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Study the Stability of Khartoum Ring under Different Fault Clearing Times Using NEPLAN Software

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***Abstract**: study of the stability of any electrical system is very important to maintain the continuity of the supply to the loads, especially when symmetrical faults occur. In this scientific paper, the stability of Khartoum ring has been studied under the influence of different times in order to know the critical clearing time to eliminate the faults. The study was based on NEPLAN simulation program by selecting 0.2 seconds as fault clearing time and the faults elimination at different times. The effect was confirmed by displaying the curves of the active power, reactive power, voltages and currents.*

Keywords— Fault Clearing Time, Critical Clearing Time, NEPLAN Software, Symmetrical Fault, Khartoum Ring

1. INTRODUCTION

Stability of the Power system is that the ability of an electrical power grid, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to physical disturbance, with most system variables bounded in order that practically the whole system remains intact [1]. In the concept of transient stability, where one studies the power the machines need to maintain synchronism after an outsized disturbance, the term 'withstand' is usually related to the ability to make sure that each machine of the facility system is in a position to take care of synchronism with reference to the opposite machines of the system [2,3].

To maintain transient stability, a power system fault must be cleared quickly enough in order that the fault-on transient remains inside the stability limits. The critical clearing time is that the maximum clearing time, and if the critical clearing time is exceeded, stability is lost by generators losing synchronism. An exact computation of critical clearing time requires numerical integration of fault-on and post-fault trajectories and identification of the controlling unstable equilibrium point that determines the relevant portion of the stability boundary. The critical clearing time is a well-established engineering metric of transient stability and its exact computation by nonlinear analysis and numerical integration [4, 5].

In this paper the stability of Khartoum ring was studied under different fault clearing times using NEPLAN to choose the maximum, critical clearing time that stabilize and prevent instability of the system.

2. METHODOLOGY

i. Fault Clearing Time:

The critical fault clearing time is the whole time, during which if a system is subject to disturbance and the fault is cleared within that time period, the system will remain stable once the fault is isolated. If the fault is cleared beyond the critical fault clearing time, it could lead to system instabilities in the form of generation/load loss. The overall fault clearing time is different for different parts of power systems. It mainly lay on the protection settings and type of protection system used. For transmission substation without generation unit the critical clearing time is longer than that has generation units. The following figure explains Total Fault Clearing Time. [6]

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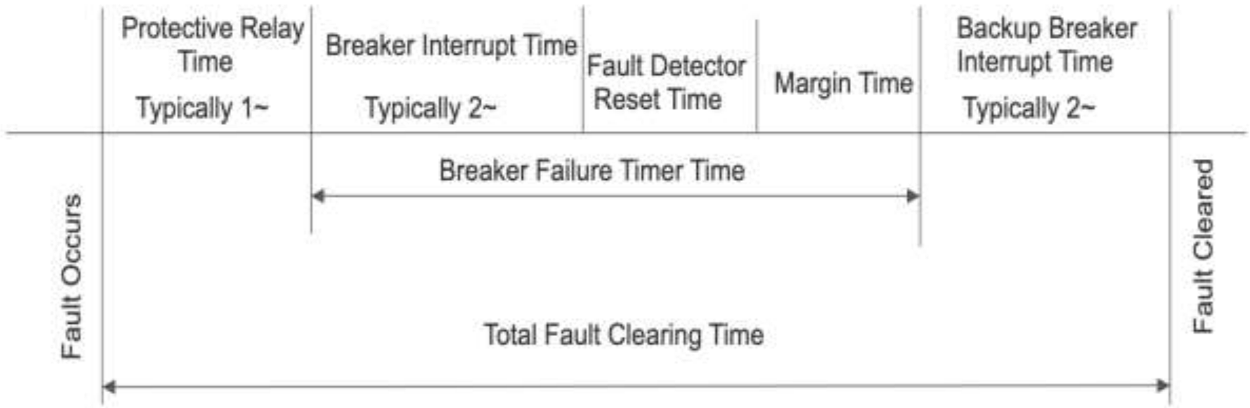

Figure 1: Total clearing time diagram

ii. NEPLAN Software:

NEPLAN is a very user-friendly planning and information system for electrical-, gas- and water-networks.

The program will be explained by examples and we show how to start a new project and how to build a small power system. That means that the user will learn how to enter the elements graphically, how to enter data, how to use libraries, how to run calculations and how to present the results in a mann.er adapted to the objectives of the analysis.

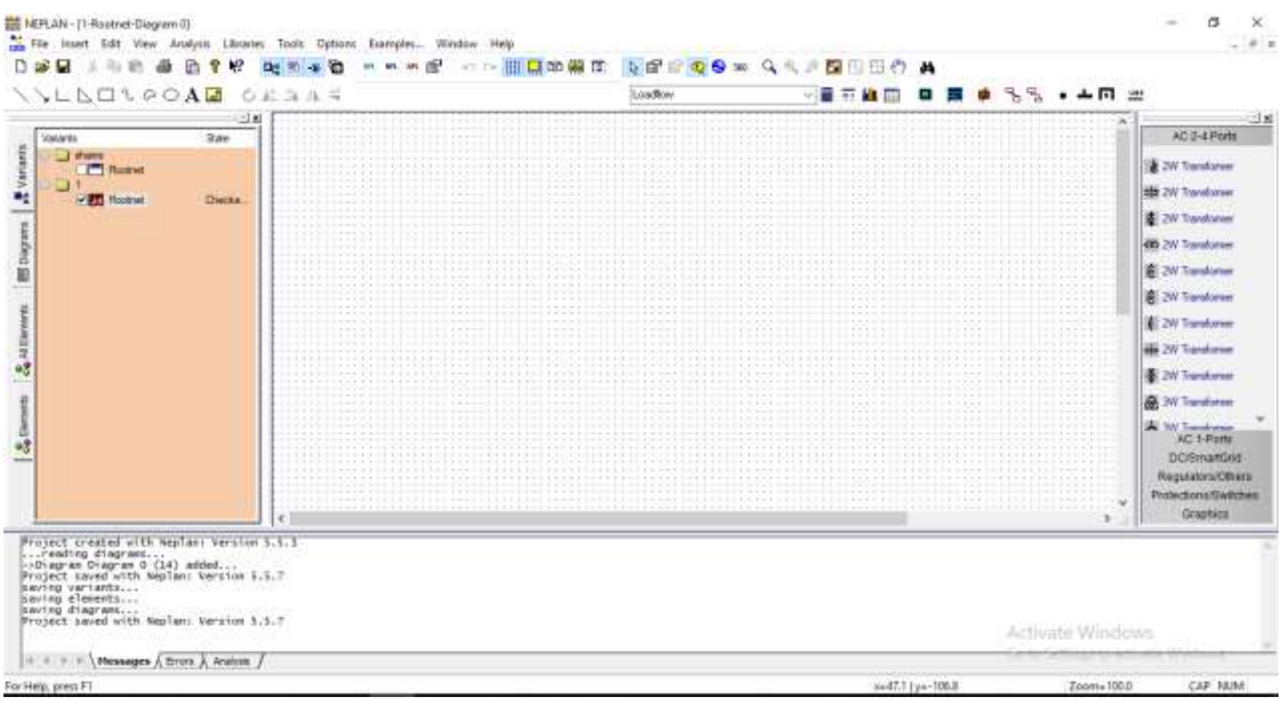

Figure 2: NEPLAN Software

iii. The Khartoum Ring (110 KV):

The diagram of the Khartoum ring is given below in figure (3.2). This network consists of 24 buses, 6 Generators, 41 Transformers. Generator data, Transformer data and loads data are given from the base case 2017.

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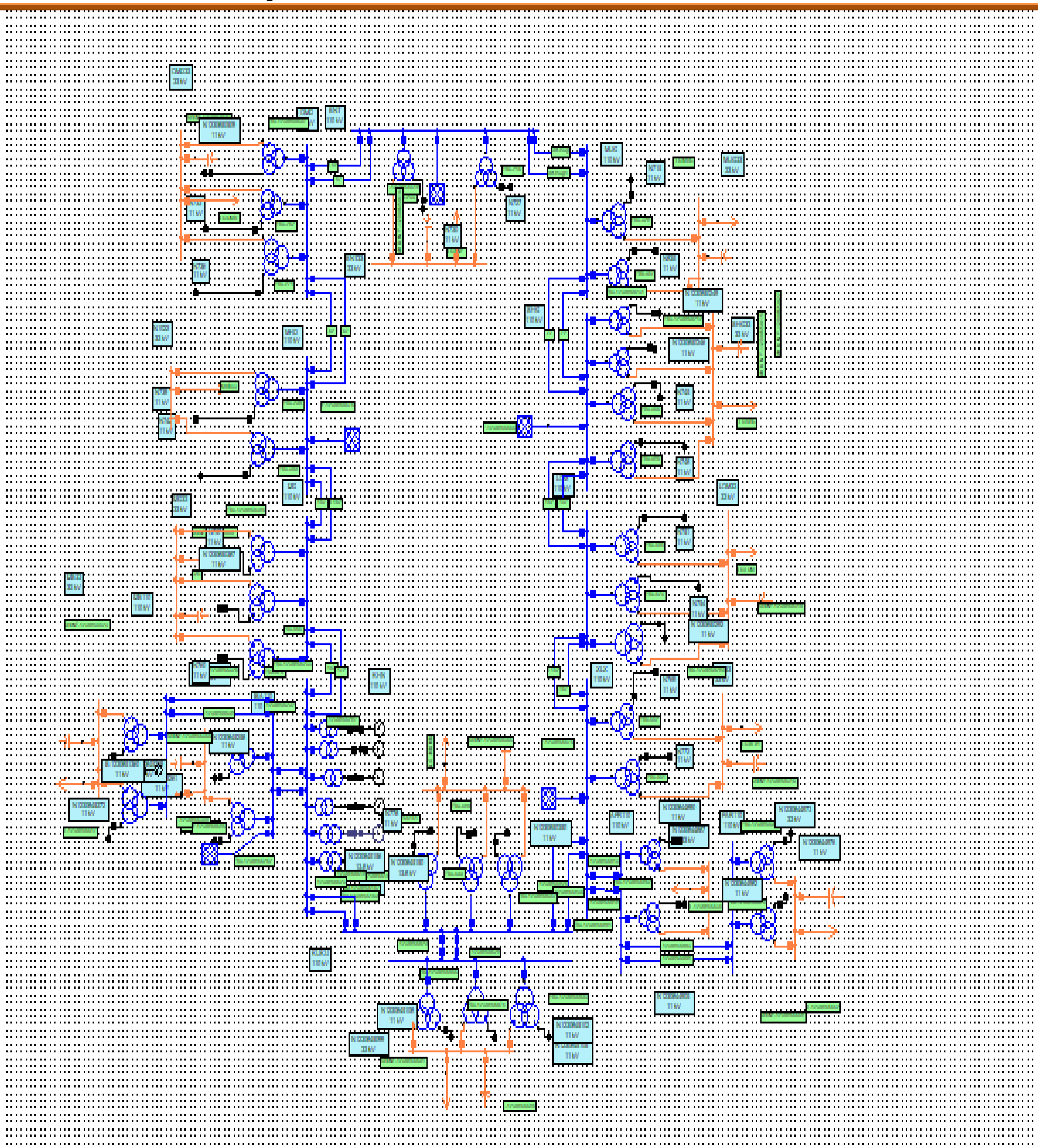

Figure 3: Single Line Diagram of Khartoum Ring

3. RESULTS AND DISCUSSIONS

- Case1: The Three Phase Fault Applied to The Line (KHN- KUKU1) at 0.2 Sec:

ACTIVE POWER

A- This fault cleared at 0.3 sec.

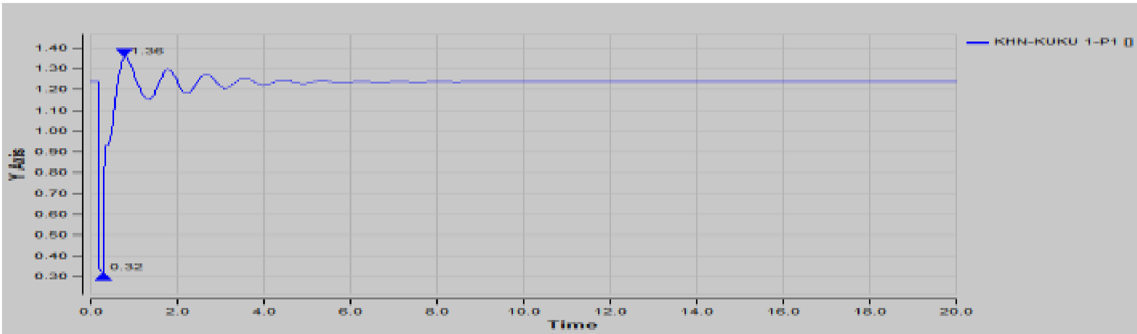

Figure 4: Active Power at (0.3) Sec.

B- Also when the fault cleared at 0.24 sec.

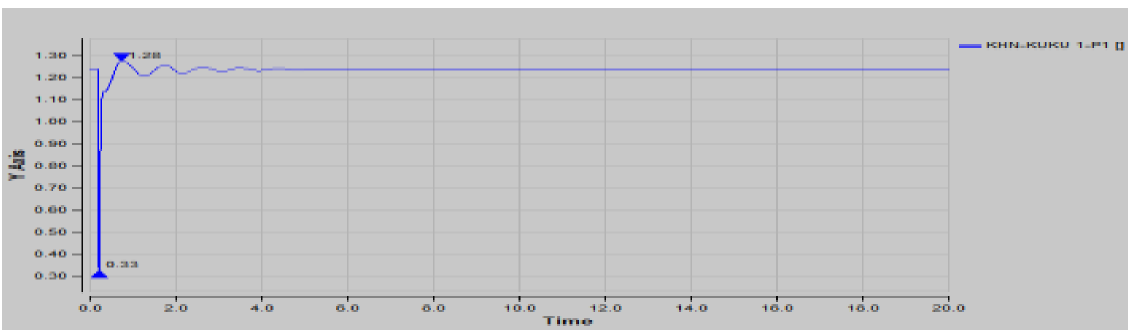

Figure 5: Active Power at 0.24 Sec.

C- When the fault cleared at 0.77 sec.

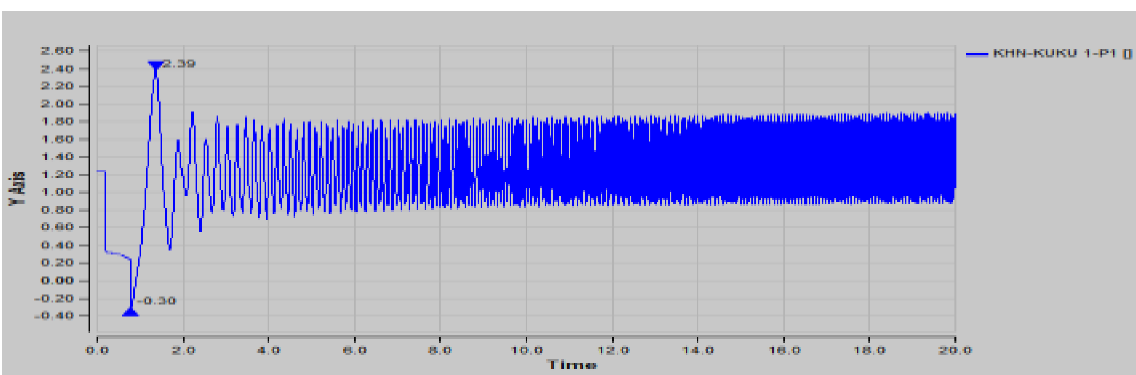

Figure 6: Active Power at 0.77 Sec.

❖ OBSERVATION:

it has been noticed that, when a three phase fault applied at 0.2 sec and cleared at 0.3 the system stabilized after

8.3 sec, and when the fault clearing time was decreased to 0.24 the system stabilized after 4.8 sec, and the overshoot of oscillation reduced from 1.36 to 1.28, and finally the fault clearing time was increased to 0.77 sec the system become unstable.

Reactive Power

A- This fault cleared at 0.3 sec.

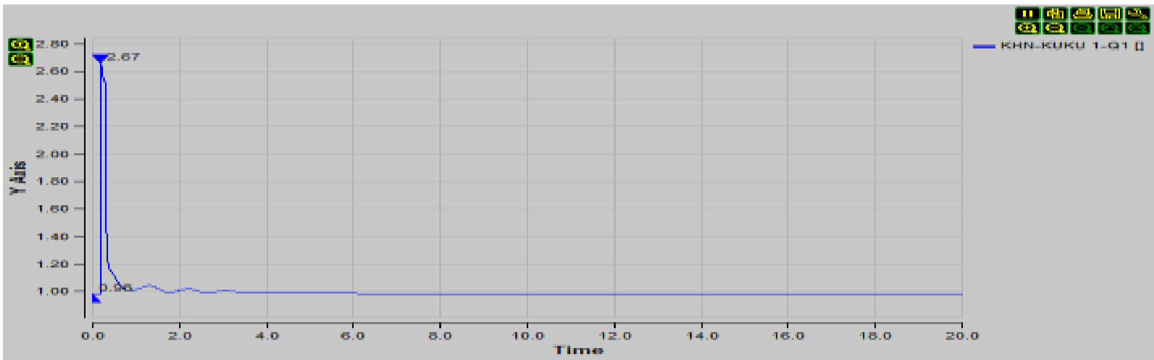

Figure 7: Reactive Power at 0.3 Sec.

B- Also when the fault cleared at 0.24 sec.

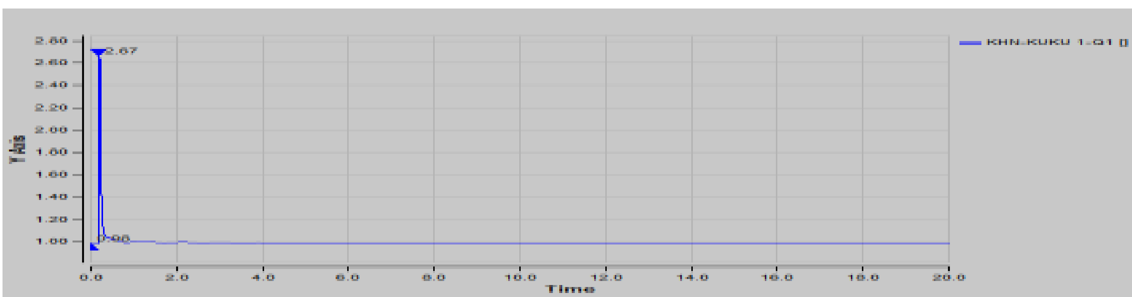

Figure 8: Reactive Power at 0.24 Sec.

C- When fault cleared at 0.77 sec.

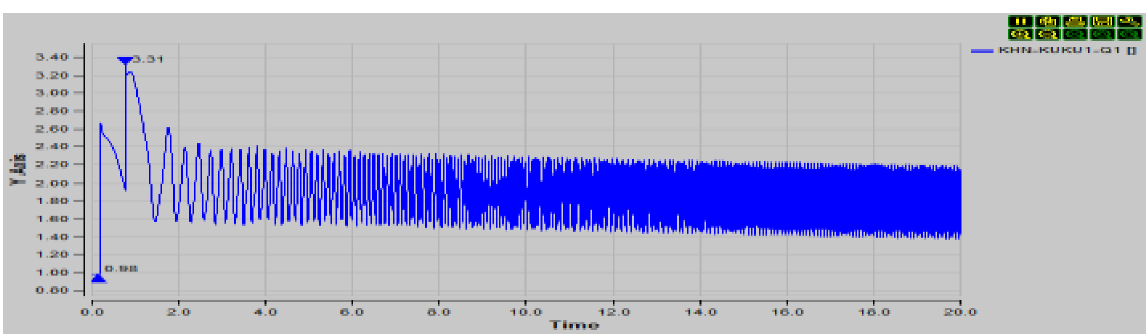

Figure 9: Reactive Power at 0.77 Sec.

❖ OBSERVATION:

it has been noticed that, when a three phase fault applied at 0.2 sec and cleared at 0.3 the system stabilized after 5.9 sec, and when the fault clearing time was decreased to 0.24 the system stabilized after 3.7 sec, and the overshoot of oscillation not changed, and finally the fault clearing time was increased to 0.77 sec the system become unstable.

- Case 2: The Three Phase Fault Applied To the Line (Kuku-XLX) at 0.2 sec:

Active Power

A- This fault cleared at 0.35 sec.

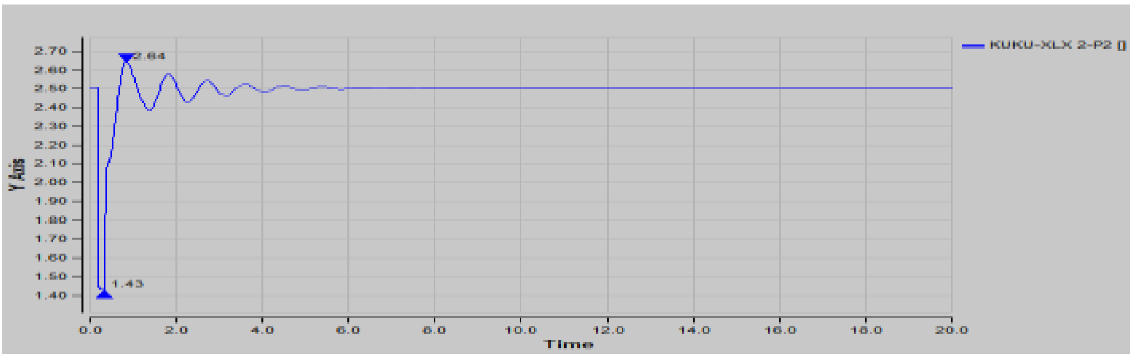

Figure 10: Active Power at 0.35 Sec

B- Also when fault cleared at 0.28 sec.

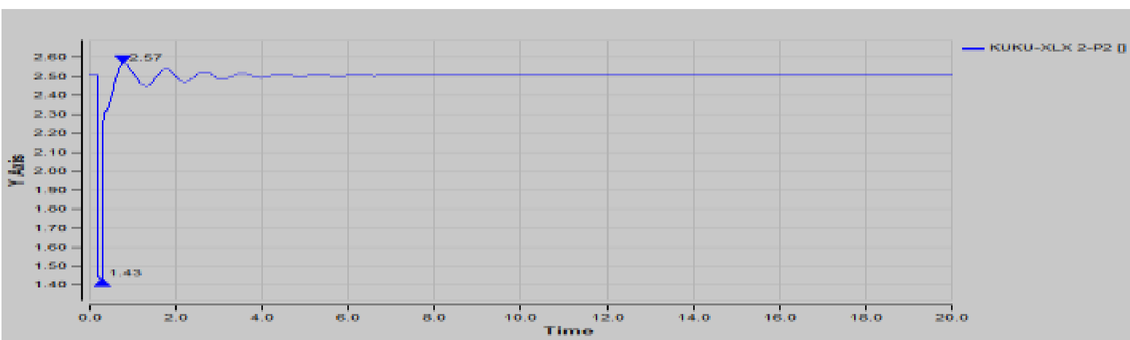

Figure 11: Active Power at 0.28 Sec.

C- When fault cleared at 1.08 sec.

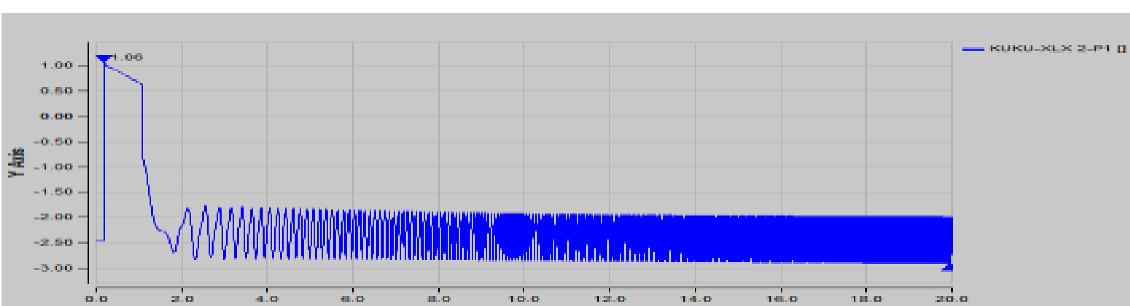

Figure 12: Active Power at 1.08 Sec.

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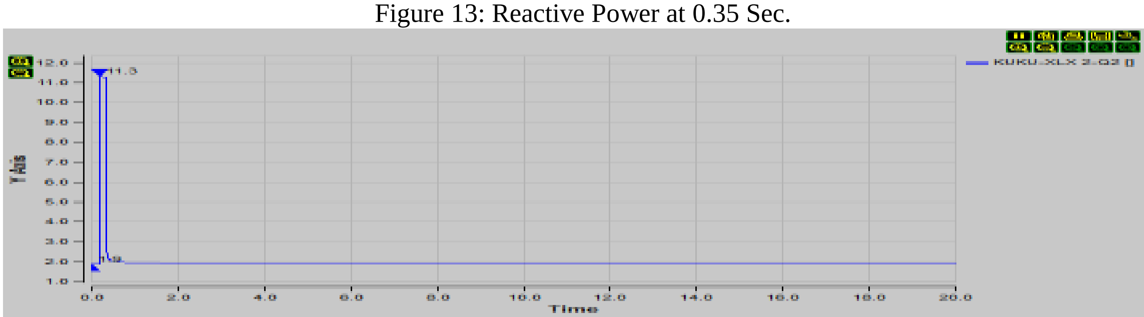
❖ OBSERVATION:

It has been noticed that, when a three phase fault applied at 0.2 sec and cleared at 0.35 the system stabilized after 7.6 sec, and when the fault clearing time was decreased to 0.28 the system stabilized after 5.8 sec, and the overshoot of oscillation reduced from 2.64 to 2.57, and finally the fault clearing time was increased to 1.08 sec the system become unstable.

Reactive Power

A-This fault cleared at 0.35sec

Figure 13: Reactive Power at 0.35 Sec.



B- Also when fault cleared at 0.28 sec.

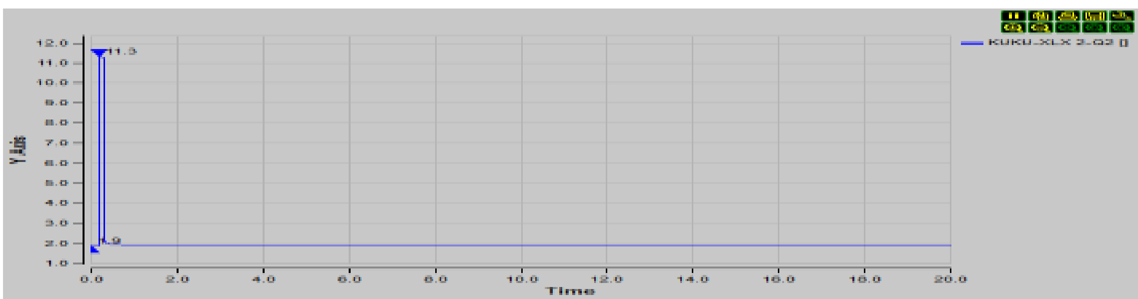


Figure 14: Reactive Power at 0.28 Sec.

C- When fault cleared at 1.08 sec.

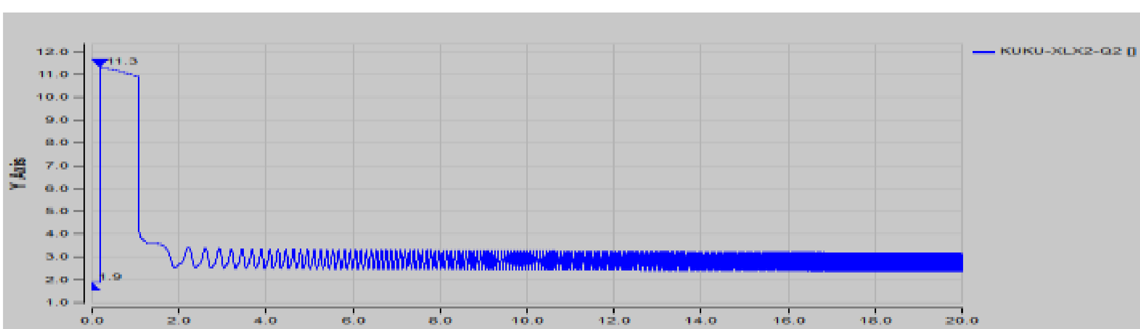


Figure 15: Reactive Power at 1.08 Sec.

❖ OBSERVATION:

It has been noticed that, when a three phase fault applied at 0.2 sec and cleared at 0.35 the system stabilized

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after 6.4 sec, and when the fault clearing time was decreased to 0.28 the system stabilized after 4.9 sec, and the overshoot of oscillation not changed, and finally the fault clearing time was increased to 1.08 sec the system become unstable.

4. CONCLUSION

In this paper, the effect of symmetrical fault has been studied under different fault clearing times. three phase fault was made in lines (KHN-KUKU1),(KUKU-XLX2) and studied different fault clearing time on them to choose the maximum critical clearing time that stabilize and prevent instability of the system and it was founded as follow:
1- In line (KHN-KUKU1) the maximum fault clearing is 0.56 sec.
2- In line (KUKU-XLX2) Maximum fault clearing is 0.87 sec.

5. REFERENCES

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