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Fuzzy Logic-Based Detection System for Loss of Excitation in Synchronous Generator

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Abstract: In this article, fuzzy logic has been applied for the purpose which detect the complete Loss of Excitation (LOE) in a synchronous generator. The primary protection in synchronous generator is the Loss of Excitation (LOE) protection. Loss of Excitation fault causes damage to the generator as well as affects the Power System. Under the fault condition synchronous generator behaves like an Induction Generator and starts absorbing reactive power from grid. The approach has been modelled using MATLAB/Simulink.

Keywords: Loss of Excitation (LOE) , Synchronous Generator, Fuzzy Logic, MATLAB.

- **Introduction**

One fundamental part of the electricity system is the generator. The generator is connected to the prime mover, DC excitation system and power grid, its protection is more intricate than that of other power system components. The DC excitation provides and maintains the synchronous speed at which the synchronous generator runs. DC, AC, and static excitation are the three different types of excitation systems. When there is unreliability in the excitation system, the system experiences the LOE phenomena. Poor brush contact, field excitation loss, inadvertent field circuit breaker tripping, short circuit of the field winding, field breaker latch failure, and failure of the alternating current supply to the excitation system [2].

The decrement of current provided by excitation system either partially or suddenly is defined as the loss of excitation. Neural network-based techniques and machine learning have also been applied. The synchronous generator's internal voltage can be utilized to identify LOE. To differentiate LOE from steady power swing condition, one can use the voltage index and reactive power index. Artificial intelligence has been used in real-world applications to identify and fix generator problems. When there are flexible AC transmission devices present, a classifier based on the radial basis function is employed to identify faults. The main disadvantage of the aforementioned systems is their need for big datasets; modern AI and ML-based techniques do not have this requirement, which is a major advantage of fuzzy interference systems.

- **Excitation Loss in Synchronous Generator**

A synchronous generator is a synchronous machine which converts mechanical power into AC electrical power through the process of electromagnetic induction. Synchronous generators are also referred to as alternators or AC generators. A synchronous generator can be either single phase or three phase. An alternator consists of two main parts:- stator and rotor. The stator is the stationary part of alternator. It consists the armature winding in which the voltage is generated. The rotor is the rotating part of the alternator. The rotor produces the main field flux.

The equation of active power of the alternator is given below,

$$P = \frac{EV}{X} sin\delta$$

Where, P is active power of the alternator, E is sending end voltage of alternator, V is terminal voltage of alternator, X is transmission line reactance and δ is the phase angle between sending end voltage and terminal voltage of alternator

Loss of Excitation fault occurs when the rotor winding is either open circuited or short circuited. This causes the synchronous generator to work as an induction generator.

- **Fuzzy Logic**

This approach uses fuzzy logic to analyse the system and identify faults related to loss of excitation, stable power swing, and partial loss of excitation. The method of processing variables called fuzzy logic allows for processing of several potential truth table values using a single variable. Fuzzy logic makes use of incomplete data to attempt to solve problems. It made use of IF THEN methodology-based rules. The synchronous generator can function normally for a while as well as malfunctioning for a while. To prevent the system from failing completely, the fault must be found as soon as possible.

Fuzzy logic was first proposed by Lotfi Zadeh in a 1965 paper for the journal Information and Control. In essence, it is an extension of Boolean logic that allows for uncertainty. The use of fuzzy logic-based techniques has grown significantly in the last few years.
Mamdani and Sugeno interference systems are the two categories of fuzzy logic systems. To detect LOE in this scheme, we have employed the Mamdani fuzzy system. Therefore, the machine's loss of excitation is correctly detected by the fuzzy logic that was designed [5].

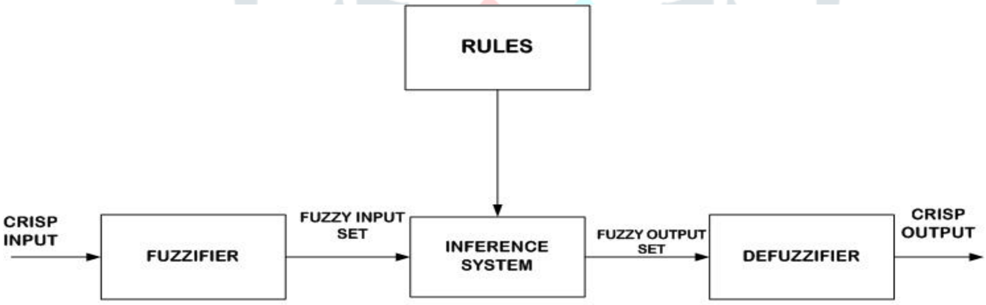


Fig.1 Fuzzy Logic Architecture

- **SIMULATION MODEL**

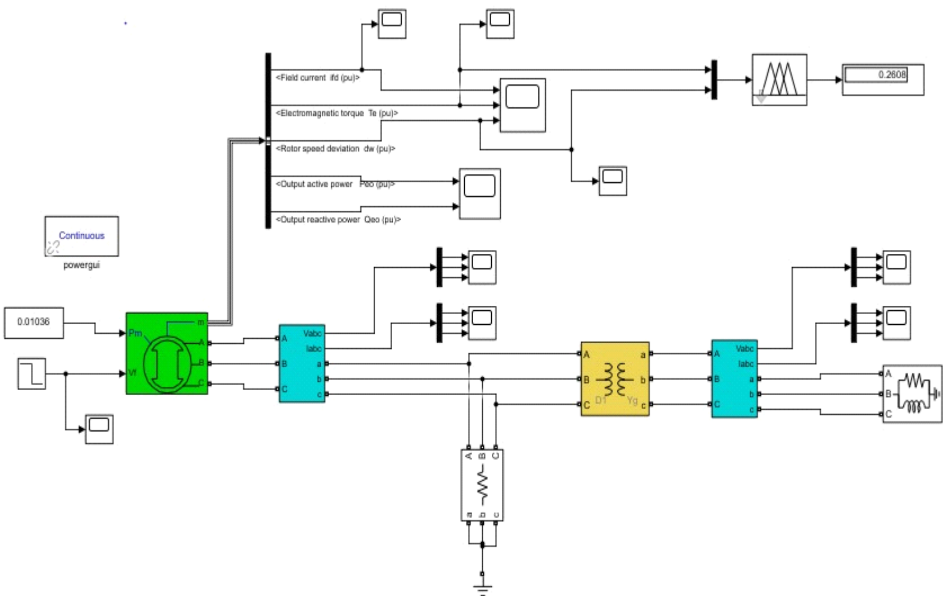


Fig.2 Simulink Model used for detection of LOE

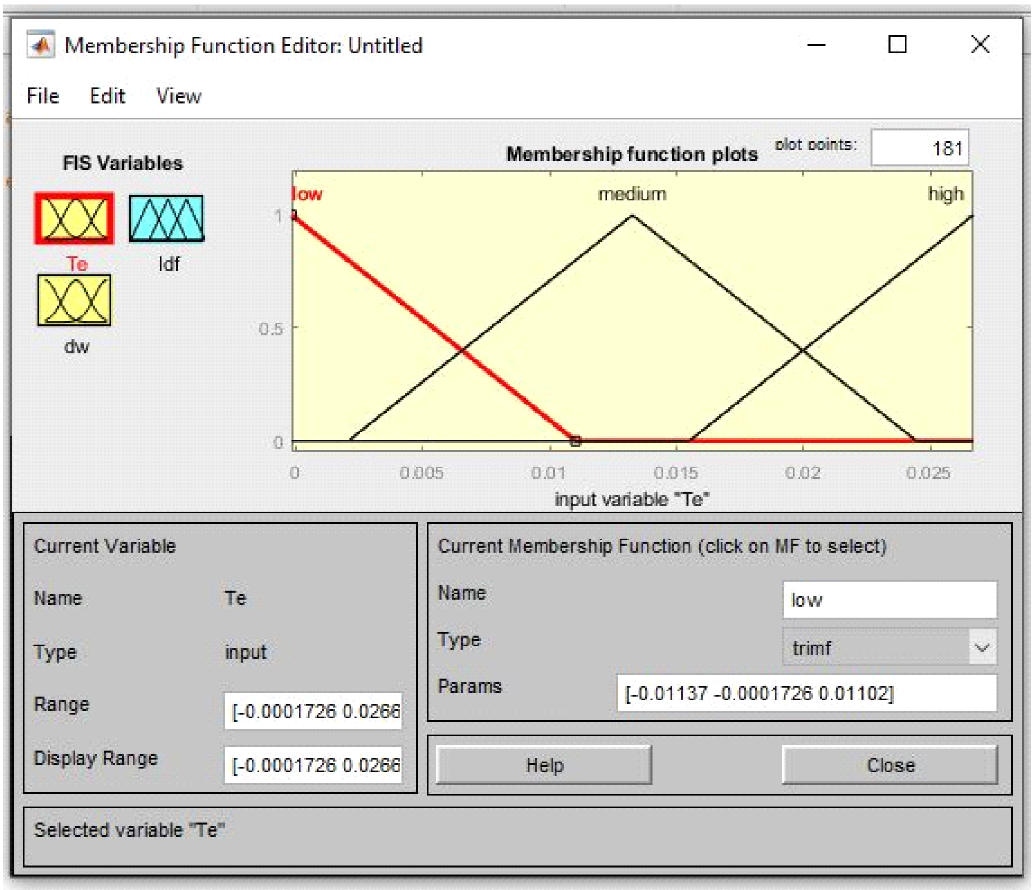


Fig.3 Torque input to Fuzzy Logic Controller

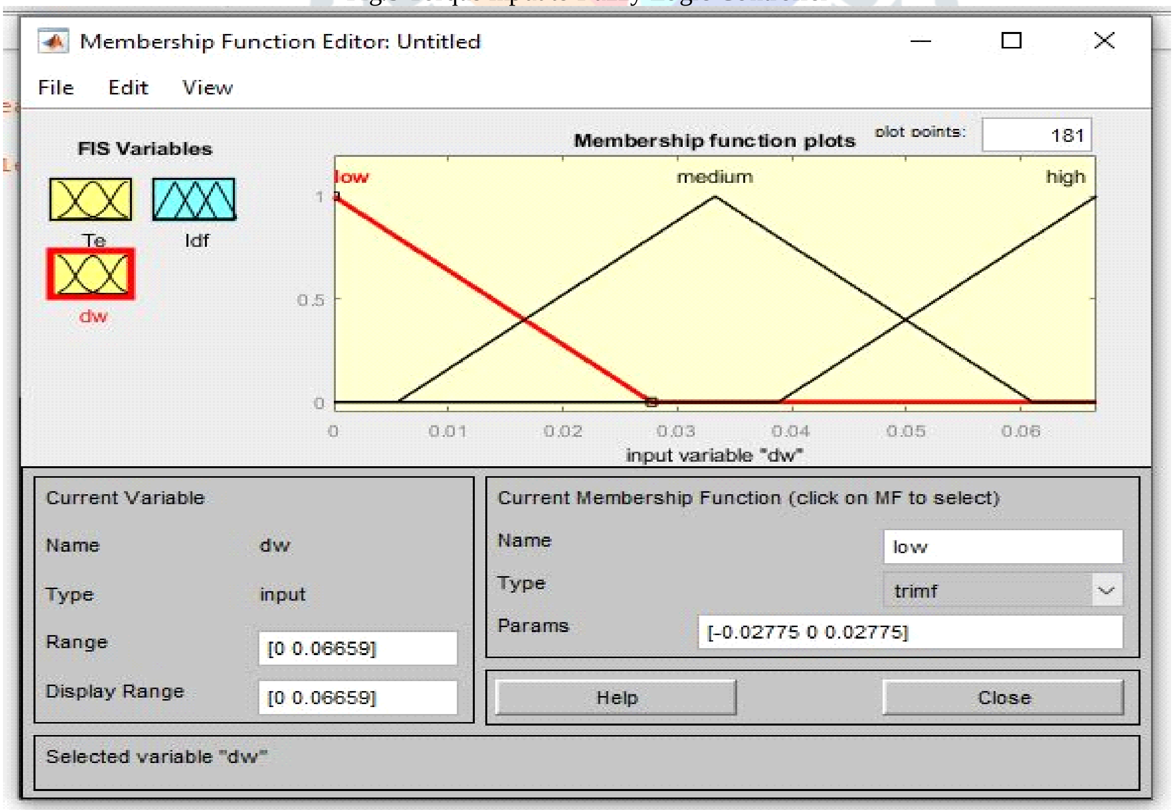


Fig.4 dw input to Fuzzy Logic Controller

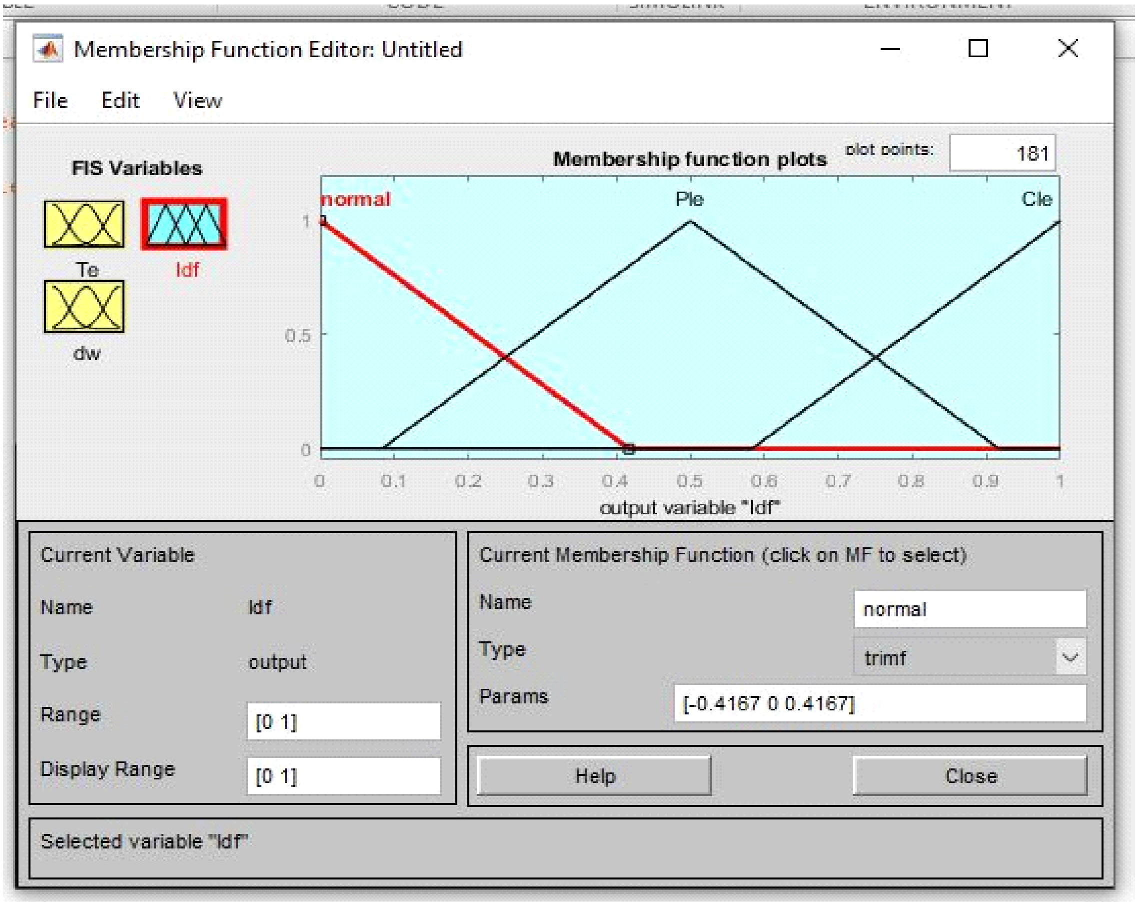


Fig.5 Fuzzy Inference for Output

- **RESULTS AND DISCUSSION**

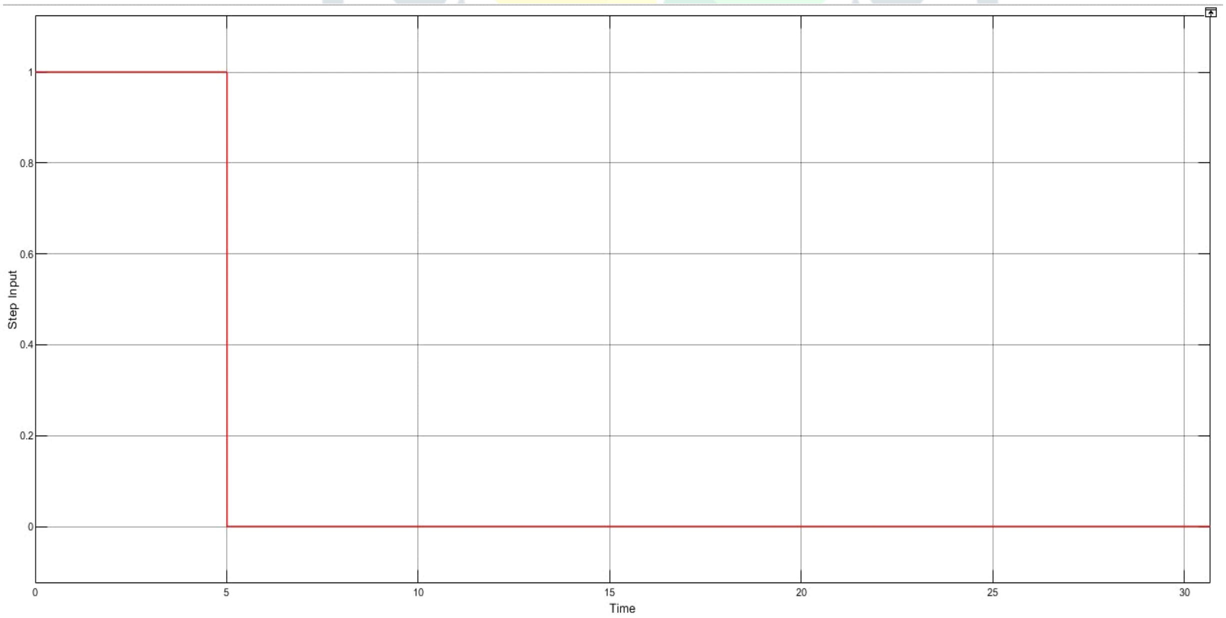


Fig.6 Field Excitation Voltage

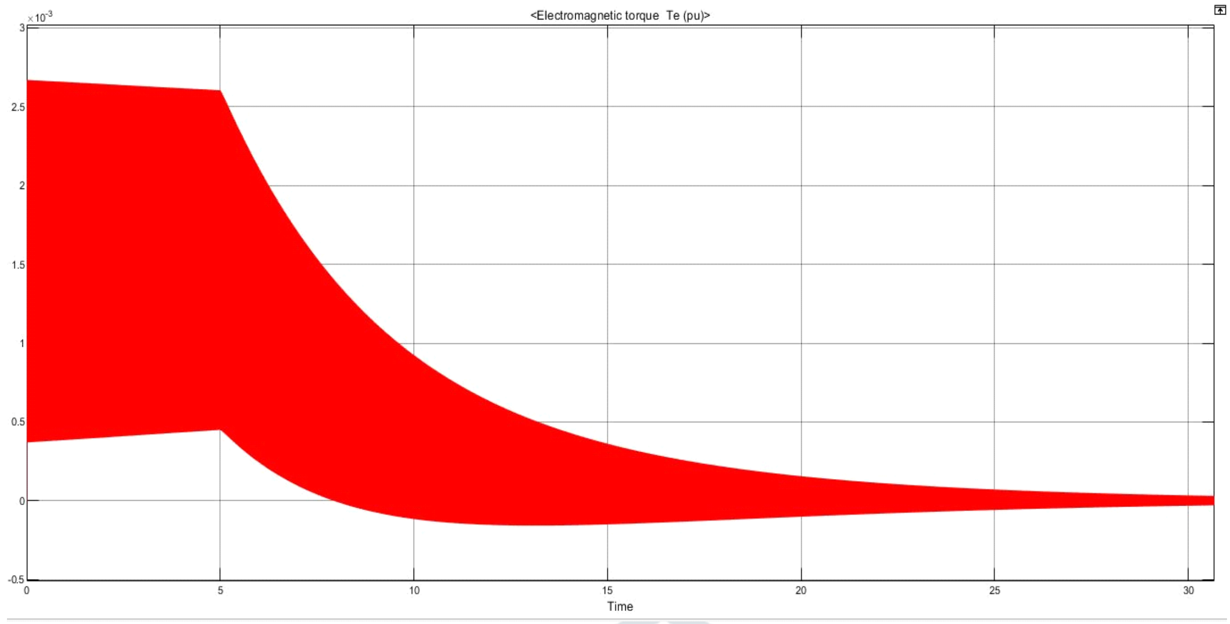


Fig.7 Electromagnetic Torque output for LOE condition

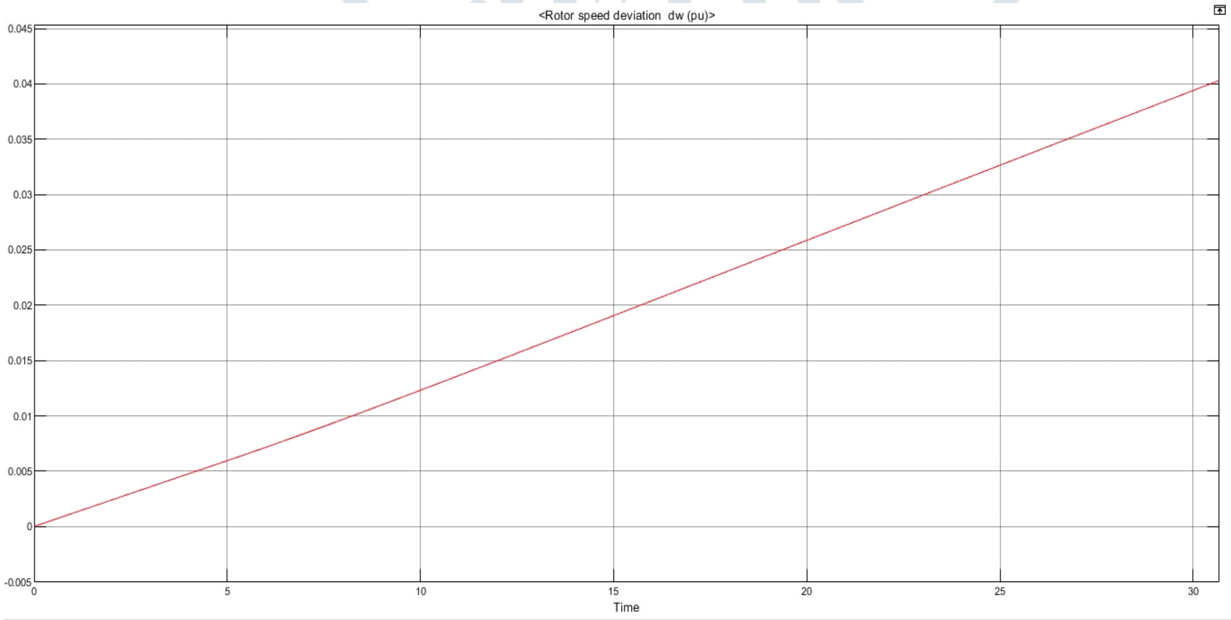
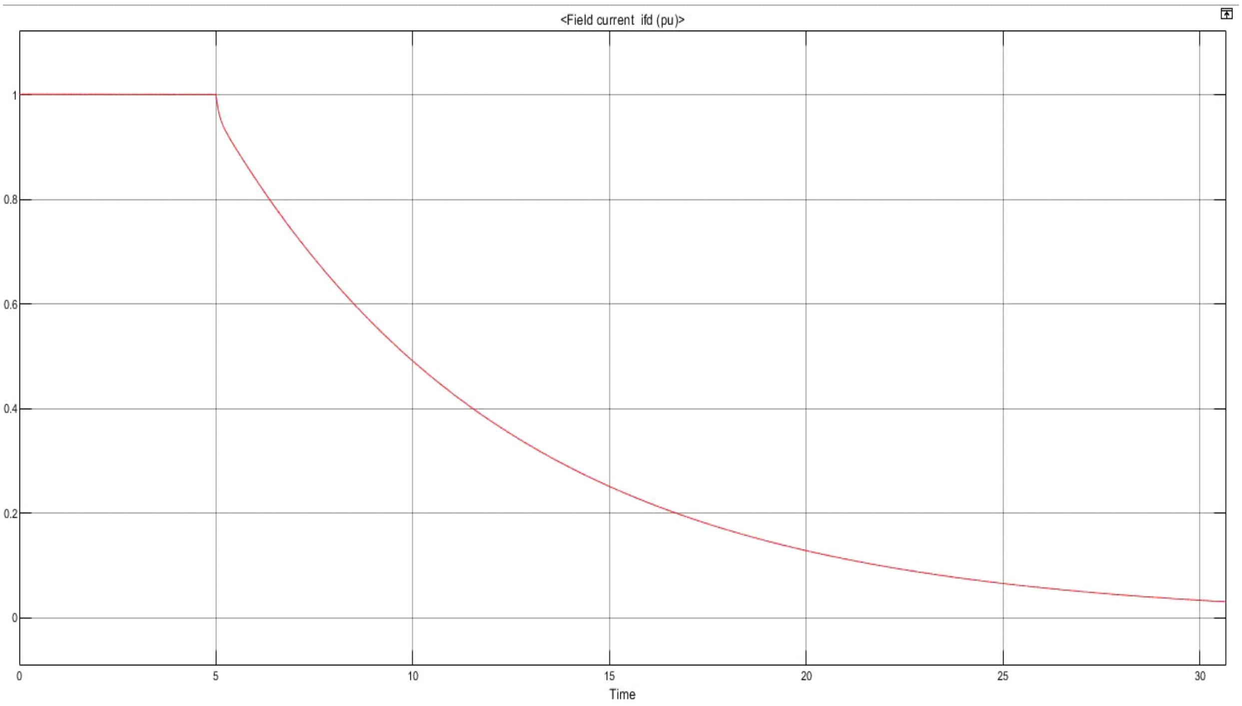


Fig.8 Rotor Speed Deviation output for LOE condition



Fig,9 Field Current output for LOE condition

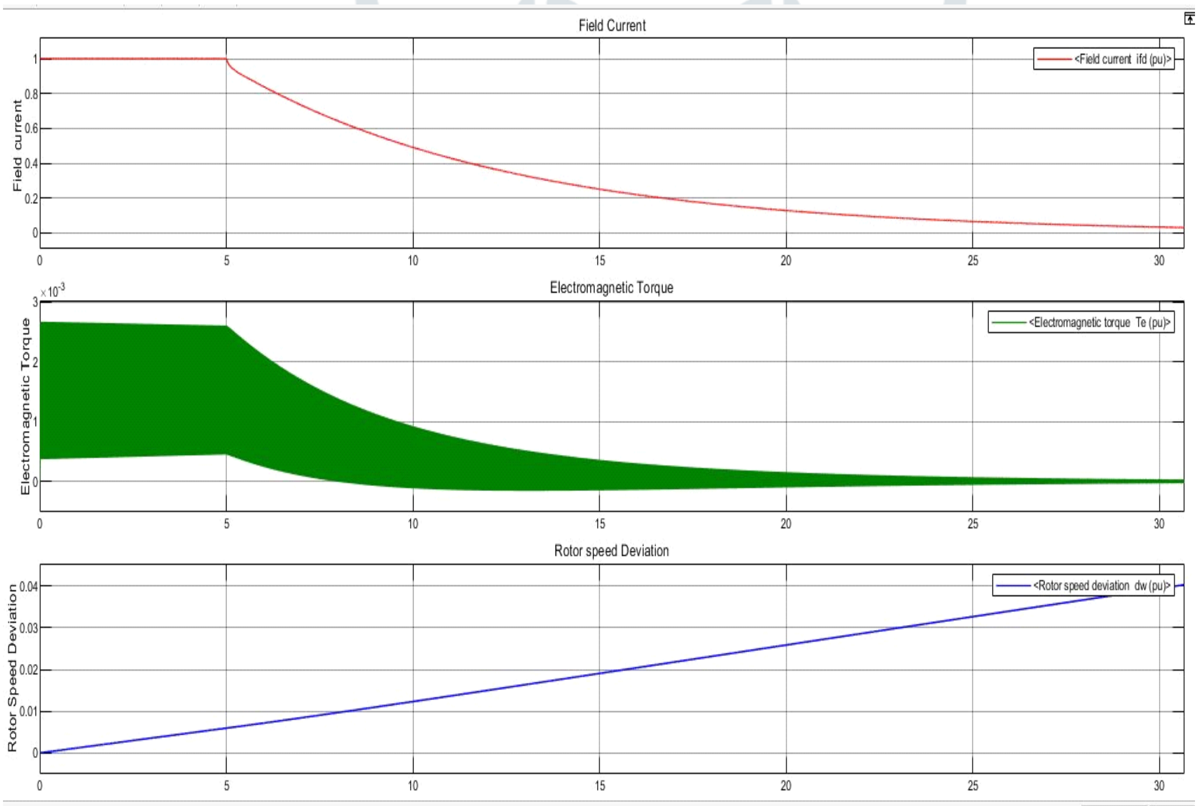


Fig.10 Output Waveforms

Fig.11 Fuzzy Logic Controller Ruleviewer

- **CONCLUSION**

Fuzzy logic is used in this method to assess the system and find flaws associated with loss of excitation, steady power swing, and partial loss of excitation. Fuzzy logic is a variable processing technique that enables the processing of several possible truth values with a single variable. Fuzzy logic attempts to answer issues by utilizing partial facts. It used rules based on the IF THEN technique. The proposed model not only detects Loss of Excitation accurately, but also detects very quickly within the span of 5-8 microseconds.

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References

- ANN based detection approach for loss of excitation protection of synchronous generator. H.G. Silva, A.L.M. Coelho, I.P. Faria, B.G. Araujo, 2022.
- Generator LOE Protection by Using Offset Mho Relay in the Presence of STATCOM. Tejal S. Barhate, Mohan P. Thakre, 2020.
- Investigation of a new method for synchronous generator Loss of excitation protection. Enass Mohammed ,Ahmed H. Eltom ,Abdelrahman A. Karrar, Gary L. Kobet, The University of Tennessee at Chattanooga, Chattanooga, Tennessee, August 2017.
- Investigation on Generator Loss of Excitation Protection in Generator Protection Coordination. Zhan Peng Shi, 2010.
- Loss of Excitation detection using Fuzzy Logic, 2021.
- Loss of excitation of synchronous generator. Vladimir Kristof, Mari ´an Meˇster, Journal of ELECTRICAL ENGINEERING, VOL 68 (2017), NO1, 54–60.
- Review of Loss of Excitation Protection Setting. M.D. Lopez, C.A. Platero, P. L. Mayor, R. Granizo, 2016.
- Synchronous generator transient behaviour and protection under loss of excitation fault. Hossein Tashakori, University of Windsor, 2007.
- Tashakori, Hossein, "Synchronous generator transient behaviour and protection under loss of excitation fault." (2007). Electronic Theses and Dissertations. 7013.