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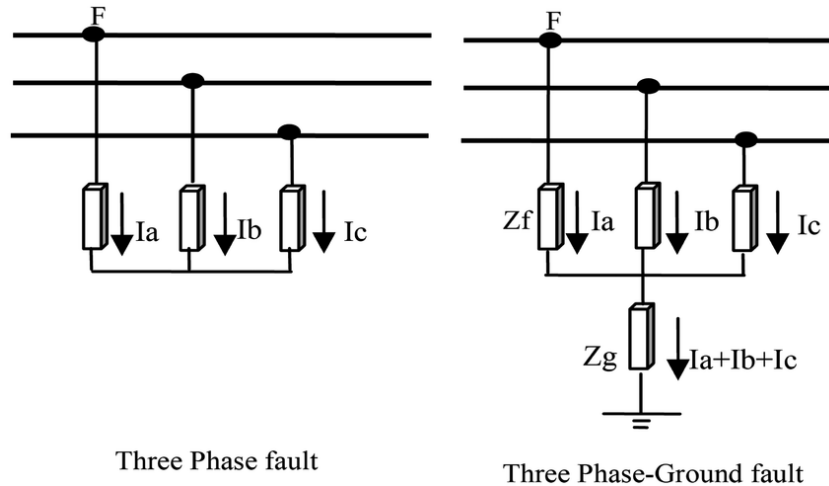
1 Fault And Its Classifications

- Faults in electrical power systems are abnormal conditions that disrupt the normal flow of current. These disruptions can range from minor disturbances to catastrophic failures.
- Faults in electrical power systems can cause significant disruptions, including power outages, equipment damage, and safety hazards.
- To mitigate these effects, power system operators employ various protection measures such as protective relays, circuit breakers, and grounding systems.
- There are primarily open and short circuit faults
- Faults can be located using terminal fault location methods or cable screening methods
- Open Circuit fault occurs in the series of transmission line - Open Conductor Fault , 2 open conductor fault , 3 open conductor fault which causes excessive current to flow into the system
- They can be tolerated but if higher power then insulation breaks down and short circuit fault occurs
- Short Circuit Fault occurs due to insulation failure between a phase conductors and ground
- These includes
 1. Symmetrical Faults
 2. Unsymmetrical Faults

1.1 Symmetrical Faults

- Arcing due to faults can lead to fire
- Voltage can fall below permissible value

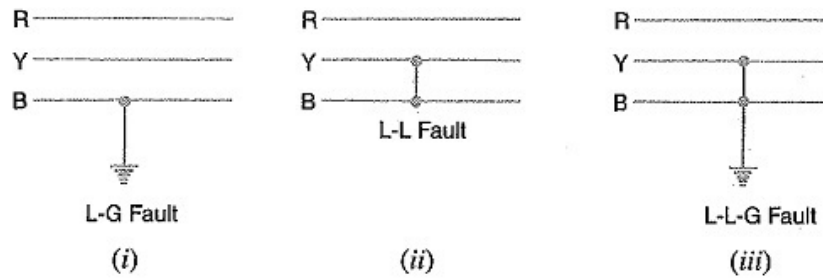
- Symmetrical Faults involves all three phases like
 1. L-L-L
 2. L-L-L-G



- Majority of symmetrical faults occur at generator terminals , system stays balance but electrical equipments can get severely damaged
- They are the most severe type of fault with highest fault current but they happens rarely

1.2 Unsymmetrical Faults

- These fault causes unsymmetrical current , meaning variation in phase and magnitude throughout all three phases
- These faults are more frequent faults
- These includes
 1. L-G
 2. L-L
 3. L-L-G



- In these faults conductors make contact with other conductor or with the ground or both
- L-L faults occurs mainly due to 2 lines swinging because of high speed winds
- Here the system is unbalanced because impedance level in each phase differs , causing unbalanced current to flow between the phases

2 ML Application in Fault Analysis

- Machine Learning (ML) algorithms can be incredibly effective at identifying abnormal patterns in sensor data, which can signal potential faults or anomalies within a system. A technique by the name of Anomaly Detection can be used here.
- Techniques like Recurrent Neural Networks (RNNs) can analyze time-series data from sensors to detect faults based on temporal dependencies (severity of a fault is dependent on its relationship with other faults).
- We can use Supervised learning (with the help of labelled dataset) to classify faults into short circuit and open circuit faults
- ML models can be used to predict faults and do timely maintenance of the system using past data
- Specific location of faults can be identified with the help of ML models which can significantly reduce clearing time of the system
- Convolution Neural Networks (CNNs) can be trained on fault signatures (waveforms, phasors) to classify faults

3 Research Papers

3.1 Integrating discrete wavelet transform with neural networks and machine learning for fault detection in micro-grids

- Additional difficulties in microgrid fault detection due to distributed generation specifically the bidirectional flow of energy
- conventional systems are ineffective due to low value of fault current in MG
- Techniques of protection differs on whether the MG is connects to main grid or is working in isolation mode
- It involves generator of different capacities and types of fault current produced at various levels
- DWT extracts wavelet coefficients