Handout no. 12

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Marks/Grade	

EXPERIMENT # 12

Modeling of Impedance Relay in Simulink

Objective:

At the end of this lab session students will be able to

- Use "Sim Power Systems" for modelling the power system.
- Implement "Impedance Relay" by using Matlab Simulink Libraries.
- Set the impedance of "Impedance Relay".
- Learn how to create an electrical subsystem.

Introduction:

Utilities are responsible for the generation, transmission and distribution of electricity to customers. Part of this responsibility is ensuring a safe but yet reliable power supply to customers. For the purpose of safety and protecting the transmission and distribution network from faults, utilities worldwide have sophisticated protective equipment. Collectively, these are known as secondary equipment and include the current transformers (CT), potential transformer (PT) and protective relays.

Protective relays:

A protective relay is one which monitors the current, voltage, frequency or any other type of electric power measurement either from a generating source or to a load for the purpose of triggering a circuit breaker to open in the event of an abnormal condition. In the electrical power system these relays are called as protective relays.

The function of protective relaying is to cause automatic removal of a part of the system, when it suffers a short circuit, or when it starts to operate in an abnormal manner that might cause damage or otherwise interference with the effective operation of the rest of the system. Relays are also used for the prompt removal of any part of the system from the service, for the purpose of maintenance.

Circuit Breakers:

Circuit breakers are generally located so that each generator, transformer, bus, transmission line, etc. can be completely disconnected from rest of the system. These circuit breakers must have sufficient capacity so that they can carry momentarily the maximum short-circuit current that can flow through them, and then interrupt this current.

Impedance Relay:

The impedance relay is used for protection of long transmission lines. If impedance is less than threshold circular value of relay than it will trip the breaker. If the value of impedance lies outside the circle than it will restrain the circuit breaker. So when fault occurs the current increases and voltage decreases and value of impedance will be decreased than threshold level.

Procedure:

Step 1: Draw a simple power system having a **3-φ** Variable Source, **3-φ** phase circuit breakers, **3-φ** VI measurement unit, **3-φ** RLC series load and block of **3-φ** fault to implement different types of fault in system. Connect the blocks as shown below.

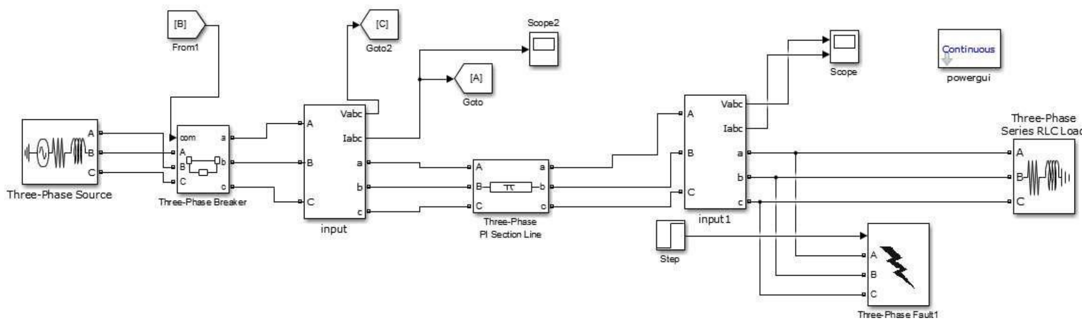


Figure 1: Block Diagram of three phase system

Set the parameters of each block as mentioned below. Accept default values for all other Parameters.

Total Simulation Time: 0.5 s
Solver: Ode23tb (stiff/TR-BDF2)

Note: To select the solver go to menu bar > Simulation > Configuration Parameters OR press (Ctrl + E) and select the solver. Also set following solver options.

Relative tolerance: 1e-3 (default)
Solver reset Method: Robust
System Frequency: 50 Hz

Three phase Programmable Voltage source:
Voltage (Phase to Phase): 11e3 V
Internal connection: Y grounded
Specify impedance using short-circuit level: Select this option

Three-Phase Breaker:
Initial status of breakers: closed
Enable switching of all Phases
External control of switching times: Select this option
Measurements: None
Breakers resistance **R_{on}:** 0.001

Snubbers resistance **Rp:** 1e6
Snubbers capacitance **Cp**: inf

Three-Phase V-I Measurement:
Voltage measurement: phase-to-phase
Current measurement: Yes
(Uncheck **labels** and **per-unit** measurements)

Three-Phase Series RLC Load:
Configuration: Y grounded
Nominal voltage: 11e3 V
Active Power (MW): **200e6** W
Inductive reactive power: 100 VAR
Capacitive reactive Power: 0 VAR

Step 2: when the fault is introduced the voltage is decreased and current is increased but the overall the value of impedance will be decreased. If the overall value of impedance is less than threshold value than it will send trip signal to circuit breaker.

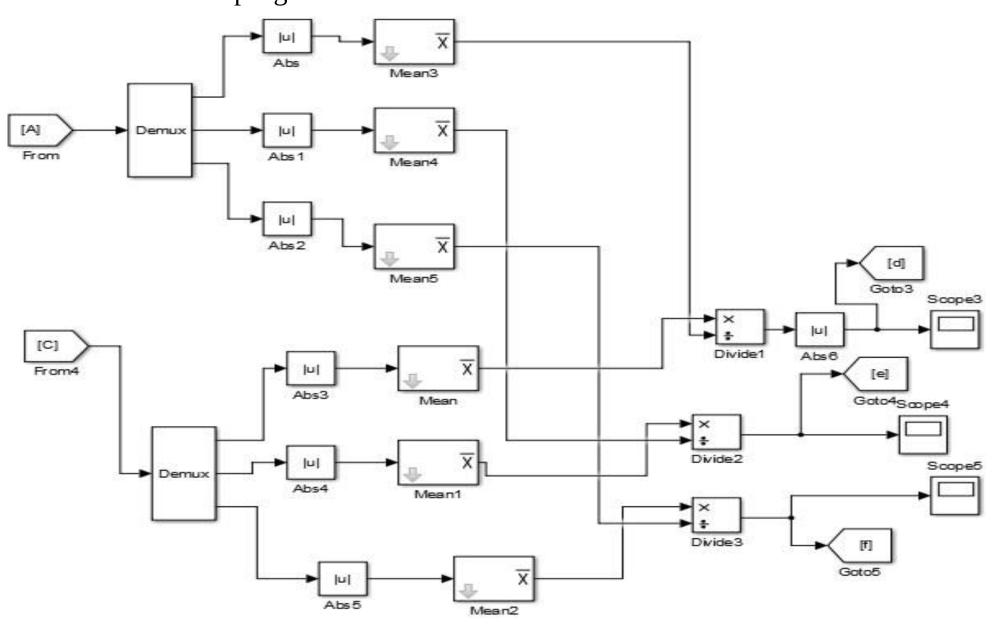


Figure 2: Impedance Relay

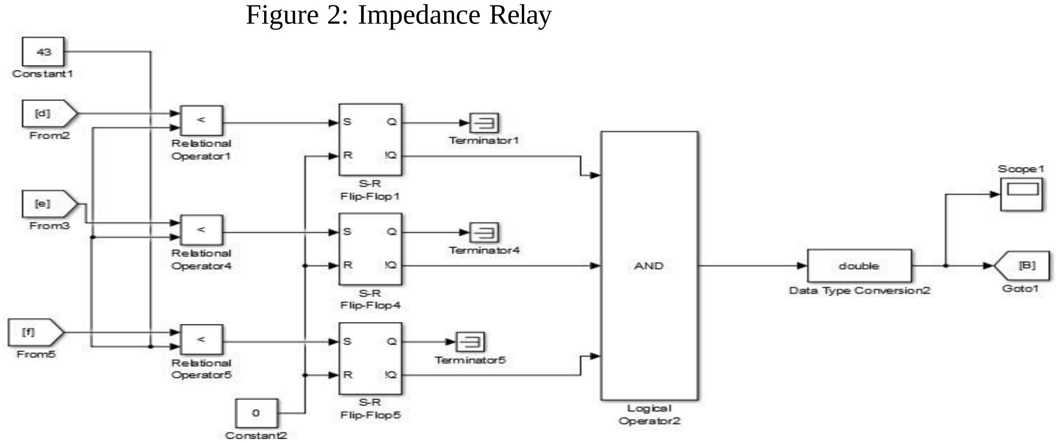
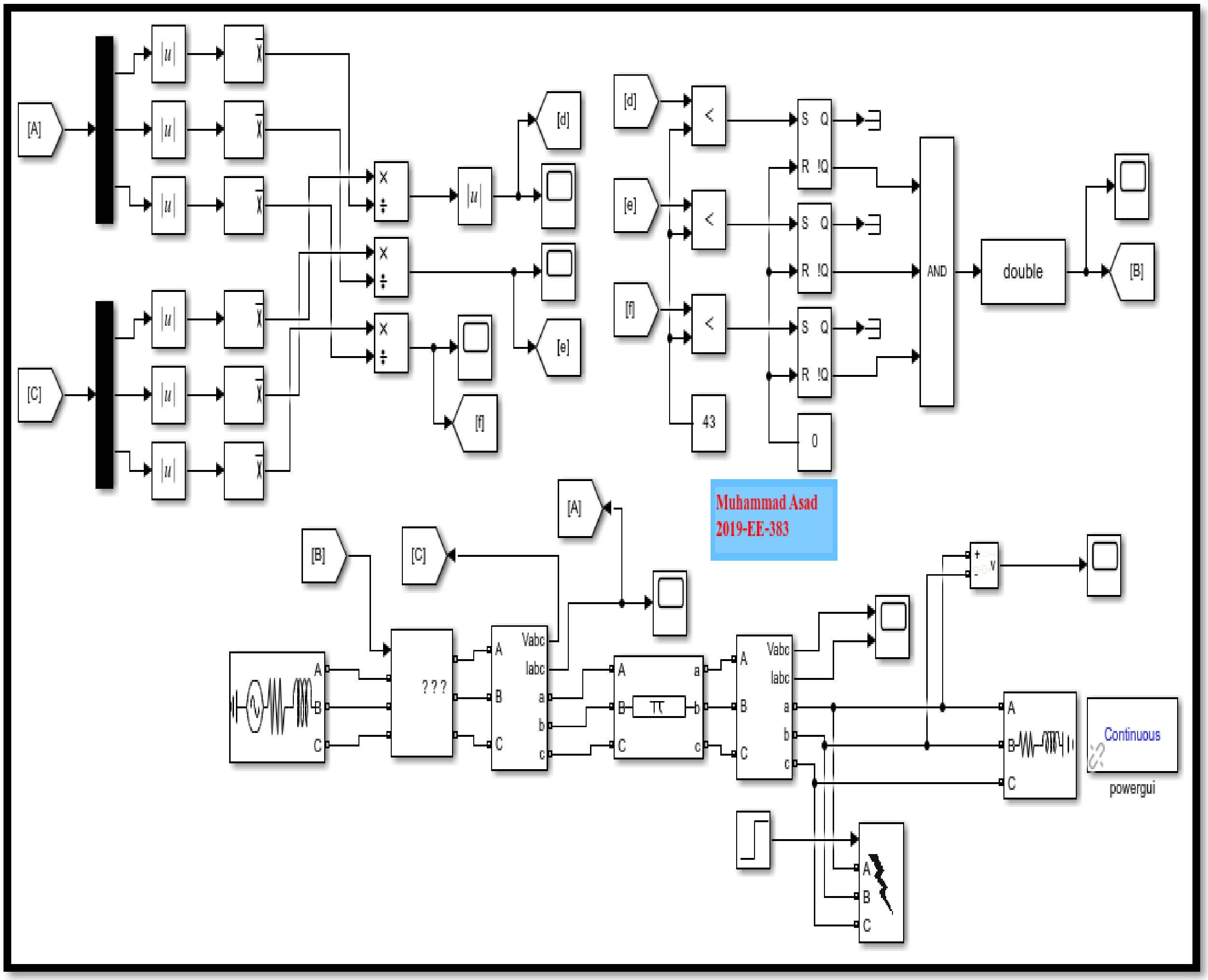
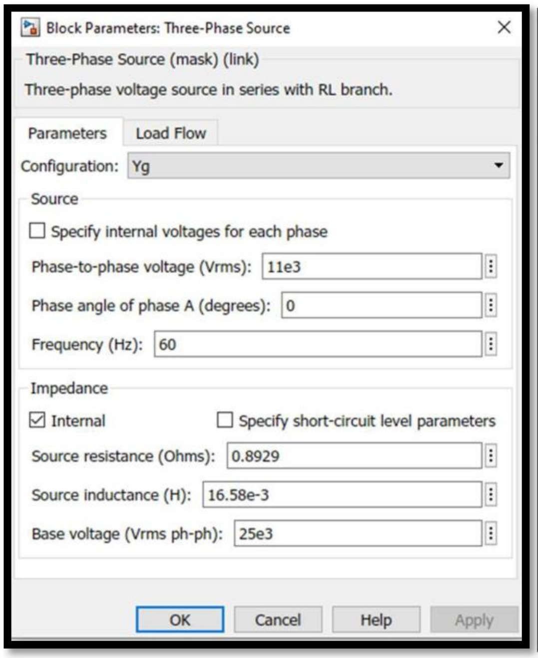


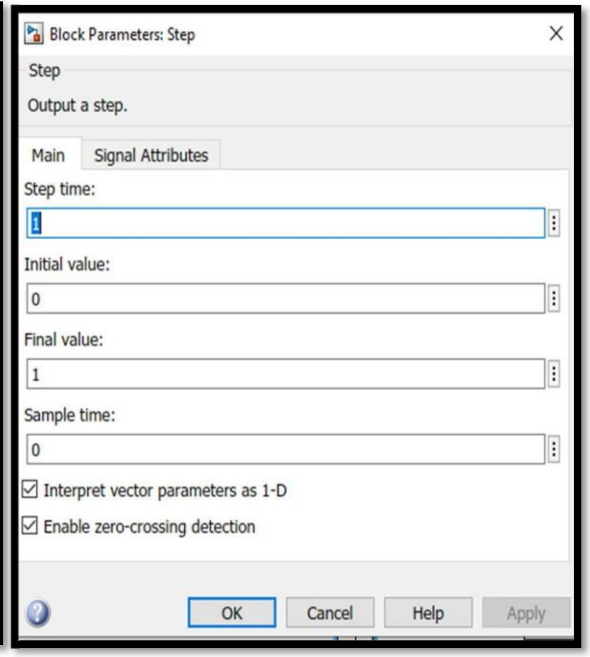
Figure 3: Impedance Relay

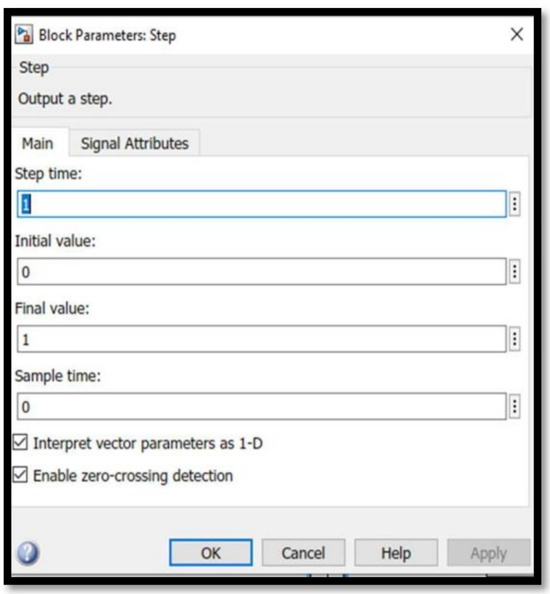
Impedance Relay MATLAB Circuit:

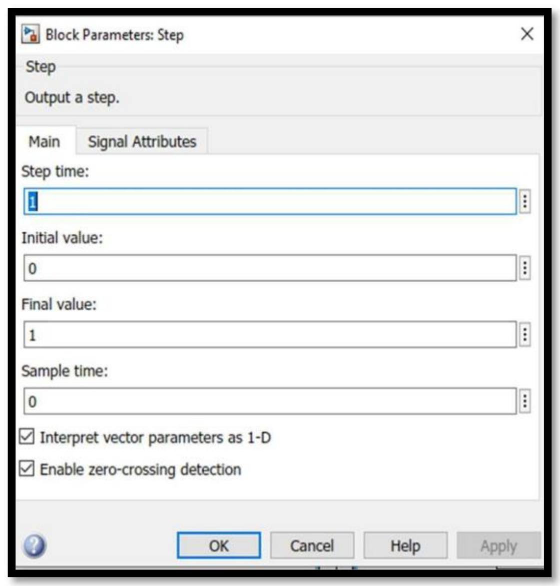


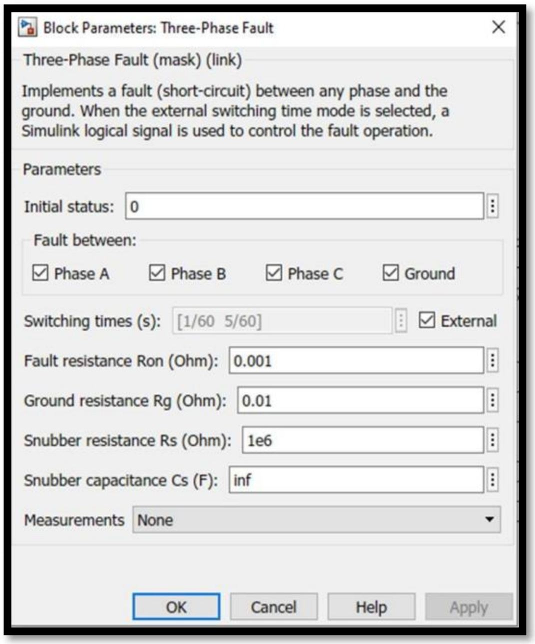
Components Setting Parameters:

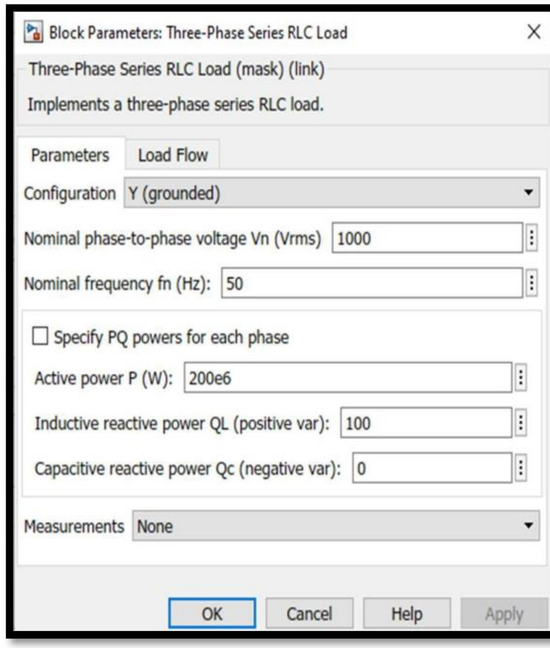


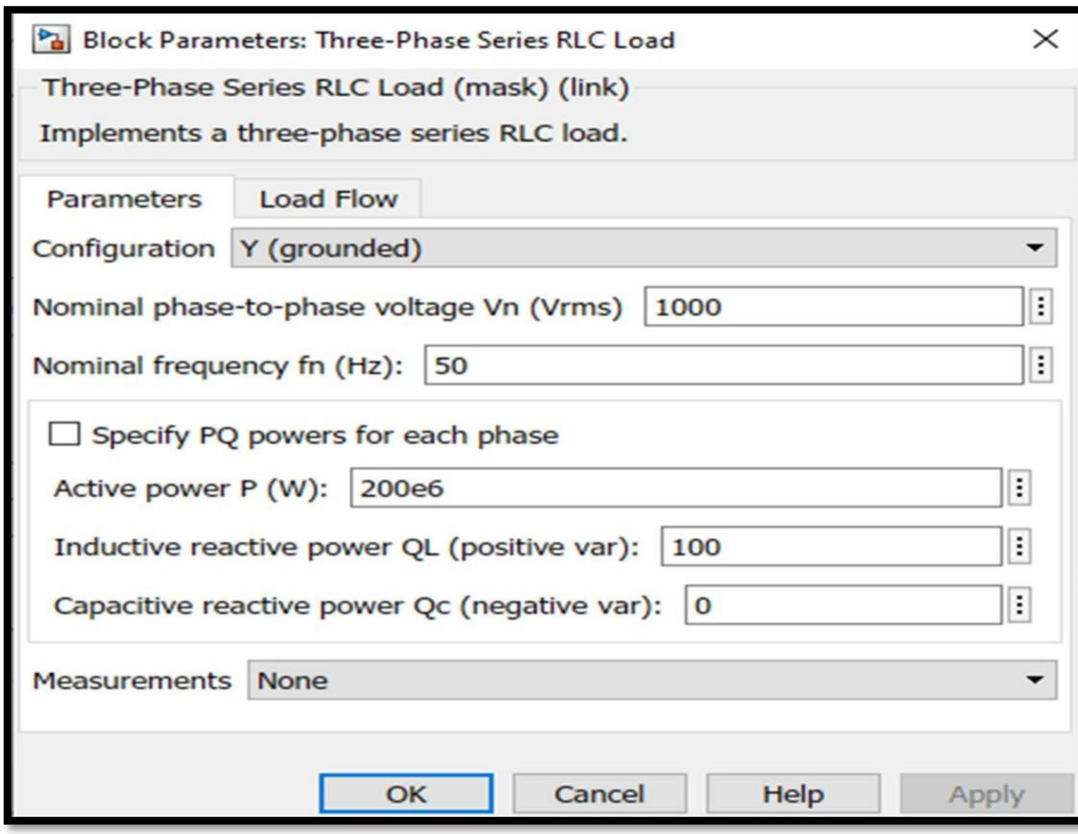




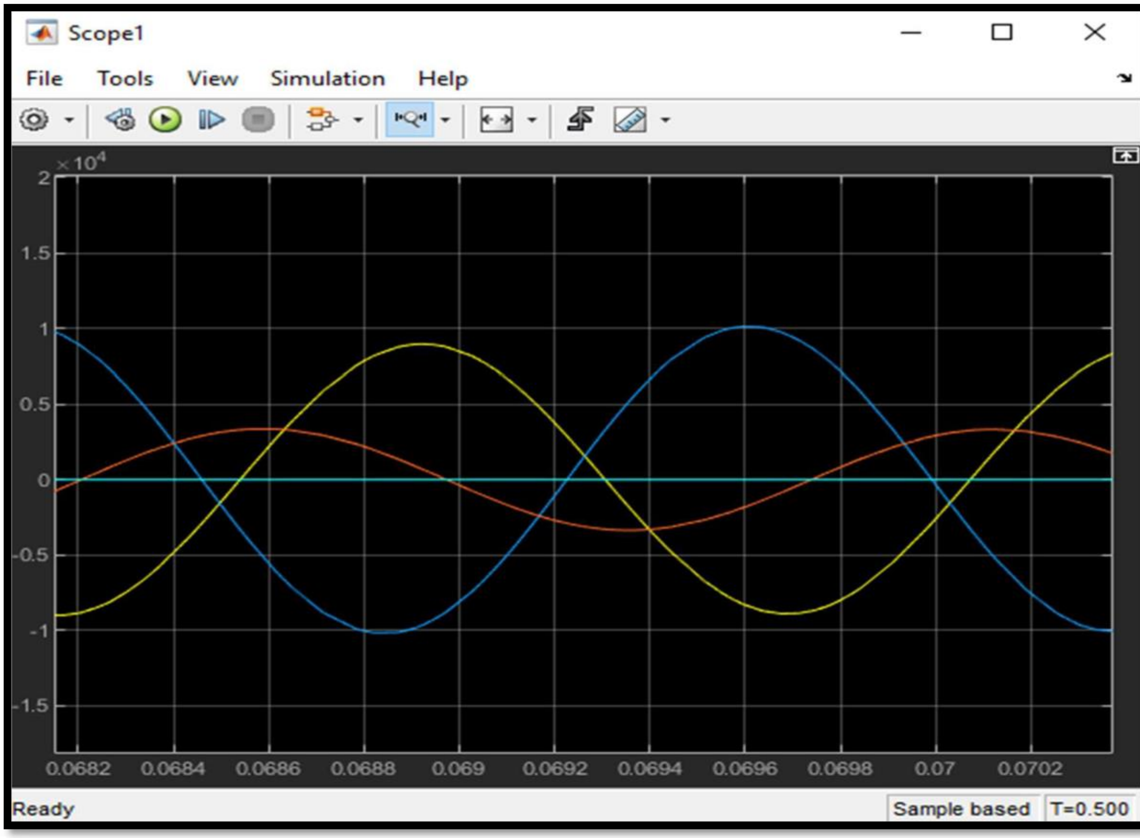



Block Parameters: Three-Phase Fault
Three-Phase Fault (mask) (link)
Implements a fault (short-circuit) between any phase and the ground. When the external switching time mode is selected, a Simulink logical signal is used to control the fault operation.
Parameters
Initial status: 0
Fault between:
Phase A
Phase B
Phase C
Ground
Switching times (s): [1/60 5/60]
External
Fault resistance Ron (Ohm): 0.001
Ground resistance Rg (Ohm): 0.01
Snubber resistance Rs (Ohm): 1e6
Snubber capacitance Cs (F): inf
Measurements None
OK
Cancel
Help
Apply

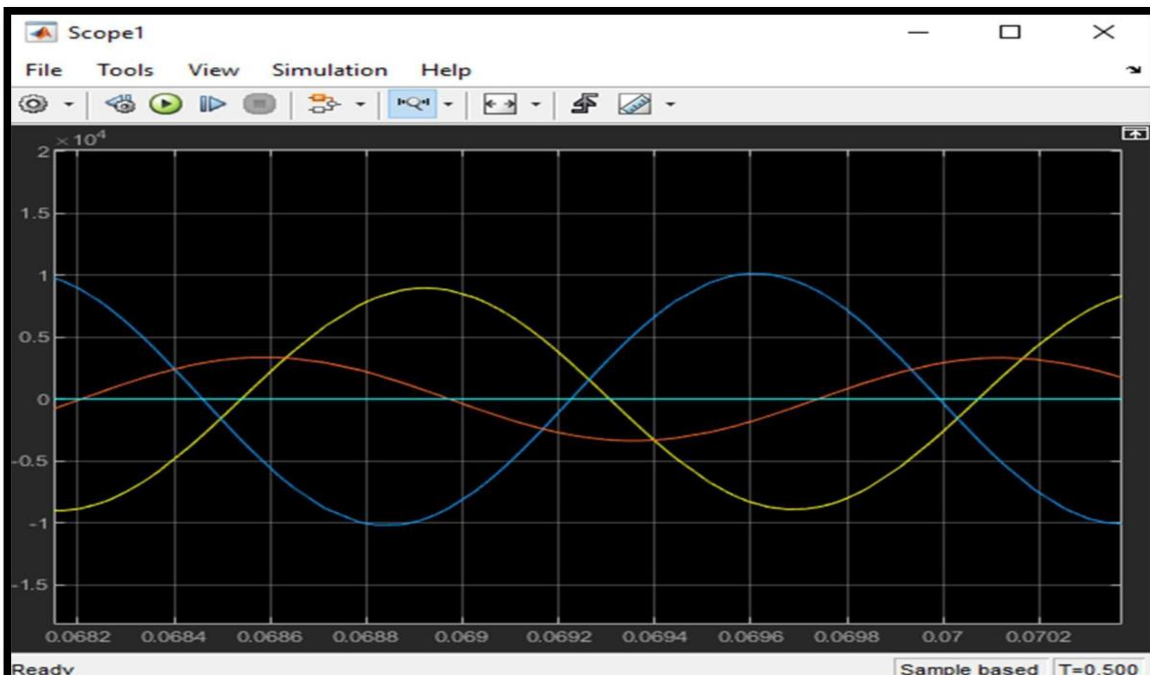

Block Parameters: Three-Phase Series RLC Load
Three-Phase Series RLC Load (mask) (link)
Implements a three-phase series RLC load.
Parameters
Load Flow
Configuration Y (grounded)
Nominal phase-to-phase voltage Vn (Vrms) 1000
Nominal frequency fn (Hz): 50
Specify PQ powers for each phase
Active power P (W): 200e6
Inductive reactive power QL (positive var): 100
Capacitive reactive power Qc (negative var): 0
Measurements None
OK
Cancel
Help
Apply


Block Parameters: Three-Phase Series RLC Load
Three-Phase Series RLC Load (mask) (link)
Implements a three-phase series RLC load.
Parameters
Load Flow
Configuration Y (grounded)
Nominal phase-to-phase voltage Vn (Vrms) 1000
Nominal frequency fn (Hz): 50
Specify PQ powers for each phase
Active power P (W): 200e6
Inductive reactive power QL (positive var): 100
Capacitive reactive power Qc (negative var): 0
Measurements None
OK
Cancel
Help
Apply

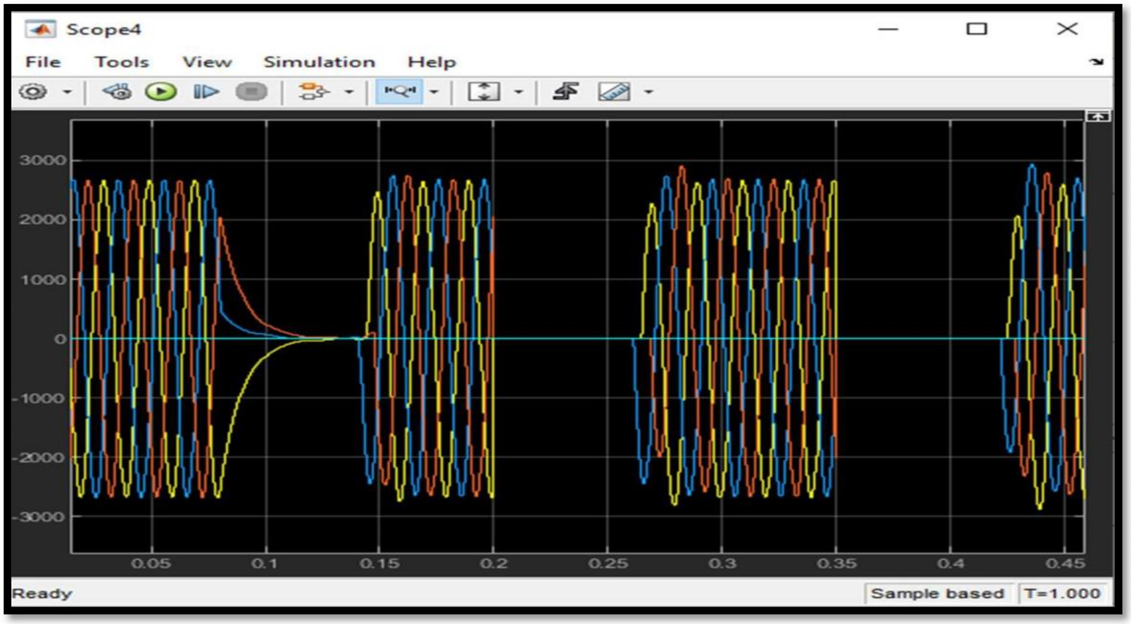
Before Fault Output:



After Fault Output:



On Load Side Output (V & I):



Conclusion:

In this lab, we learn about the protection of our power system by using impedance relay. An impedance relay is basically a voltage restrained overcurrent relay. The relay measures impedance up to the fault point and gives tripping signal to breaker if this impedance is less than the set value of relay impedance. To observe the working of this relay, we make a Simulink model of power system along with protection by using impedance relay. We introduce a fault in our system at 0.2sec. When this fault occur, impedance falls down from 60ohm to 45ohm. We set relay impedance is 50ohm. When impedance decrease from this value, relay sense the fault and sends tripping signal to breaker. We also observed the current, voltage, relay trip point and impedance graph in this lab.
At the end we conclude that this relay is beneficial to use because:

- This relay can be used as both backup and primary protecting device.
- This relay also applicable in transmission lines protection and easy to install.
- This relay also employed for protection of distribution lines in the case of high AC voltage levels