Fault Analysis in 30 Bus Systems by Using MiPower

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***Abstract*—In order to keep up a constant power supply, these days relays in transmission systems are required to have the capacity to manage complex burdens including non-traditional associations, which represents a test to the short circuit investigation performed for the information settings of the hand-off. Short circuit scheming are critical in the application and settings of protective relays and in the examination of system activities. Short circuit projects give the node voltages and line flows, in the phase domain and sequence, for stable and unstable short circuits in the system under examination. Three kinds of stable fault event on power system transmission lines are single line to ground issues, line to line issues, and two lines to ground faults. Fault studies are utilized to choose and set the best possible protective strategies and switchgears. The assurance of the node voltages and line flows is essential in the fault study of power system network. The procedure comprises of different techniques for numerical calculation which is hard to perform by hand. The figuring can be effortlessly done by PC which is created by a program created utilizing MIPOWER. In this paper impede done on the system gives us the most extreme fault current and fault MVA rating which helps in relay setting, coordination and setting up the general overall protection system.**

Keywords- Fault; Single Line to Ground Fault; IEEE 30 bus system; MiPower;

I. INTRODUCTION

Today, the electric power system faces a progression of difficulties extending from consistently expanding burden request, voltage insecurity of the system, control transmission misfortune, regularly expanding fault currents, power outages and so on. In the advanced exceedingly industrialized society, because of the expansion in power utilization, blockage has achieved an all-time high. Every one of these issues can be diminished complex by the enhanced utilization of superconducting materials in electric power network [1]. Fruitful activity of a power system depends generally on the architect's capacity to give trustworthy and continuous provision to loads. The consistency of the power supply infers considerably more than simply being accessible. In a perfect world, the loads should be providing at constant voltage and frequency continuously. In commonsense terms this implies both voltage and frequency must be held inside close resiliencies with the goal that the buyer's hardware may work reasonably. For instance, a drop in voltage of 10-15% or a decrease of the system frequency of just a couple of hertz may prompt slowing down of the engine stacks on the system.

Power exchange through transmission system is stretched out over huge separations covering enormous zones to take into account appropriation network found even at far off spots. There might be event of symmetrical short circuit faults or flash over of lines because of lightning, protection harm, and so on. Measurements demonstrate [2] that just about 50% of power system faults happen in the transmission and distribution systems. In spite of the fact that the symmetrical issues are uncommon, they for the most part prompt most extreme current to stream against which the power system must be ensured. Be that as it may, greater part of the shortcomings engaged with power system are unsymmetrical composes where it is important to register, voltages and flows in the system under such unequal working conditions by utilization of symmetrical segments. The gathering of fault is as far as Unsymmetrical and Symmetrical compose where a fault including all the three stages on the power system is known as symmetrical fault or three-stage fault while the one including a couple of stages is known as unsymmetrical fault. Single Line-to ground, Line-to-line and two line-to-ground faults are unsymmetrical shortcomings [3].

Fault studies are utilized to choose and set the correct protective devices and switchgears. The assurance of the node voltages and line flows is essential in the fault study of power system. The procedure comprises of different strategies for scientific estimation which incorporates loads of equation and matrix way to deal with decides the magnitude of the voltage and current. The calculation may form an extensive lines and segments of matrix depending upon the quantity of nodes. The computation is conceivable when managing modest number of nodes. In any case, it is hard to perform by hand when managing extensive number of nodes. We will talk about the technique for analysis in the approach.

Future transmission systems will be significantly more unpredictable than those of today. This implies the power system organizer's assignment will be more perplexing. In the event that the systems being arranged are to be ideal concerning development cost, execution, and working effectiveness, better arranging devices are required. As a rule, the significant power system arranging apparatuses are [4]: Load stream investigation, Short circuit examination, Stability examination and system insurance and relay co-appointment. The fundamental target of load stream investigation is to distinguish the potential issues, as

far as unsuitable voltage conditions, over-burdening of offices, diminishing dependability, or any disappointment of the transmission system to meet execution criteria. After this examination arrange the organizer builds up the elective designs or situations that not exclusively will keep the predicted issues yet additionally will best meet the long haul destinations of system dependability and economy. The adequacy of the elective designs is controlled by load stream examination.

These kinds of shortcomings are mostly caused because of protection disappointment and lightning stroke. Despite the fact that symmetrical faults are uncommon, it prompts most serious fault current to stream in the system and may make overwhelming harms gear. Along these lines, cut off is performed to shield the system from any harm and point of confinement the stream of current in the system. Short circuit investigation is done to decide the best possible decision of protective devices, select productive intruding on hardware and confirm the sufficiency of the current interfering with gear [5].

II. SYSTEM DESCRIPTION

In this paper an established model of a synchronous machine (6 machine 30 node systems) has been utilized for the examination reason. Starter Load Flow thinks about are directed to ascertain the relentless state steadiness of the system.

Dissecting the arrangement of load stream investigation for various conditions guarantees that the power system is intended to fulfil its execution criteria while acquiring the most ideal venture and activity costs. A few precedents [6] of the employments of load stream examines are to decide,

- Component or circuit stacking.
- Steady state node voltages.
- Power streams.
- Transformers tap settings
- System misfortunes
- Current

In any case, these little vacillations can be disregarded in computing the enduring state consequences for system gear. The heap stream demonstrate is likewise the reason for a few different kinds of concentrates, for example, hamper, engine beginning, and consonant investigations. The heap stream display supplies the system information and an underlying enduring state condition for these investigations.

Short circuit studies were led to decide the fault flows and fault MVA levels in the plant for single line to ground fault and three stages to ground fault. The investigation is improved the situation different sorts of faults at various areas all through the system. Two components whereupon the correct choice of circuit breakers depends are the current streaming promptly after the fault happens and the current, which the breaker must intrude. Furthermore, the after effects of the short circuit investigations are utilized to decide the settings of relays, which control the circuit breakers.

Voltage, Current, Kilovolt amperes and impedance are related to the point that determination of base qualities for any two of them decides the base estimations of the staying two[2]. For single stage systems or a three stage systems, the term current alludes to line current and the term voltage alludes to voltage to unbiased. The per unit estimation of a line to impartial voltage on hold to unbiased voltage base is equivalent to the per unit estimation of the line-to-line voltage at a similar point on hold to-line voltage base if the system is adjusted.

Thus the three stage kVA is three times the kVA per stage and the three stage KVA base is three times the base kVA per stage. Along these lines the per unit estimation of the three stage kVA on the three stage kVA base is indistinguishable to the per unit estimation of the kVA per stage on the kVA per stage base. Base impedance and base current can be registered straightforwardly from three stage estimations of base kilovolts and base kilovolt amperes [7]. On the off chance that we translate base kilovolt amperes and base voltage in kilovolts to mean base kilovolt amperes for the aggregate of the three stages and base voltage from line to line, we find

$$Base\ Current = BasekVA_{3ph}/\sqrt{3}BasekV$$

$$BaseZ = (BasekV)^2/BaseMVA_{3ph}$$

In some cases per unit impedance of a segment of a system is communicated on a base other than the one chose as base for the piece of the system in which the segment is found. Since all impedances in any one a player in a system must be

communicated on a similar impedance base when making calculations, it is important to have a methods for changing over per unit impedances starting with one base then onto the next. Per unit impedance is given by condition.

$$per\ unit\ Z = \frac{(Actual\ Z\ in\ ohms \times baseMVA)}{BasekV^2} \times 100$$

Which demonstrates that per unit impedance is specifically relative to base megavolt amperes and conversely corresponding to the square of the base voltage. Accordingly to change from per unit impedance on an offered construct to per unit impedance in light of another base, the accompanying condition is utilized:

$$\text{perunit}Z_{new} = \text{perunit}\ Z_{given} \times \left(\frac{\text{BasekV}_{given}}{\text{BasekV}_{new}}\right)^2 \times \left(\frac{\text{BaseMVA}_{new}}{\text{BaseMVA}_{given}}\right)$$

III. TYPES OF FAULTS

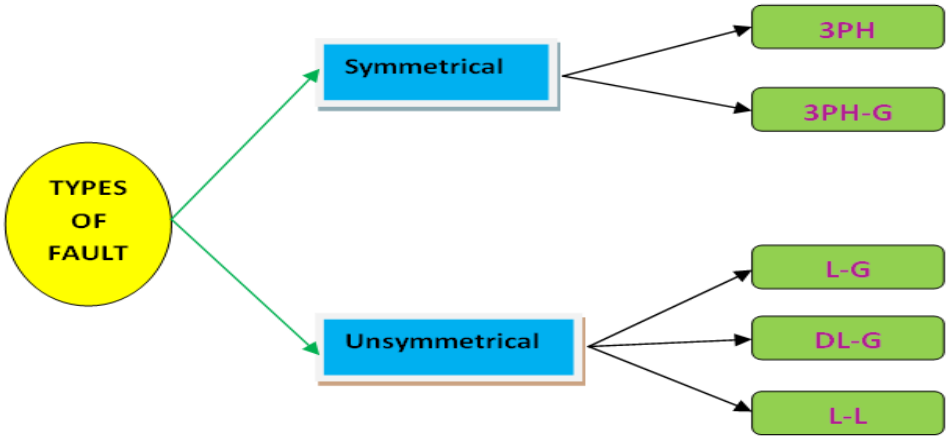

Fig 1.Types of Fault

A. SYMMETRICAL FAULTS

A symmetrical fault offers ascend to symmetrical fault flows that are uprooted with 1200 one another. Symmetrical fault is additionally called as adjusted fault. This fault happens when all the three stages are at the same time short circuited. Event of symmetrical faults is in the scope of 2 to 5% of the aggregate system faults. Nonetheless, if these faults happen, they cause an exceptionally serious harm to the gears despite the fact that the system stays in adjusted condition. The symmetrical faults for the most part happen at the terminal of generator.

i. 3 Phase Faults:

A three phase bolted fault describes the situation where the three conductors are substantially held in common with zero impedance among them, correspondingly as were bolted together. For a balanced symmetrical system, the fault current magnitude is adjusted similarly inside the three phases. While this kind of fault does not happen as often as possible, its outcomes are utilized for protective relay choice, since this fault kind by and large yields the most extreme short circuit current qualities [8]-[9].

ii. 3 Phase to Ground Faults:

A 3-phase to-ground fault (rather than only a 3-phase fault), would the ground resemble an unbiased that ostensibly has no current coursing through it for adjusted load conditions. That is, are we again discussing a decent fault with just positive succession systems relevant (and no negative arrangement organize and no zero grouping systems) [10]-[11]. The likelihood of event of such sort of fault is almost 2 to 3 percent. Voltage droop because of power system fault, three-stage to ground is made in circulation line demonstrate, their impact on the voltage extent variety by fluctuating deficiency opposition for each stage are inspected [12].

B. ASYMMETRICAL FAULTS

The most well-known faults that happen in the power system organize are unsymmetrical faults. This sort of fault offers ascends to unsymmetrical fault flows. These issues are additionally called as uneven faults as it causes lopsided flows in the

system. Unsymmetrical issues are the faults which leads unequal flows with unequal stage moves in a three stage system. The unsymmetrical fault happens in a system because of essence of an open circuit or short circuit of transmission or distribution line. It can happen either by characteristic aggravations or by manual blunders. The characteristic unsettling influences are overwhelming breeze speed, ice stacking on the lines, helping strokes and other catastrophic events.

i. Line to Ground Fault:

For the most part, a solitary line-to-ground fault on a transmission line happens when one conductor falls to the ground or interacts with the unbiased conductor. Such kinds of failures may happen in power system because of numerous reasons like fastest wind, dropping off a tree, lightning, and so on [13]-[15].

ii. Line to Line Fault:

A line to line fault happens when two conductors are short circuited. The significant reason for this kind of fault is the overwhelming breeze. The overwhelming breeze swinging the line conductors which may contact together and subsequently causes hamper. The level of such sort of issues is around 15-20% [16]-[17].

iii. Double Line to Ground Fault:

In twofold line-to-ground fault, the two lines interact with one another alongside the ground. The likelihood of such sorts of issues is about 10%. Single line-to-earth fault may turn out to be twofold line-to-earth faults. For this situation, the technique for deciding the fault area takes quite a while, as a group of specialists conducts bypassing the whole system [17]-[18].

The primary purposes behind the twofold line-to-ground faults event are disadvantageous voltage and current drifters amid the single line-to-ground fault. The frequency and the likelihood of the twofold line-to-ground faults event in addition to other things rely upon the term of the single line-to-ground fault and the length of galvanic associated lines in the system [19].

IV. METHODOLOGY

Table 1 demonstrates that most extreme quantities of shortcomings are happening on overhead lines. If there should arise an occurrence of three stage network, the breakdown of protection between one of the stages and earth is known as line to ground fault. In line to line fault, there is protection breakdown between two stages. While the protection breakdown between two stages and earth frames twofold line to ground fault. The breakdown of protection between three stages is only three stage fault.

TABLE I
PERCENTAGE OF FAULT ON THE DIFFERENT ELECTRICAL EQUIPMENT

S.No.	Equipment	% Of Total Faults
1	Overhead Lines	50
2	Switchgear	15
3	Transformer	12
4	Cables	10
5	Miscellaneous	8
6	Control Equipment	3
7	CTs and PTs	2

Presentation of transmission line to ecological conditions, for example, tree falling, lightning stroke, creatures and so on makes a higher probability of fault when contrasted with power system segments. Quick reclamation of transmission line requires keeping the spreading of fault impact to guarantee the steadiness of network. As per Tenaga Berhads (TNB) 5 years study (2001 to 2006), 90% of faults are SLG shortcomings [20].

TABLE II
OCCURANCE OF DIFFERENT TYPES OF FAULTS

S.No.	Types of Faults	% Occurrence
1	Line to Ground	86
2	Line to Line	7
3	Double Line to Ground Fault	5
4	3 Phase Fault	2 or less

V. SIMULATION RESULTS

In the power system most of the faults are line to ground fault so line to ground fault is taken for analysis of fault. The TABLE III shown that the fault current values in KA and fault MVA rating for all busses. During the fault on bus 11 the fault current is high.

For example, the phase fault current wave for the fault on 28th bus is shown in figure 3 & 4.Figure 2 shown the IEEE 30 bus system for the fault on the 28th bus.

TABLE III
FAULT CURRENT FOR FAULT AT ALL BUSSES

Fault on Bus	Fault Current in KA	MVA Rating
1	19.495	4457.201
2	21.563	4930.023
3	3.966	906.820
4	5.756	1315.975
5	17.465	3992.991
6	8.969	2050.544
7	3.924	897.037
8	17.902	4092.943
9	194.627	337.105
10	10.951	625.940
11	195.741	3729.361
12	10.917	623.975
13	64.478	3685.404
14	4.238	242.254
15	6.658	380.568
16	5.495	314.102
17	6.935	396.411
18	4.108	234.800
19	4.166	238.109
20	4.528	258.799
21	7.582	433.375
22	7.466	426.761
23	4.142	236.742
24	4.989	285.143
25	3.215	183.782
26	1.351	77.199
27	3.574	204.310
28	3.803	869.458
29	1.686	96.346
30	1.527	87.270

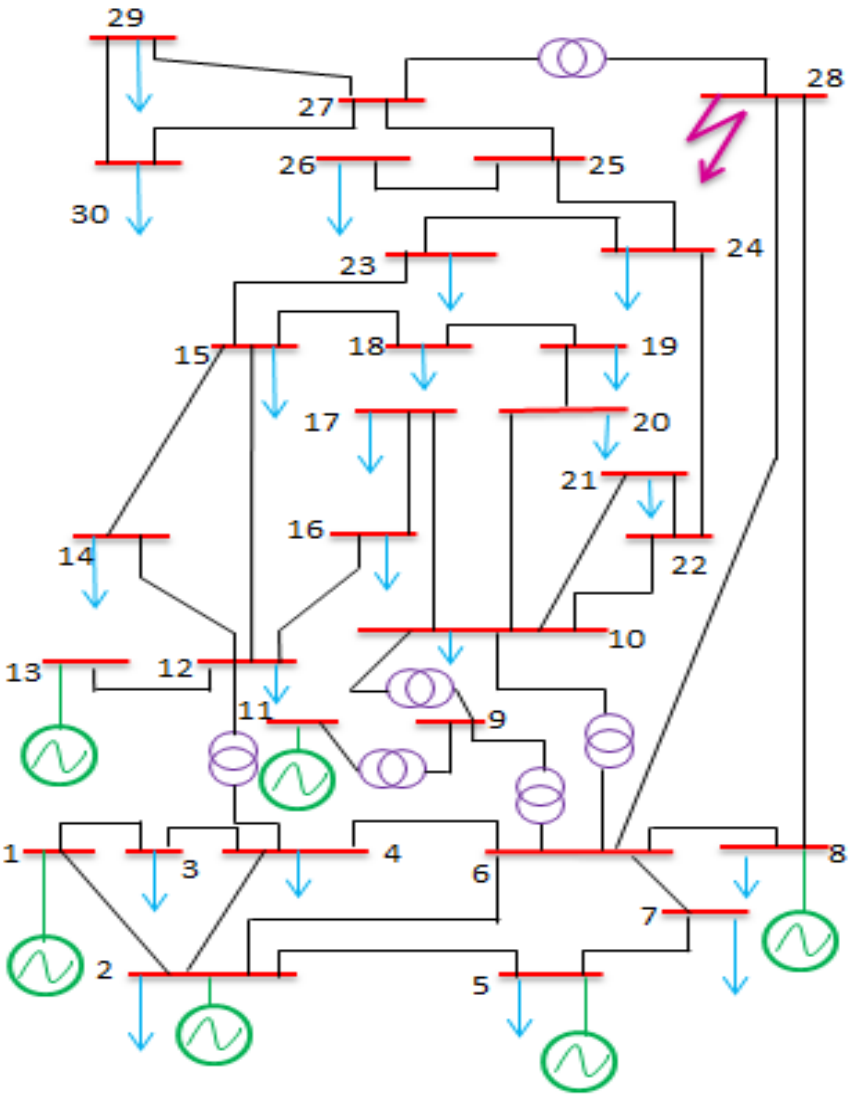

Fig 2.Fault Analysis 30 Bus system

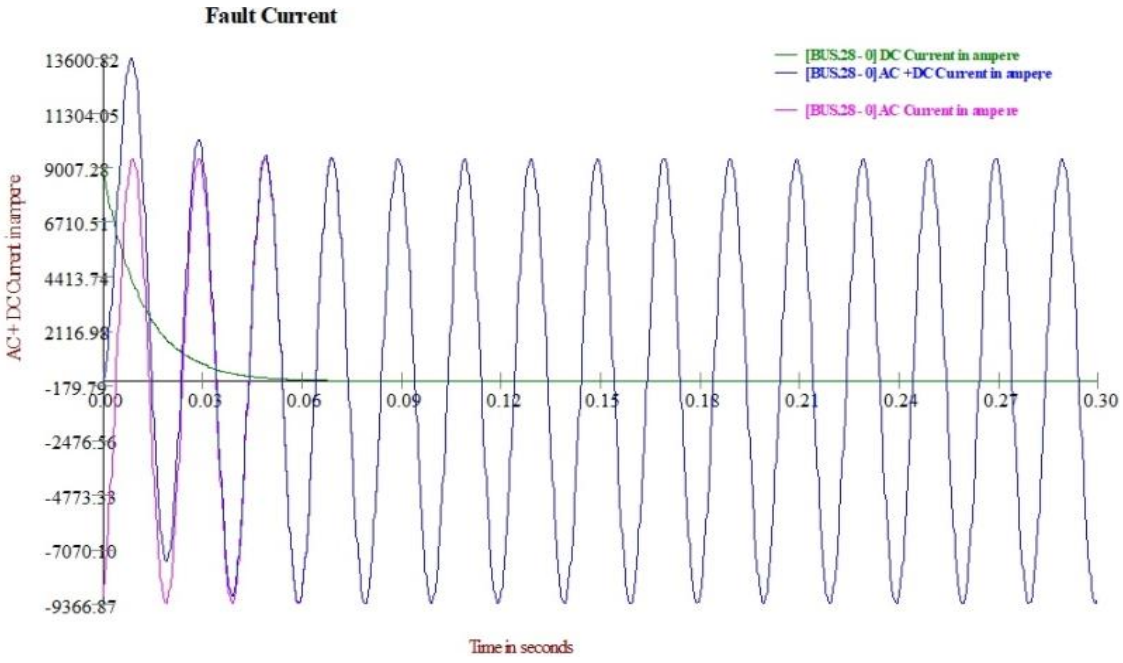

Fig 3.Fault Current in KA

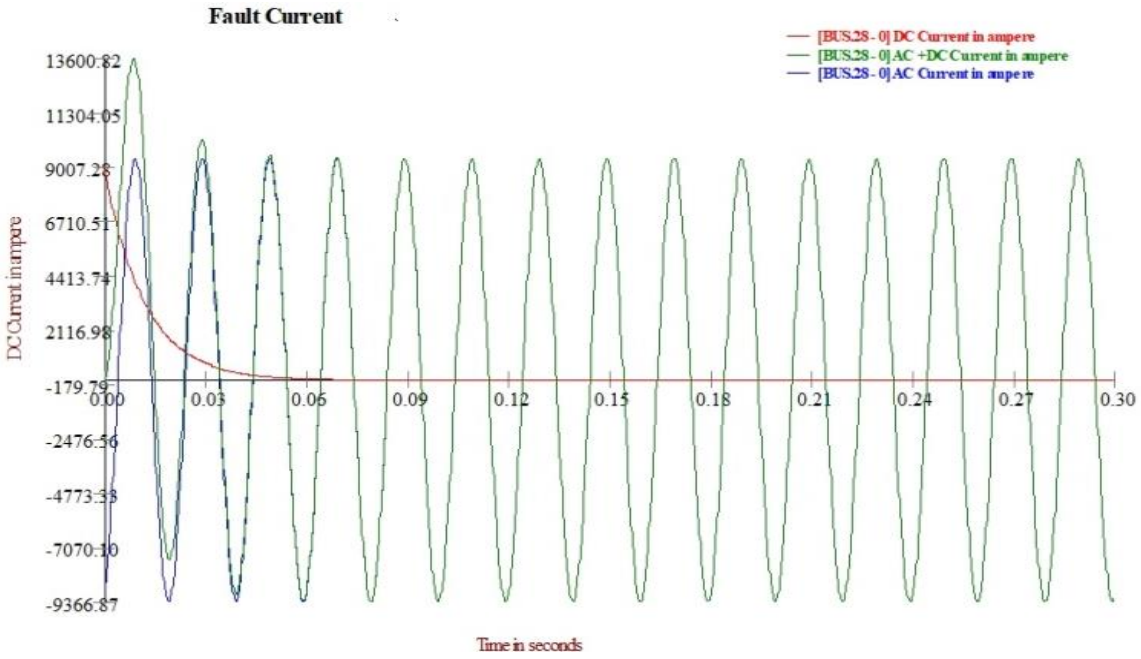

Fig 4.Fault in MVA

VI. CONCLUSION

We have finished up from the above simulation result of 30 bus system that when blame happens in transmission line the voltage and current esteem will be change from its rated value. By utilizing various types of instabilities happens in the system through which serious mischances will happen in transmission system stayed away from effectively. This paper presents simulation of single line chart utilizing MiPower programming for single stage to ground blame (unsymmetrical blame). Short circuit analysis is improved the situation computing the evaluations of existing switchgears and settings for security adapt. In this paper clarifies impede done on every one of the transports. The transport 11 gives high blame current of 195.741 KA and blame MVA of 3729.361. Additionally when performed on load transport 7 gives the low blame current 3.924 KA and blame MVA of 897.037. These qualities show that the evaluations of switchgear utilized in the test framework are well over as far as possible.

REFERENCES

[1] Ashish Tomar, “Feasibility Analysis of replacing 10kV, 50MVA short transmission overhead line with HTS cable in IEEE 14-bus system, on a pilot basis; by simulating the system on PowerWorld Simulator 18,” IEEE conference, 978-1-4673-7918-2/16/$31.00 ©2016 IEEE.
[2] B. Ram and D. N. Vishwakarma, “Power system protection and switchgear”, NewDelhi: Tata McGraw-Hill, (1995).
[3] M. Tijani and D. Olatunji, “An Evaluation of Three-Phase Fault Currents on the Nigerian 330kV Transmission Grid‟, Journal of Research in Technology and Engineering Management, vol. 4, no. 2, (2011), pp. 37-45.
[4] "Electrical Energy Systems Theory an Introduction,"(Book) Olle I.Elgerd, Tata McGraw Hill Edition, Year 1983.
[5] Renuka Kamdar,Mukesh Kumar Kirar,Manoj Kumar , Ganga Agnihotri (2013), "Short Circuit, Analysis of an Industrial distribution System," Conf. on Advances in Computer, Electronics and Electrical Engineering, CEEE.
[6] Edward Wilson Kimbark (1948), Power System Stability, Volume I: Elements of Stability Calculations.
[7] Swati Srivastava , "Three Phase Fault Analysis And Breaker Sizing Using Mipower Software," ISBN: 978-93-82702-28-3, sept. 2013.
[8] Tarang Thakur, "Three Phase Faults Analysis of Power System," Global Journal of Researches in Engineering: F Electrical and Electronics Engineering , Volume 16 Issue 5 Version 1.0 Year 2016. https://electrical-engineering-portal.com/worst-type-three-phase-faults.
[9] https://electronics.stackexchange.com/questions/105255/three-phase-ground-fault.
[10] https://www.eng-tips.com/viewthread.cfm?qid=264105.
[11] Rijavan Farade, Bandanawaz Kotiyal and Altaf hussain Balsing, "Three-phase-to-ground fault and its impact on voltage magnitude," IJIERT, ISSN: 2394-3696, VOLUME 2, ISSUE 3, MARCH.-2015.
[12] Amol Birajdar and Sachin Tajane, "Modelling and Simulation of Transmission Line to Detect Single Line to Ground Fault Location," ICPEICES-978-1-4673-8587-9/16/$31 .00 ©2016 IEEE.
[13] Aoyu Lei, Xinzhou Dong, Shenxing Shi and Bin Wan, "A Novel Current Travelling Wave Based Singleended Fault Location Method for Locating Singlephaseto-ground Fault of Transmission line," 978-1-4673-9682-0/15/$31.00 ©2015 IEEE.
[14] https://circuitglobe.com/single-line-to-ground-fault.html.
[15] Felix J. Nepveux IV, P.E. "Using Negative Sequence Current To Detect Llne-To-Line Faults In Transformers," 978-1-5090-0416-4/15/$31.00 © 2016 IEEE.
[16] https://circuitglobe.com/line-to-line-fault.html
[17] Elmir Khakimzyanov , Ramil Mustafin and Pavel Platonov," Method of fault location for double line-to-earth faults in distribution networks" Engineering Science and Technology, an International Journal 19 sep. (2016) 1668–1671.
[18] Roman Korab and Edward Siwy, " Statistical analysis of the double line-to-ground short-circuit current in MV urban network for the power cable metallic screen rating," 9th International Conference on Probabilistic Methods Applied to Power Systems KTH, Stockholm, Sweden - June 11-15, 2006.
[19] A. M. Zin, S. P. A. Karim, "The Application of Fault Signature Analysis," in Tenaga Nasional Berhad Malaysia, IEEE Transactions on Power Delivery, Vol. 22, No. 4, October 2007.