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POWER SYSTEM PROTECTION SCHEMES USING OVER CURRENT PROTECTION AND DIFFERENTIAL PROTECTION OF A TRANSMISSION LINE.

[1]Dr. Gitanjali Saha, [2]Manisha Banik,[3]Koushik Chakraborty,[4]Aryamitra Das

[1]Professor, [2,3,4]Student. [1]Department of Electrical Engineering,
[1]Tripura Institute of Technology,Agartala, India

Abstract :The main purpose of this research work is to build a simulation model of a power system protection schemes for transmission lines based on MATLAB to detect the faults (symmetric and asymmetric). We also know that the electric power system is made up of important and costly components, so these parts must be protected. The major purpose of this article is to studies and analysis the different faults and declares the impact on power system. Two types of protection are used, differential protection and overcurrent protection. This work is approach to MATLAB/SIMULINK package. In this work, we designed a Simulink model which is represent the three power stages of electrical system, i.e.: generation unit, transmission lines and distribution systems.

***IndexTerms*: Differential relay, Overcurrent relay, Power system, Power transformer, MATLAB Simulink.**

I. INTRODUCTION

In power system network, fault is a major problem. With the growing demand of electricity, the distribution system of electricity is growing year on year and for that reason, the protection of power system equipment and maintenance is very important in order to decreasing the costs and increase the life of the reliable and uninterrupted power system equipment [1]. The power system must be operating in a secure method at all times. Faults will result in a total blackout or a partial system. In order to protect the power system from the disturbances that have happened, a protection system is essential. There are many types of protective relays obtainable to solve this problem [2]. The benefit of protection relay is to reduce a dangerous damage in the electrical equipment at fault occurs, it is designed according to the basis of reliability, selectivity and fast response [3]. In order to protect this equipment from such problems, we need some protective measures. These shall consist of protective relays and circuit breakers. If there is a fault in the system, an automatic protection device is required to insulate the faulty section and maintain a healthy section in operation [4]. Power transformer is the bulk essential applications used in substations and main station. Power transformer is very important toward the effective functioning in the power system. Differential operation is the most popular method of operation of the various power transformer operations [5]. The overcurrent protection plays an essential role in protecting the power system due to unexpected increase in the current that damages the components of the system [6]. The differential protection scheme is a simple conceptual technique i.e., it compares the current between primary and secondary of power transformer [7]. As we know, for Transmission Line (T.L) protection the circuit breaker is mounted and it relies on ternary line fault because this type of fault is hyper high compared to the other types of faults. There are two faults on the 3-phase balanced fault power system and the unbalanced faults in the power system are phase to ground, phase-to-phase, phase to phase to ground [8]. This project study the rumour fault types, which classified as symmetrical and unsymmetrical fault. MATLAB environment is used to analysis this circuit and obtain on the different simulation parameters of fault types [10].

II. THE PROPOSED METHOD

The aim of the project on power system protection schemes using over-current protection and differential protection of a transmission line, is to ensure the reliability, safety, and efficiency of electrical power systems. This involves implementing protective mechanisms to detect and isolate faults, thus preventing equipment damage, minimizing power outages, and ensuring the safety of the electrical grid and its components.

III. Differential Protection

When the discrepancy between the primary and secondary current equal to zero, this mean that the system is healthy. In the strict transformer, there is no loss of power in the transformer, and eddy current and core losses appeared practically in the transformer in spite of no operation current. Mismatch of the phase shift, (CTs) ratio, ratio of the transformer and tap-changer. Because of this current, it will not be zero. Because of this relay, the sensitivity and the trip signal of the differential relay may decrease due to an increase in uncalled tripping. We use a bias differential relay to avoid this [9]. Figure (1) illustrates single phase of a three-phase differential protection .Figure (1) shows that both of (CTs) enclose the protection zone. Due to its normal tendency, (DP) does not offer backup protection to the rest of the protective devices, for that cause; this form of protection scheme is commonly recognized as a protection scheme of unit. (CTs) current that passes through the conductors, these conductors are name as trial wires. In no condition of fault, the input current of the IP protection unit is same as to the output current of the protection zone at all instants. When considering the (CTs) A. The current that is carrying by a trial wire of (CTs) A and (CTs) are equal to:

(1) IAS = αA IP-IAe

(2) IBS = αB IP- IBe

Where: αA: Ratio of (CT) A; αB: Ratio of (CT) B; IAe, IBe: (CT) A and (CT) B Secondary excitation current.

By considering that the transformation ratios are equally, αA= αB=α, the relay operation current lop is equal to:

(3) IOP = IAe - IBe

At the time of out-of-zone system faults, the Iop of relay operating current is quite small, but doesn't to be zero. But when an inside zone fault occurs (internal fault), the input current is no secular worth to the output. Figure (2) represents the differential relay within internal zone [10].

IOP = α(IF1 + IF2) – IAe -IBe

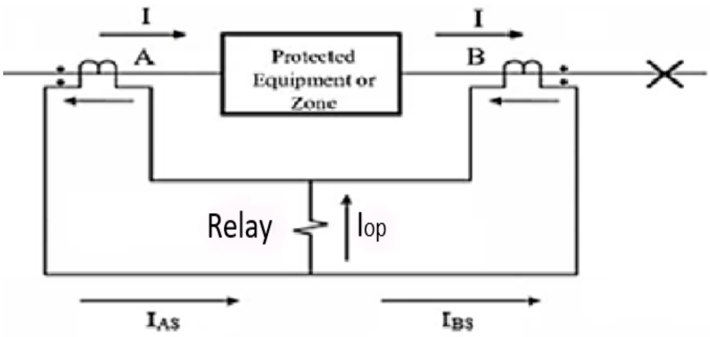


Fig.1. One line diagram of Differential relay when the fault is out of zone.

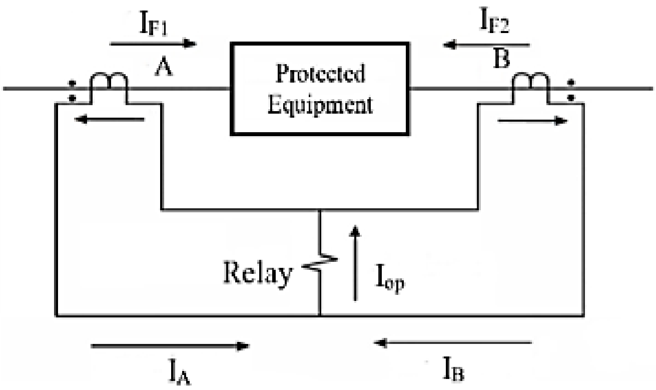


Fig.2. One line diagram of Differential relay when the fault of internal zone.

In terms of the operational characteristics of the electromechanical relay effect, the inclination of the characteristics increases. The bias differential relay (DR) is used for the (DR) of the high-power transformer. Figure (3) illustrates the operational characteristics of the (DR).

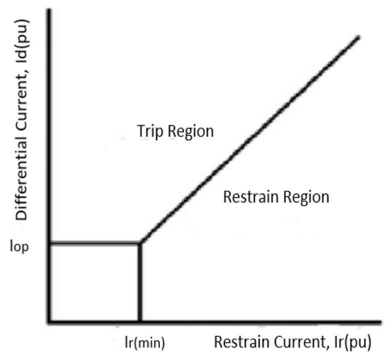


Fig.3. Characteristics of differential relay.

When the pick-up ratio is set to a higher bias, the pick-up ratio is set to a positive (tripping) area, when the pick-up ratio is set to a smaller bias; the pick-up ratio is set to a negative (blocking) area. In this kind of relay, operating coil is putting in parallel with the restraining coils. Conflicting torque is created by restraining coils to the operating torque. When the faults occur out of zone, the restraining torque is bigger than operating torque. Therefore, the relay is no operating. When the fault occurs internal, the relay is operating when the operating torque is greater than the bias torque. The changing in the turn's number of the restraining coil will affect on the bias torque [10].

IV. Over Current Relay

The function of the relay is to discriminate between normal operation and fault conditions. The OC relay in Figure(4) has an operating coil, which is connected to the CT secondary winding, and a set of contacts. When $|I'|$ exceeds a specified pickup value, the operating coil causes the normally open contacts to close. When the relay contacts close, the trip coil of the circuit breaker is energized, which then causes the circuit breaker to open. Note that the circuit breaker does not open until its operating coil is energized, either manually or by relay operation. Based on information from instrument transformers, a decision is made and relayed to the trip coil of the breaker, which opens the power circuit, hence the name over current relay [11].

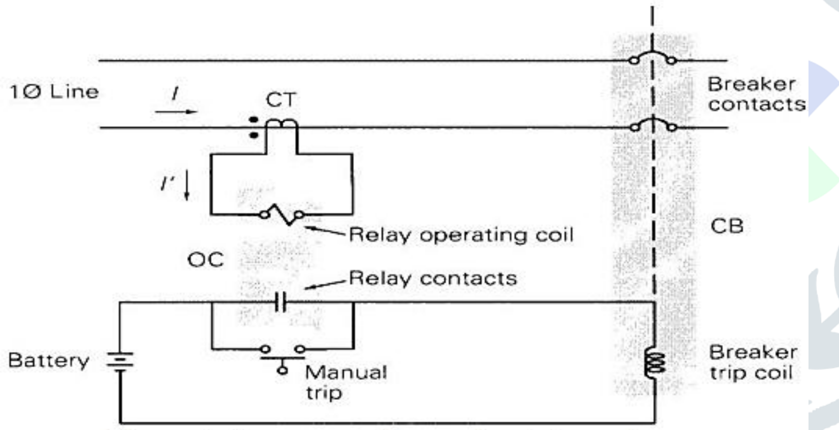


Fig.4. Over-Current Protection Schematics.

V. RESEARCH METHODOLOGY

Now we have started building the Simulink model of the Power System Protection. We have designed this Simulink model for protect the whole power system from over current or voltage.

VI. SIMULATION MODEL

Figure (5) illustrate the diagram of the power system module based on MATLAB/Simulink.

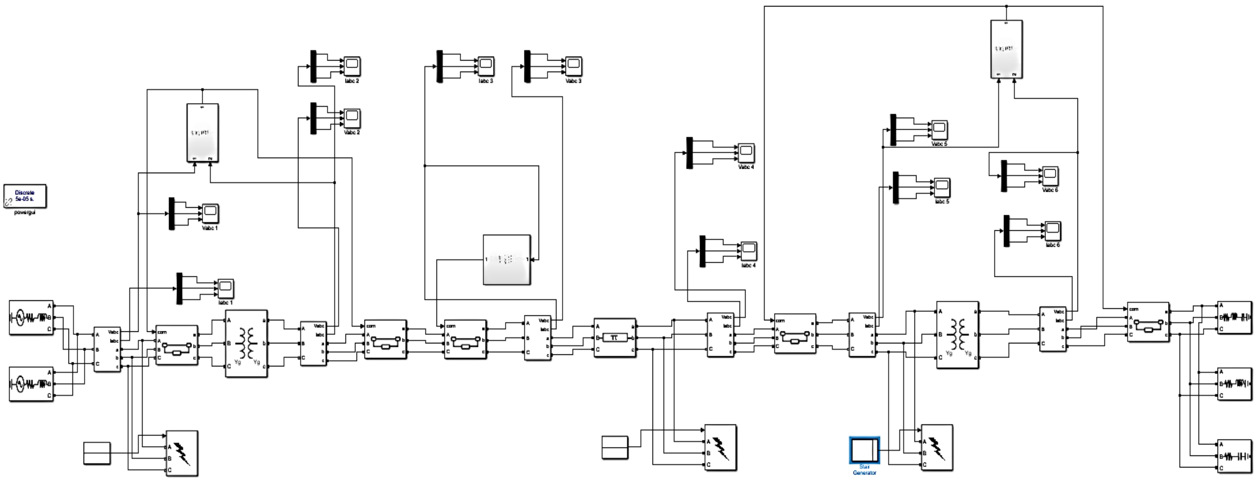


Fig.5. Power System Module

Figure (6) illustrate the contents of differential relay subsystem block.

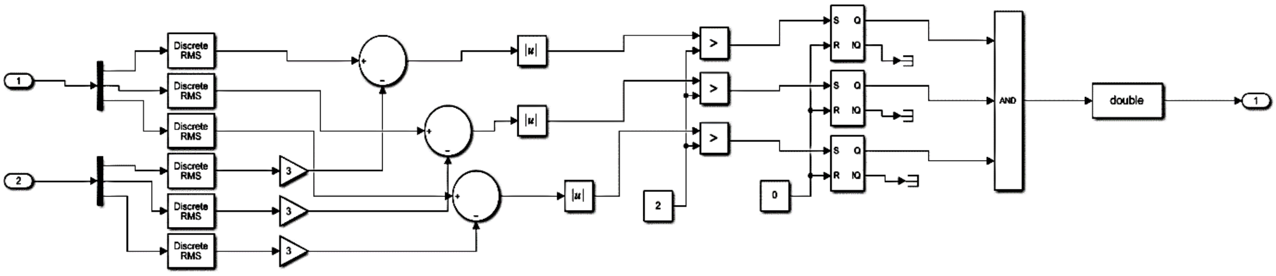


Fig.6. Scheme of differential relay subsystem

Figure (7) illustrate the contents of over current relay subsystem block.

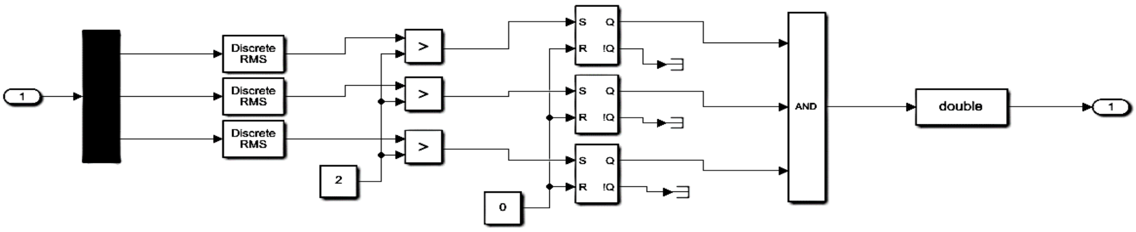


Fig.7. Scheme of over current relay subsystem

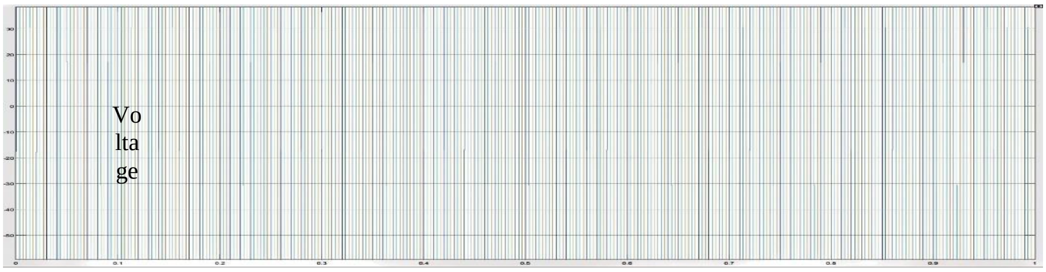
VII. RESULTS AND DISCUSSION

Case No.1: At no fault (normal operation).

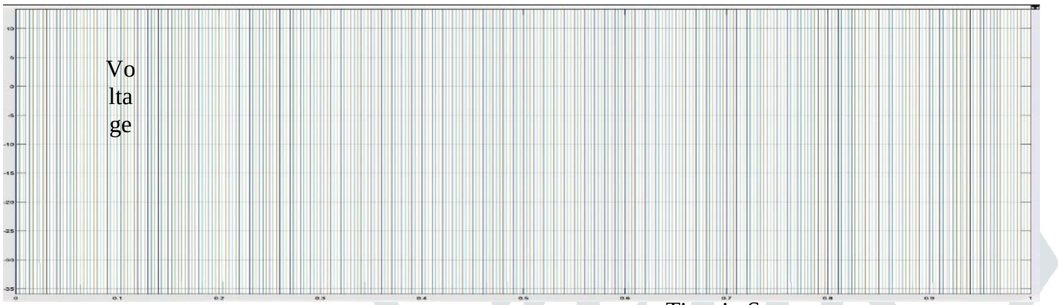
The simulation results of voltages and currents for power system are shown in figure.

a. Voltage Status:-

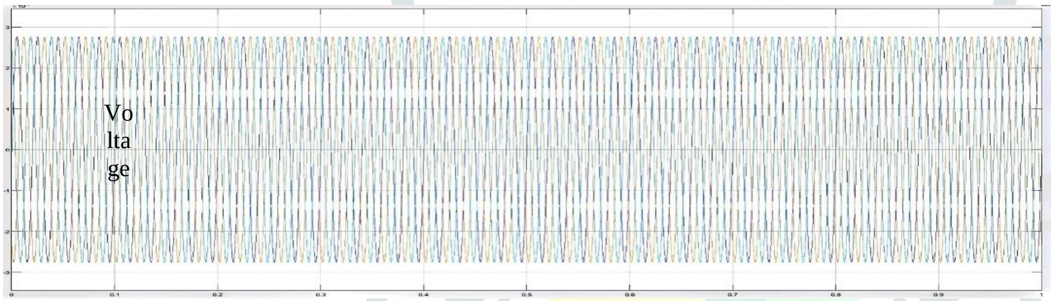
i. Vabc1:-



ii. Vabc2:-

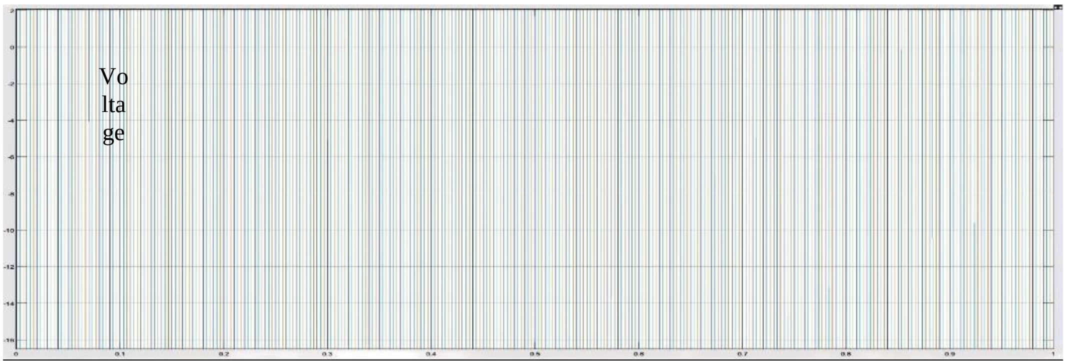


iii. Vabc3:-

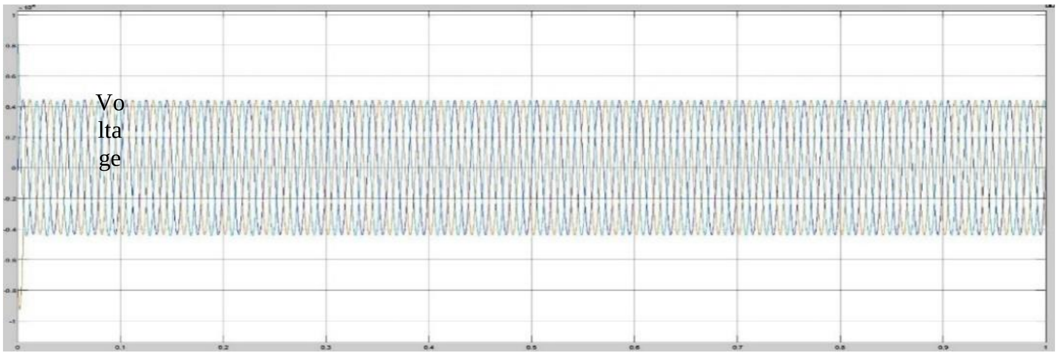


iv. Vabc4:-

v. Vabc5:-



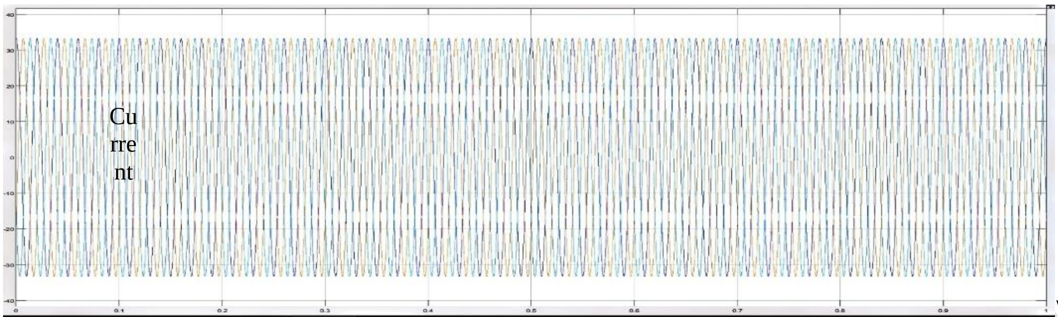
vi. Vabc6:-



b. Current Status:-

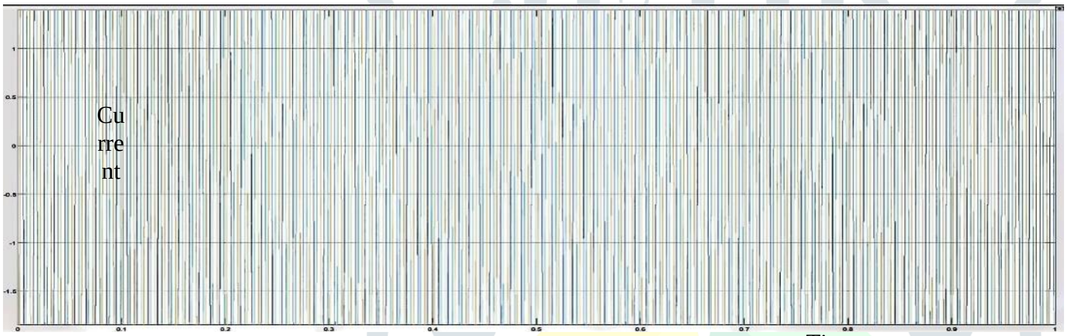
Time in Sec

i. Iabc1:-



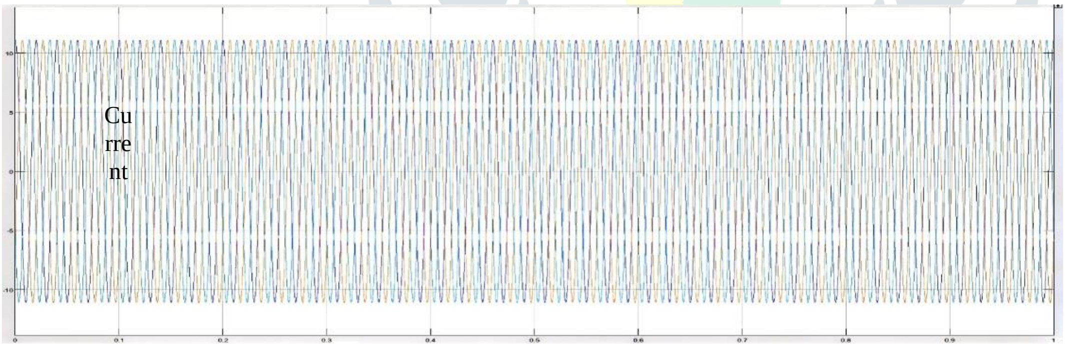
Time in Sec

ii. Iabc2:-



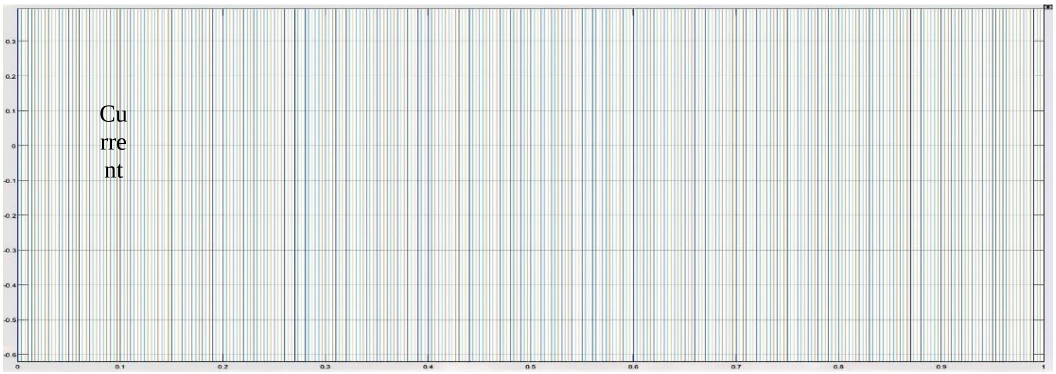
Time in Sec

iii. Iabc3:-



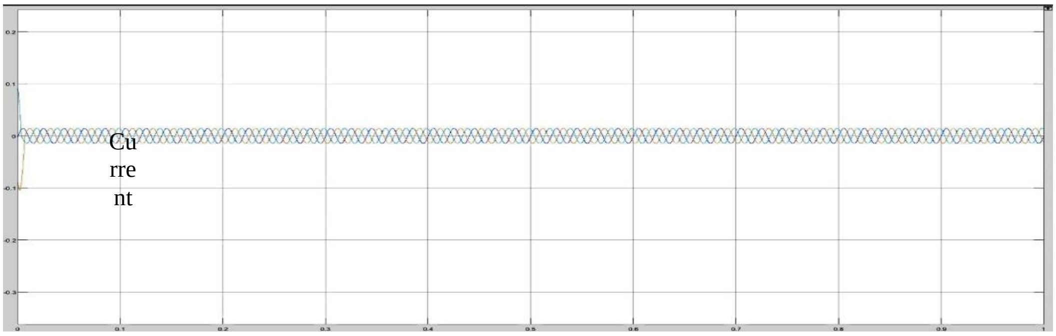
Time in Sec

iv. Iabc4:-

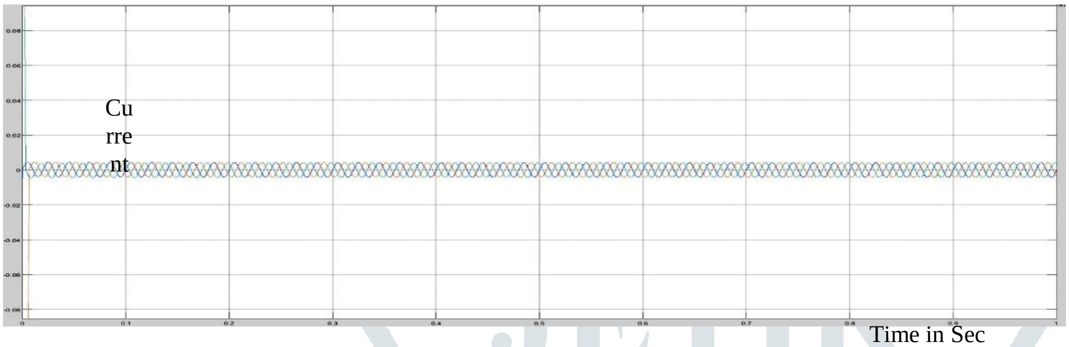


Time in Sec

v. Iabc5:-



vi. Iabc6:-

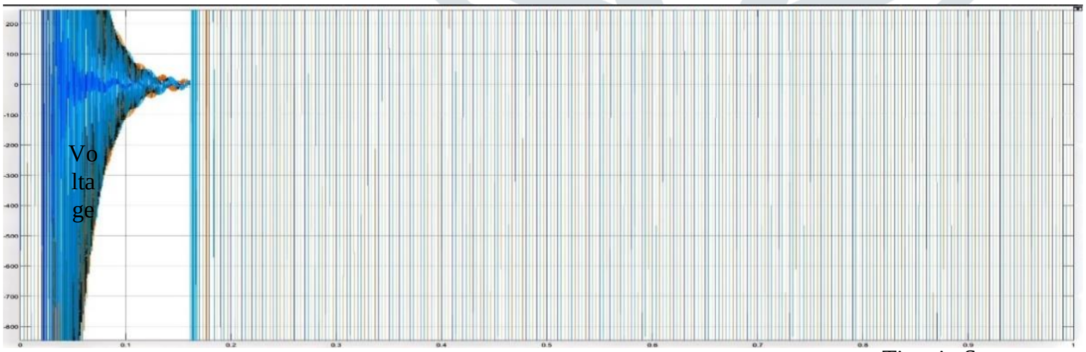


A)Case No.2: When first fault occurs.

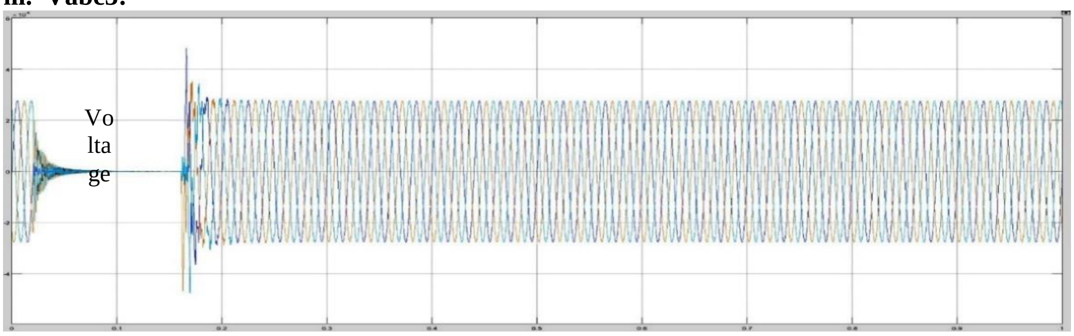
a. Voltage Status:-

i. Vabc1:-

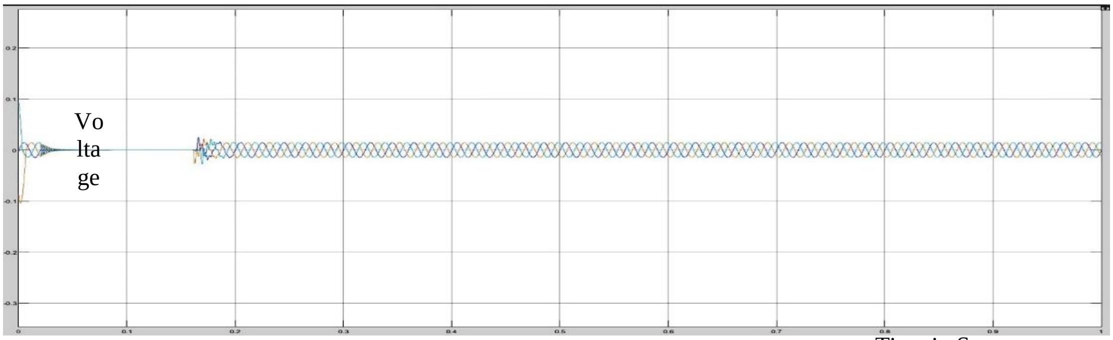
ii. Vabc2:-



iii. Vabc3:-

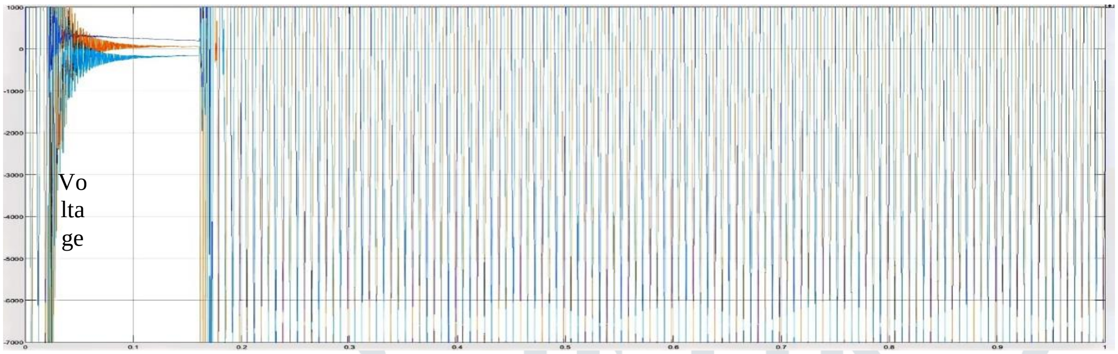


iv. Vabc4:-



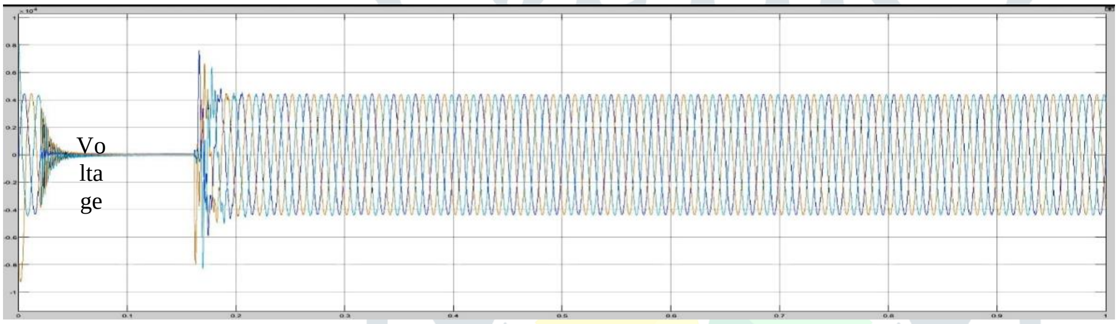
Time in Sec

v. Vabc5:-



vi. Vabc6:-

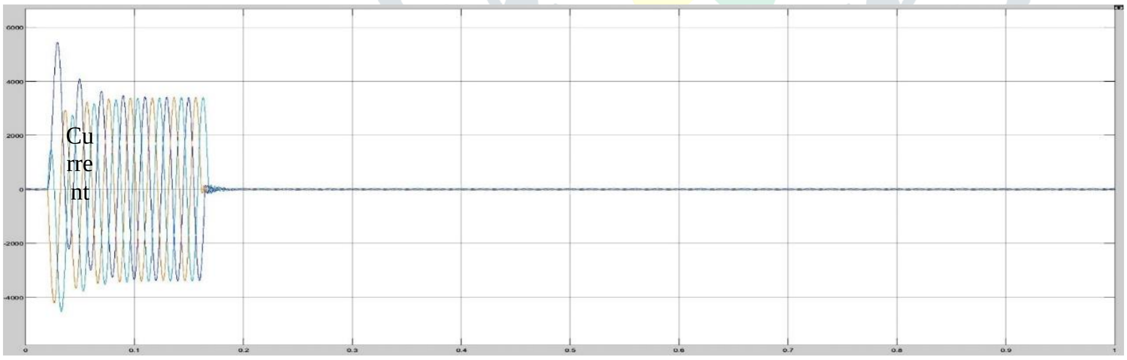
Time in Sec



Time in Sec

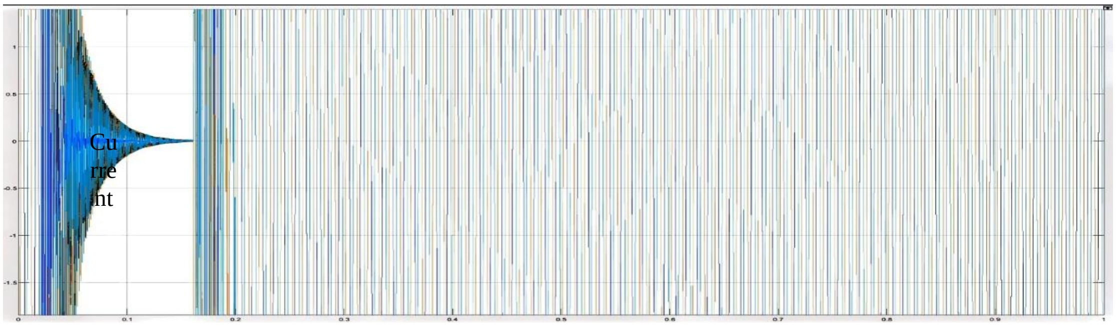
b. Current Status:-

i. Iabc1:-



Time in Sec

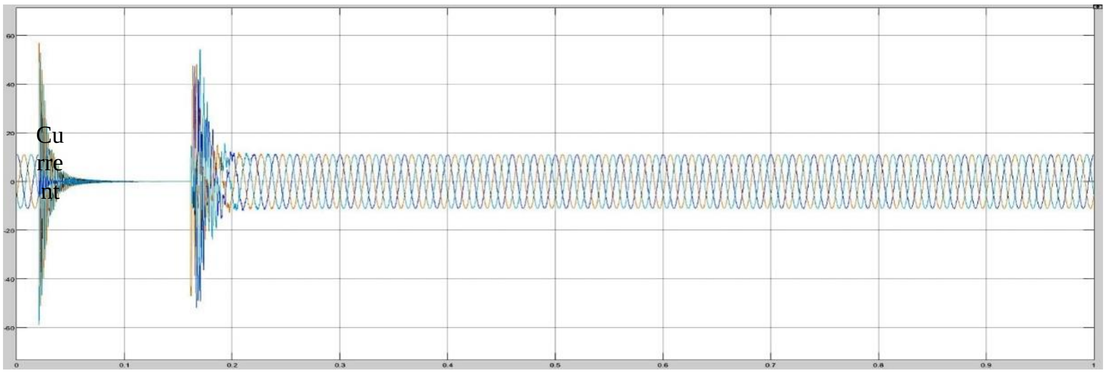
ii. Iabc2:-



Time in Sec

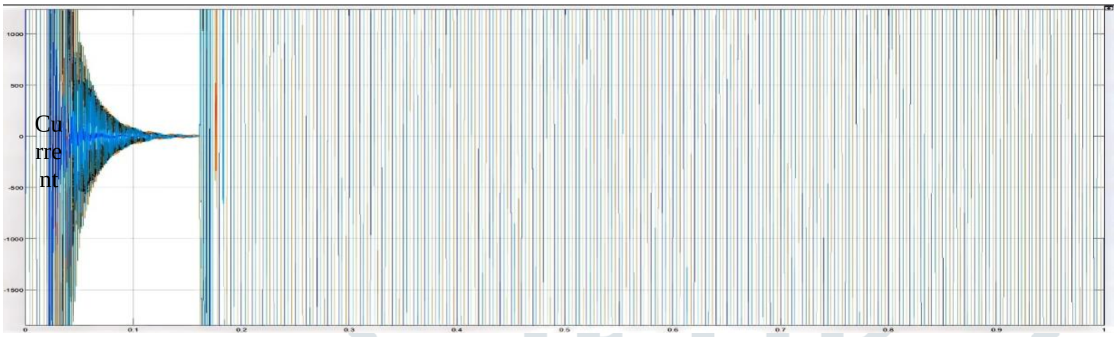
iii. Iabc3:-

Time in Sec



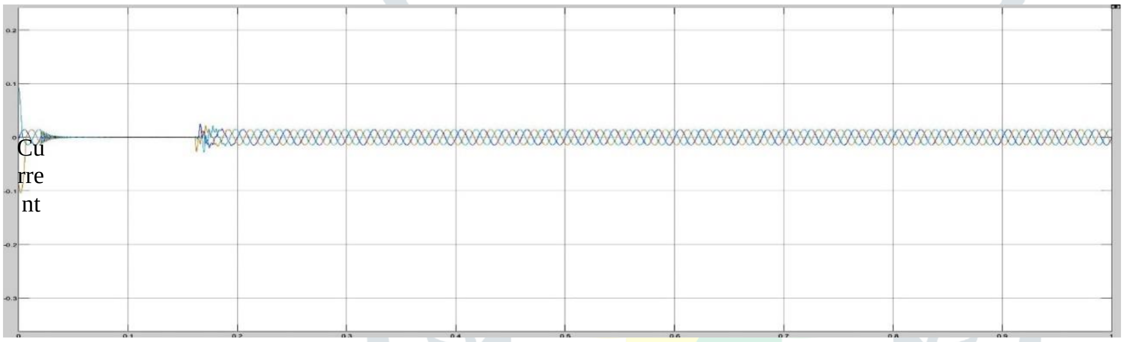
Time in Sec

iv. Iabc4:-



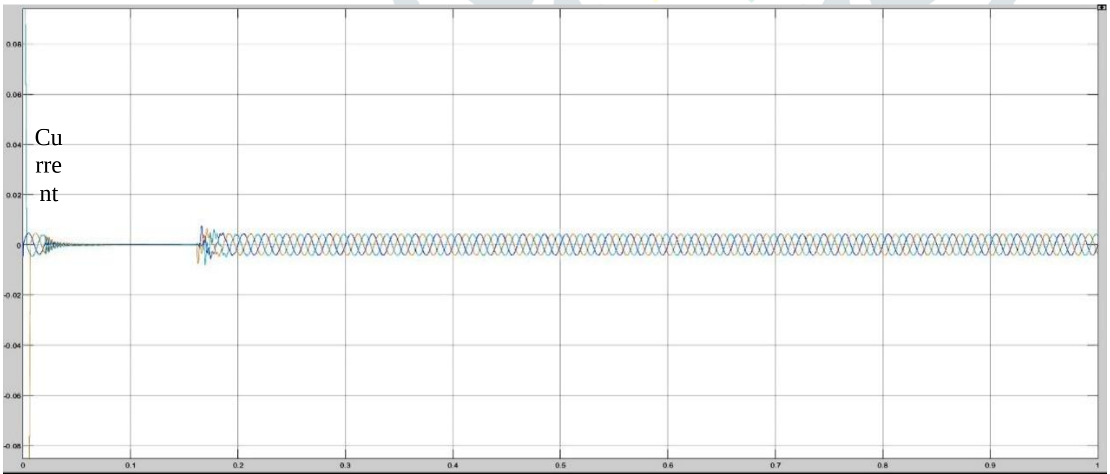
Time in Sec

v. Iabc5:-



Time in Sec

vi. Iabc6:-

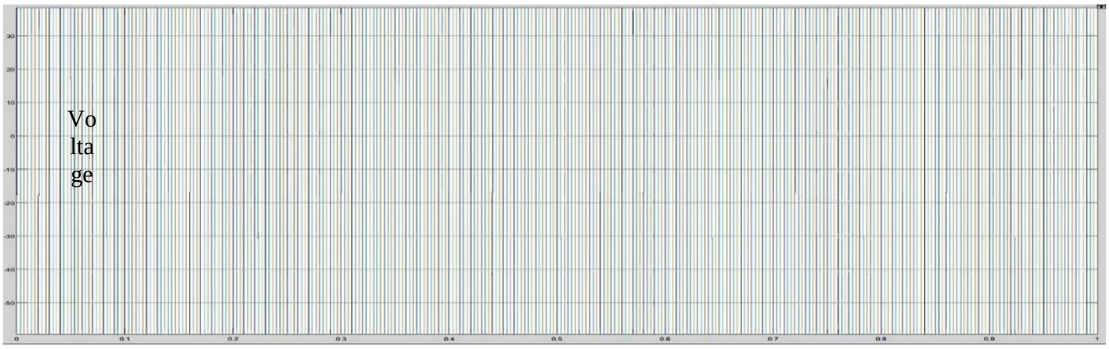


Time in Sec

B) Case No.3: When second fault occurs.

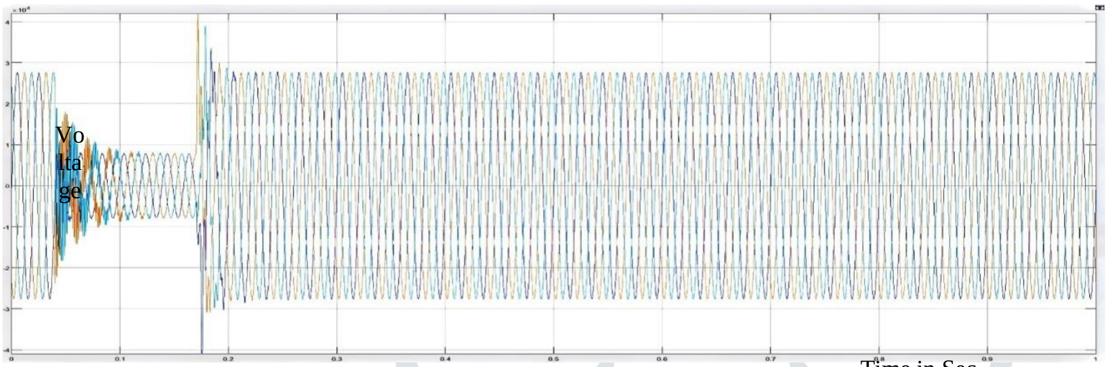
a. Voltage Status:-

i. Vabc1:-



ii. Vabc2:-

Time in Sec

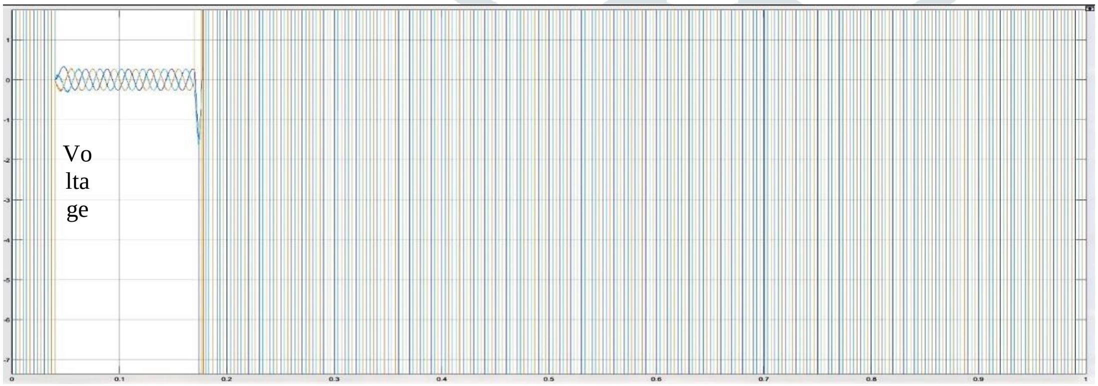


Time in Sec

iii. Vabc3:-

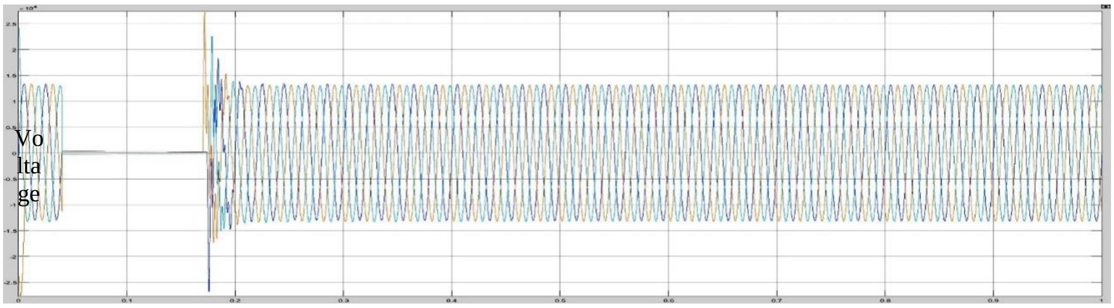
Time in Sec

iv. Vabc4:-



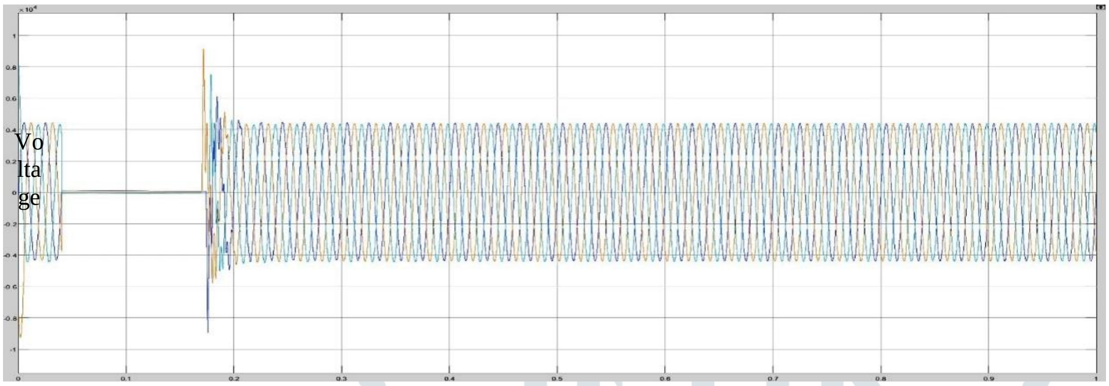
Time in Sec

v. Vabc5:-



Time in Sec

vi. Vabc6:-



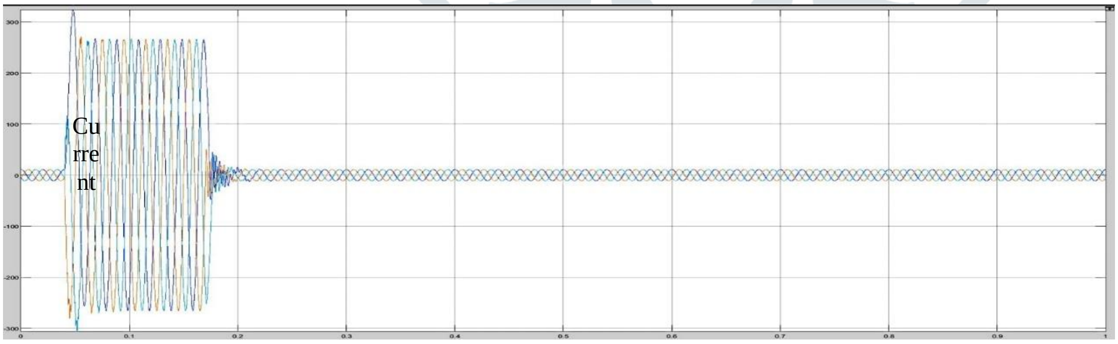
Time in Sec

b. Current Status:-

i. Iabc1:-

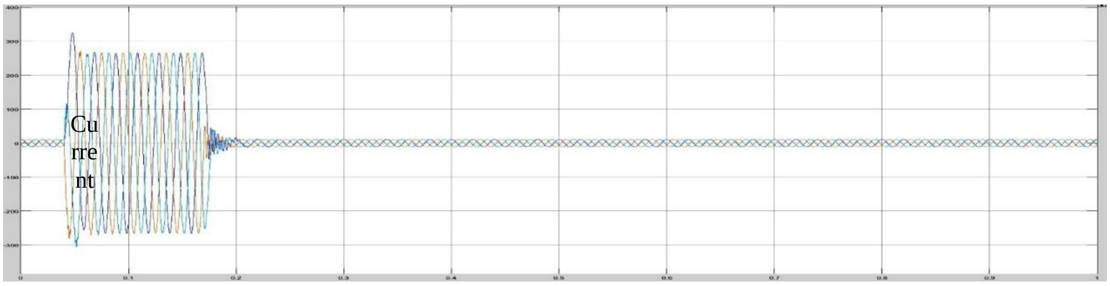
Time in Sec

ii. Iabc2:-



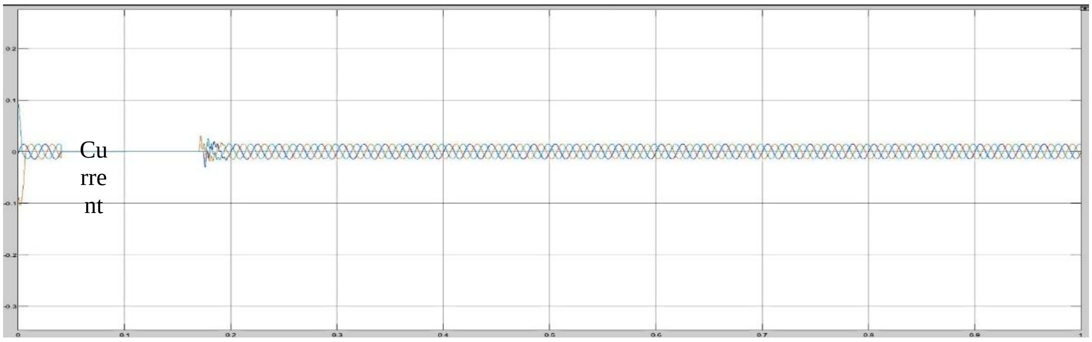
Time in Sec

iii. Iabc3:-



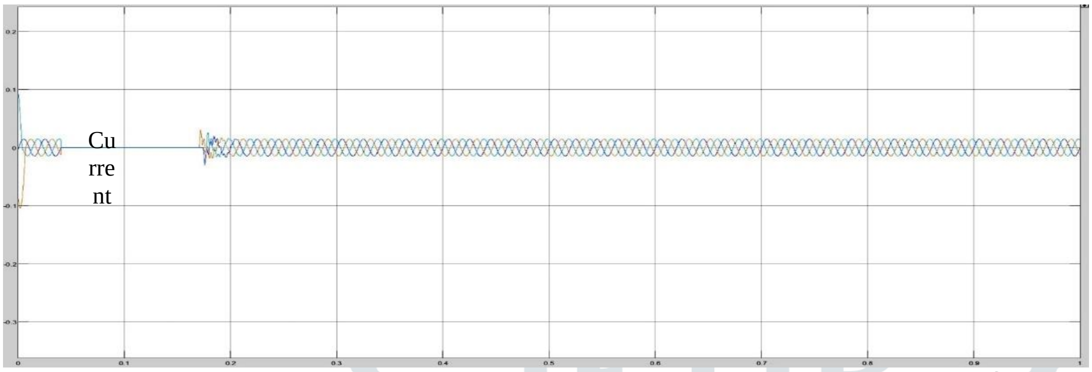
Time in Sec

iv. Iabc4:-



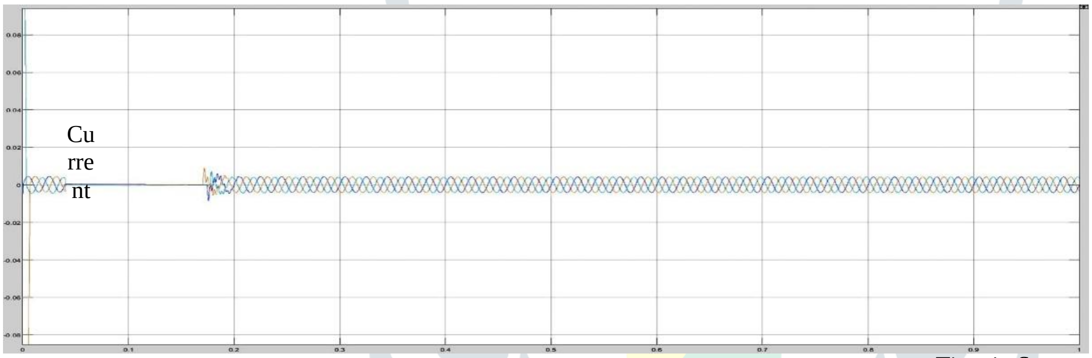
v. Iabc5:-

Time in Sec



Time in Sec

vi. Iabc6:-

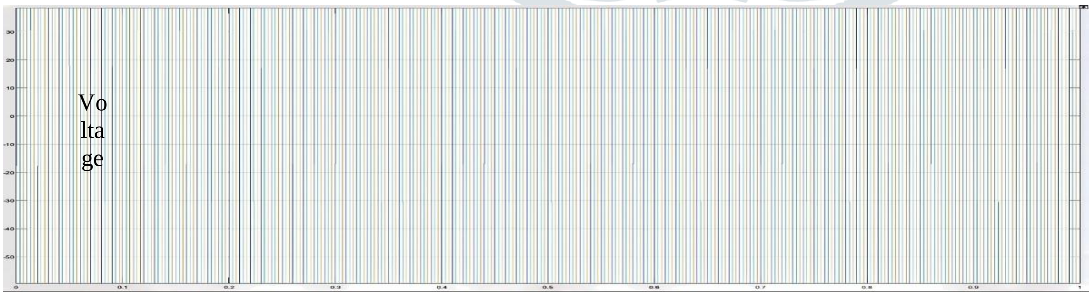


Time in Sec

C) Case No.4: When third fault occurs.

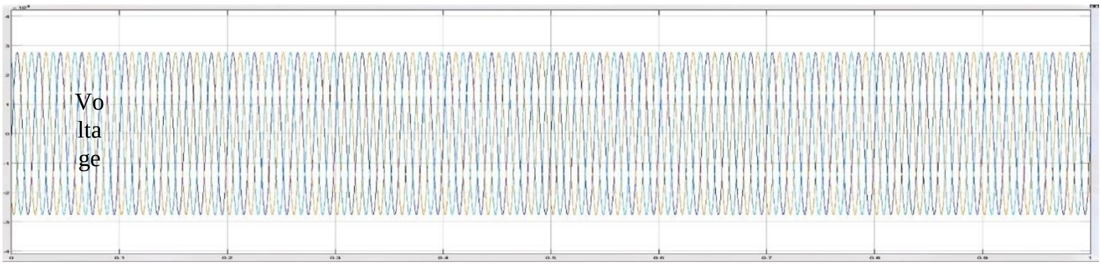
a. Voltage Status:-

i. Vabc1:-



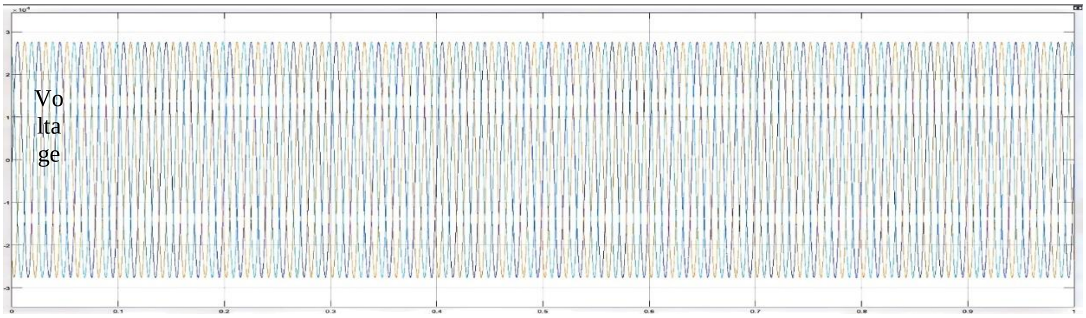
Time in Sec

ii. Vabc2:-



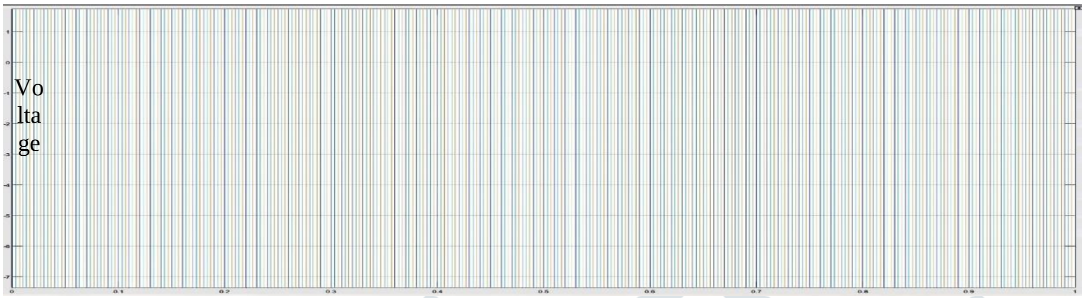
Time in Sec

iii. Vabc3:-



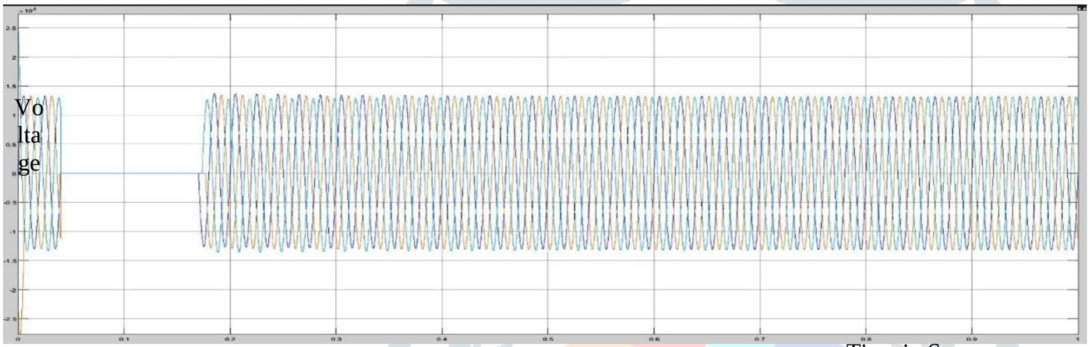
Time in Sec

iv. Vabc4:-



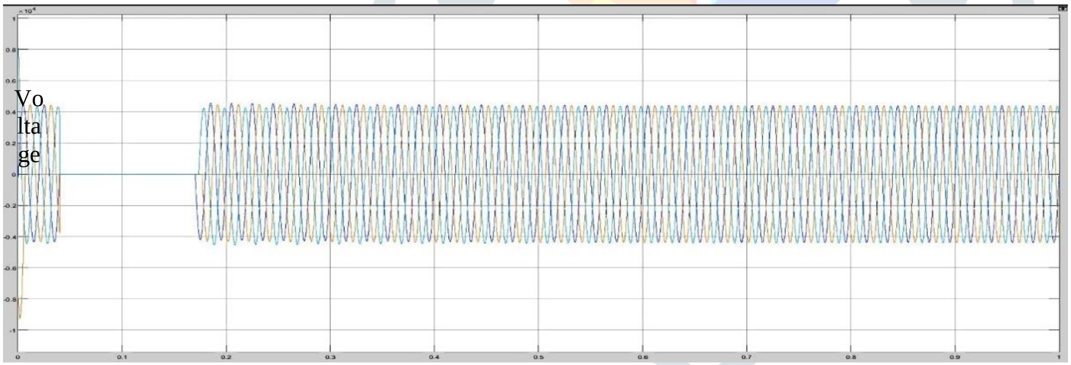
Time in Sec

v. Vabc5:-



Time in Sec

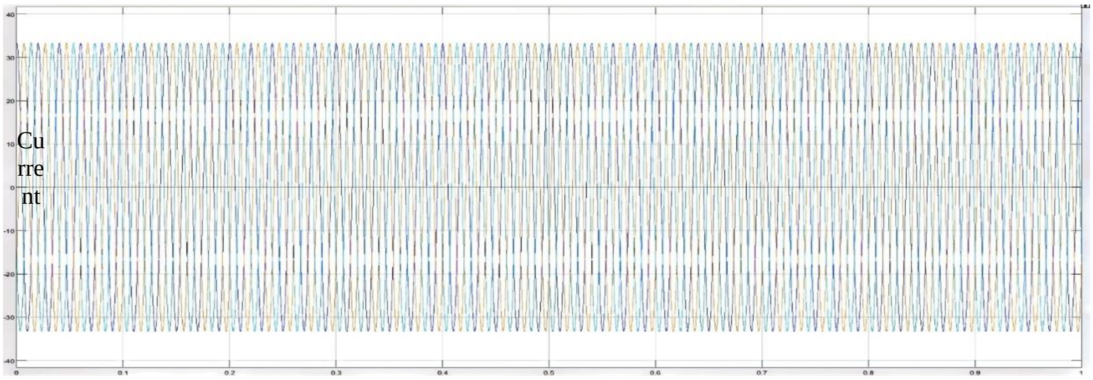
vi. Vabc6:-



Time in Sec

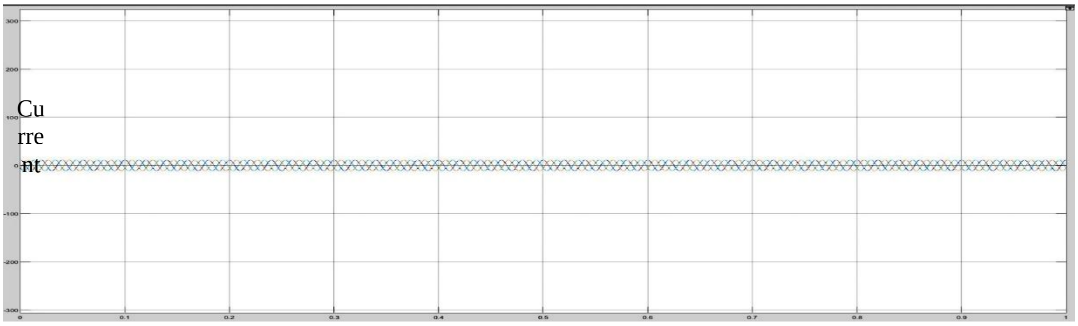
b. Current Status:-

i. Iabc1:-



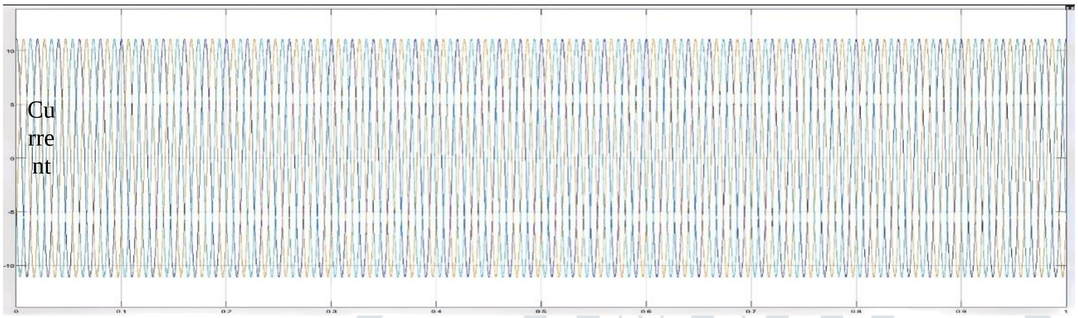
Time in Sec

ii. Iabc2:-



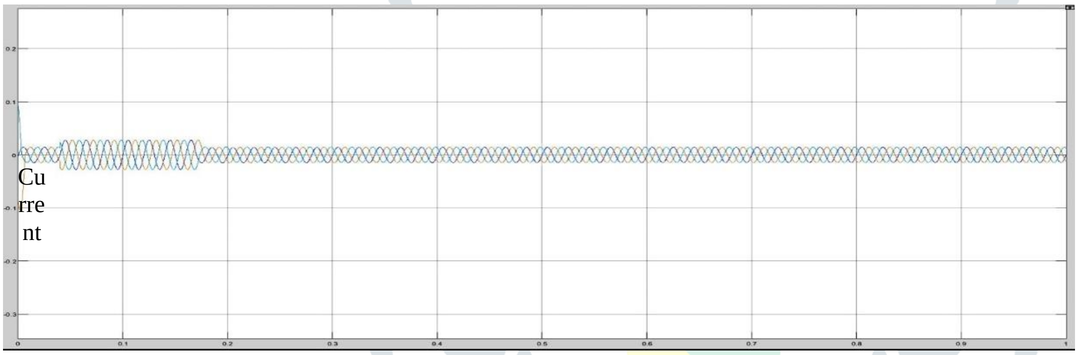
Time in Sec

iii. Iabc3:-



Time in Sec

iv. Iabc4:-



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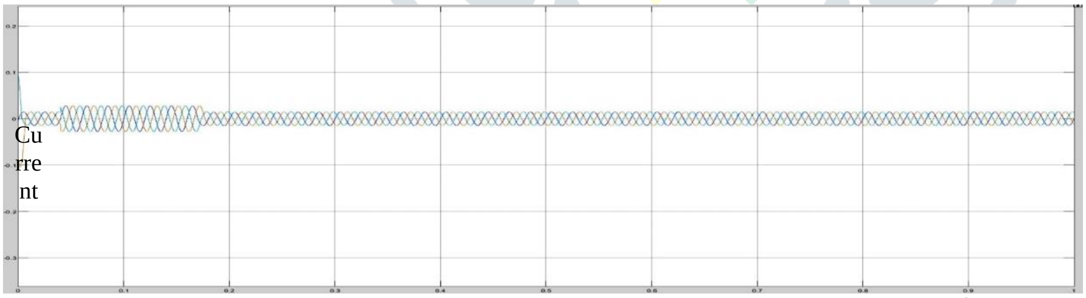

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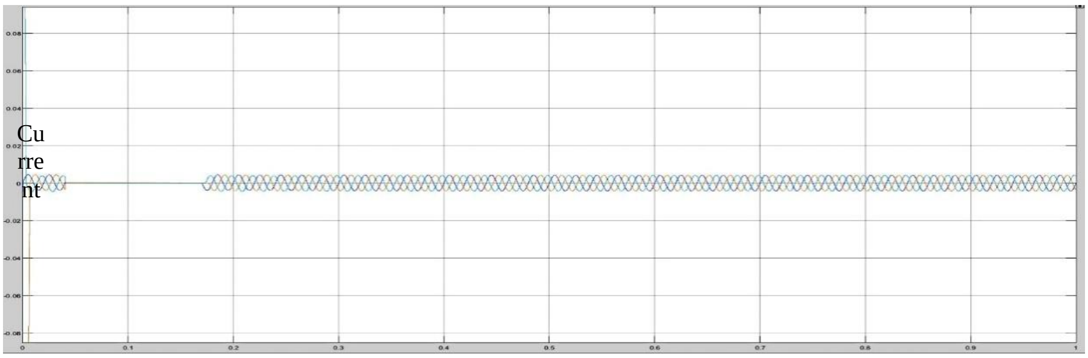

Time in Sec

VIII. CONCLUSION

In this paper, the designed ofpower system protection schemes using over-current protection and differential protection of a transmission line proves to be an effective solution using MATLAB/Simulink.

- **Over-current Protection:** Acts as a broad safeguard against various fault types and overloads, ensuring general system protection and stability.
- **Differential Protection:** Provides precise, fast-acting protection for internal faults within specific equipment like transformers and designated transmission line sections, enhancing reliability and minimizing damage.

By combining these protection methods, power systems can achieve robust protection, ensuring quick fault isolation, minimizing damage, and maintaining operational stability and safety. Proper design, setting, and coordination of these protection schemes are essential for effective system protection and reliability.

As shown in case no.1, when no faults occurred, the current and voltage normal case. As shown in case no.2 when internal fault occurred in sending side of the transformer, the differential relay will send signal to the circuit breaker at time (0.1 sec), this signal will be circuit breaker open, because the currents signal of secondary (C.Ts)A are don't similar to that obtained from secondary (CTs)B, that due to operation of relay. As shown in case no.3 the fault occurred in Transmission Lines the type of fault is three phase to ground, when the current increase up to set value the over current relay will be send signal to the circuit breaker, due to operation of the circuit breaker. As shown in case no.4 the fault occurred in internal of receiving transformer.

REFERENCES

[1] P. Maji and G. Ghosh, "Designing Over-Current Relay Logic in MATLAB," vol. 8, no. 3, pp. 40–43, 2017.

[2] H.Eteruddin et al., "Line Differential Protection Modeling with Composite Current and Voltage Line Differential Protection Modeling with Composite Current and Voltage Signal Comparison Method," no. July, 2014, doi: 10.12928/TELKOMNIKA.v12i1.1966.

[3] N. H. Hussin et al., "Modeling and simulation of inverse time overcurrent relay using MATLAB/Simulink," Proc. - 2016 IEEE Int. Conf. Autom. Control Intell. Syst. I2CACIS 2016, no. October, pp. 40–44, 2017, doi: 10.1109/I2CACIS.2016.7885286.

[4] M. P. Thakre and V. S. Kale, "D Istance P Rotection for L Ong T Ransmission L Ine Using Pscad," 2018 Int. Conf. Adv. Electr. Electron. Eng., vol. 6, no. 6, pp. 2579–2586, 2014.

[5] P. P. Aye, W. K. Myint, and W. T. Zar, "Modelling and Simulation of Protection for Power Transformer at Primary Substation by Using Differential Protection," Int. J. Sci. Eng. Appl., vol. 7, no. 11, pp. 474–478, 2018, doi: 10.7753/ijsea0711.1014.

[6] P. Mehta and V. Makwana, "Modelling of overcurrent relay with inverse characteristics for radial feeder protection using graphical user interface," 2017 Int. Conf. Intell. Comput. Instrum. Control Technol. ICICICT 2017, vol. 2018-Janua, pp. 74–79, 2018, doi: 10.1109/ICICICT1.2017.8342537.

[7] © May 2018 | IJIRT | Volume 4 Issue 12 | ISSN: 2349-6002 IJIRT 146262 INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY 139 Differential Protection scheme for Power Transformer Ashaka D. Desai MEFGI.

[8] S. Maharana and C. Sharma, "Fault Analysis of Transmission Line," vol. 1, no. 4, pp. 4–7, 2014.

[9] N. S. Jadhav and A. R. Thorat, "Design of a differential relay for 1000-kV Transmission Line using MATLAB," 2013 Int. Conf. Energy Effic. Technol. Sustain. ICEETS 2013, pp. 1164–1168, 2013, doi: 10.1109/ICEETS.2013.6533551.

[10] 1. Mohammed A. IBRAHIM1 , 2. Bashar M. SALIH2 , 3. Mahmoud N. Abd3 Power Technical Engineering Department, Northern Technical University (1,2) Ninavah Electricity Distribution, Directorate General Directorate of North Distribution Electricity, Ministry of Electricity, Iraq (3) ORCID. 1. /0000-0003-3182-2771, 2. 0000-0002-2437-0765, 3. https://orcid.org/0000-0002-8018-0093 doi:10.15199/48.2021.10.04 Protection Transformer and Transmission Line in Power System Based on MATLAB Simulink.org.

[11] International Journal of Computer Sciences and Engineering Open Access Research Paper Vol.-6, Issue-6, June 2018 E-ISSN: 2347-2693 Overcurrent Protection of Feeder Using Numerical Relay A. Kamani 1* , J. Satapara2 , T. Patel 3 1 Dept. of Electrical Engineering, Indus Institute of Technology and Engineering, Indus University, Ahmedabad, India 2 Dept. of Electrical Engineering, Indus Institute of Technology and Engineering, Indus University, Ahmedabad, India 3 Dept. of Electrical Engineering, Indus Institute of Technology and Engineering, Indus University, Ahmedabad, India *Corresponding Author: ankit.kamani41295@gmail.com Tel.: 8511527090 Available online at: www.ijcseonline.