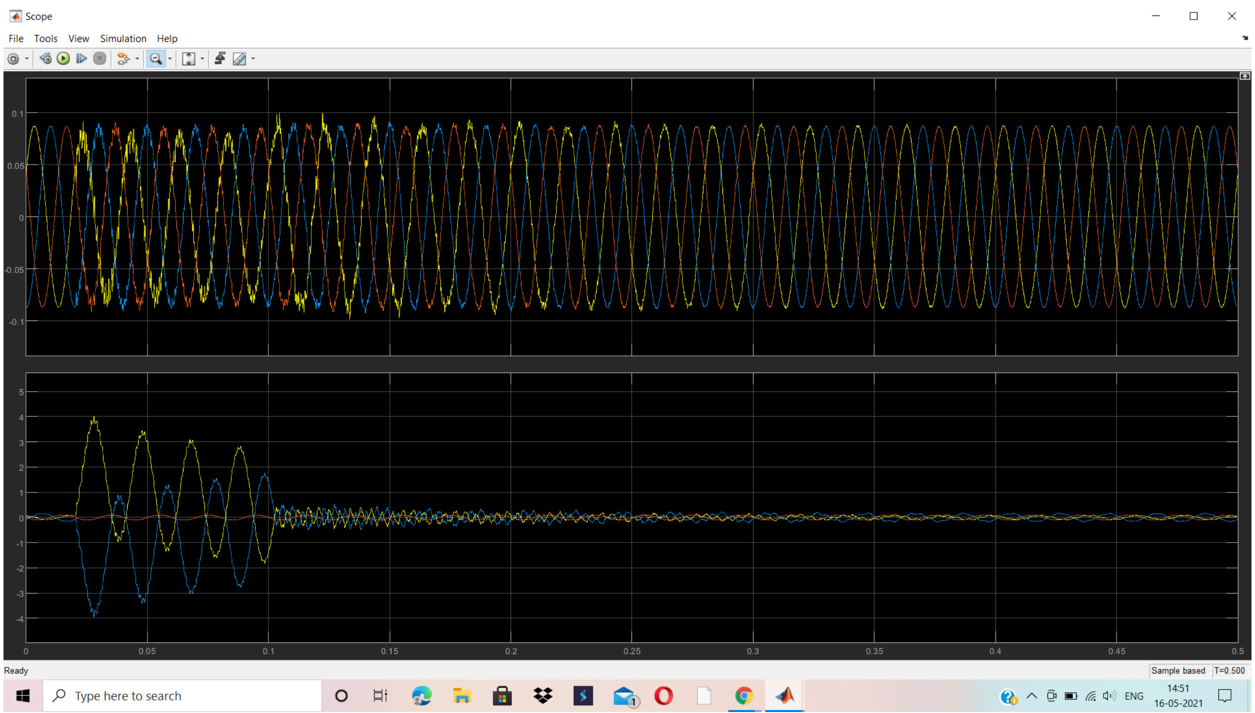
- Now in the first output we found that without fault in the system there are no disturbances present in the system hence it is working as a balanced system.

2) Line-Ground fault



- Now in the 2 output we put an unsymmetrical fault which is L-G fault in this we take fault at the phase A and ground hence the phase A current amplitude of the graph goes high and rest of the phase current are remain same or the voltage graph remain same(unchanged). As we discussed in the above point that the disturbance take place for some time interval (subtransient + transient)after this the graph attain its original value as shown in the output.

3) Line to Line fault



- Now in the 3 output we put an unsymmetrical fault which is L-L fault in this we take fault at the phase A and phase B hence the phase A and B current amplitude of the graph goes high and rest of the phase current are remain same or the voltage graph remain unchanged(very minimal change occurs). As we discussed in the above point that the disturbance take place for some time interval (subtransient + transient)after this the graph attain its original value as shown in the output .

4) Line-Line-Line-Ground fault

- Now in the 4 output we put an symmetrical fault which is L-L-L-G fault in this we take fault at all the phases and ground hence the current amplitude of the graph of all the phases was disturbed and amplified but the voltage graph remained unchanged (very minimal change occurs). As we discussed in the above point, the disturbance takes place for some time interval (subtransient + transient)after this the graph attains its original value as shown in the output .

6) CONCLUSION

1) This project was used to detect which of the faults took place in the transmission line with the help of the respected graph of the simulink output.

2) Through this project we found that the fault is a high current and low voltage phenomenon therefore only the current waveform got disturbed highly and the voltage waveform got disturbed very slightly .

3)Fault has 3 states which are subtransient , transient and steady state

4)Fault analysis was used to design a circuit breaker .

5)We found that an unbalanced system can be broken into 3 balance systems by C.L.fortescue.

6)Through this we can approach a major project in the underground transmission line where the fault takes place so that workers can dig the particular area to remove the fault.

7) REFERENCES

1) A.G. Phadke, J.S. Thorp Computer Relaying for Power Systems, 2nd Edition, A John Wiley and Sons, Ltd (2009)

2) Bao Lian and M.M.A. Salama (1994). An overview of digital Fault Location Algorithms for power transmission lines using transient waveforms, Electric Power Systems Research

3) J.A. Jiang, J.Z. Yang, Y.H. Lin, C.W. Liu, J.C. MaAn adaptive pmu based fault detection/location technique for transmission lines. i. theory and algorithms.

4)“Three Phase Fault Analysis with Auto Reset for Temporary Fault and Trip for Permanent Fault”,Sathish Bakanagari1, A. Mahesh Kumar2, M. Cheenya 312(Asst.prof in EEE Department) 3(Asst.Prof in ECE Department) Mahaveer Institute of Scienceand Technology, bandlaguda, Hyderabad.A.P.

5) Power system analysis notes of Prof. Bhupinder singh senior faculty of made easy.