# MODULE 1

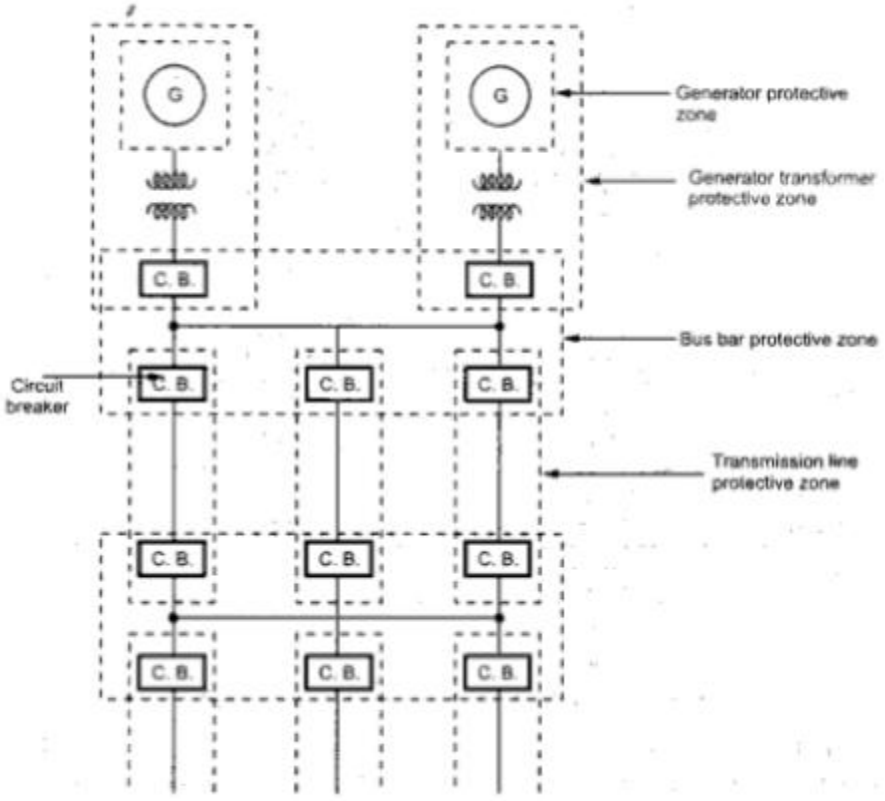
## PROTECTIVE RELAYING

- Requirement of Protective Relaying
- Zones of protection, primary and backup protection
- Essential qualities of Protective Relaying
- Classification of Protective Relays

**Introduction** Protective Relaying is one of the several features of the power system design. Every part of the power system is protected. The factors affecting the choice of protection are type and rating of equipment, location of the equipment, types of funks, abnormal conditions and cost. The protective relaying is used to give an alarm or to cause prompt removal of any element of power system from service when that element behaves abnormally. The abnormal behavior of an element might cause damage or interference within effective operation of rest of the system. The protective relaying minimizes the damage to the equipment and interruptions to the service when electrical failure occurs. Along with some other equipment's the relays help to minimize damage and improve the service.

The relays are compact and self-contained devices which can sense the abnormal conditions. Whenever an abnormal condition exists the relay contacts get closed. This in tum closes the hip circuit of a circuit breaker. The circuit breakers are capable of disconnecting a fatty element, when they are called upon to do so by the relays. Thus entire process includes the operations like fault, operation of relay, opening of a circuit breaker and removal of faulty element. This entire process is automatic and fast, which is possible due to effective protector relaying scheme. The protective relaying scheme includes protective current transformers, voltage transformers, protective relays, time delay relays, auxiliary relays, secondary circuits, top circuits etc. Each component plays its own role, which is very important in the overall operation of the scheme the protective relaying is the team work of all these components. The protective relaying also provides the indication of location and type of the fault.

**Protective Zones** in a protective relaying scheme, the circuit breakers are placed at the appropriate points such that any element of the entire power system can be disconnected for repairing work, usual operation and maintenance requirements and also under abnormal conditions like short circuits. Thus a protective covering is provided around rich element of the system. A protective zone is the separate zone which Es established around each system element. The significance of such a protective zone I B that any fault occurring within cause the tripping of relays which causes opening of all the circuit breakers within that zone. The various components which are provided with the protective zone are generators, transformers, transmission lines, bus bars, cables, capacitors etc. No part of the system is left unprotected The Fig. shows the various protective zones used in a system




The boundaries of protective zones are decided by the locations of the current transformer. In practice, various protective zones are overlapped. The overlapping of protective zones is done to ensure complete safety of each and every element of the system. The zone which is unprotected is called dead spot. The zones are overlapped and hence there is no chance of existence of a dead spot in a system. For the failures within the region where two adjacent protective zones are

overlapped, more circuit breakers get tripped than minimum necessary to disconnect the faulty element If there are no overlaps, then dead spot may exist, means the circuit breakers lying within the zone may not trip even though the fault occurs. This may cause damage to the healthy system. The extent of overlapping of protective zones is relatively small. The probability of the failures in the overlapped regions is very low; consequently the tripping of the too many circuit breakers will be frequent. The figure shows the overlapping of protective zones in primary relaying.

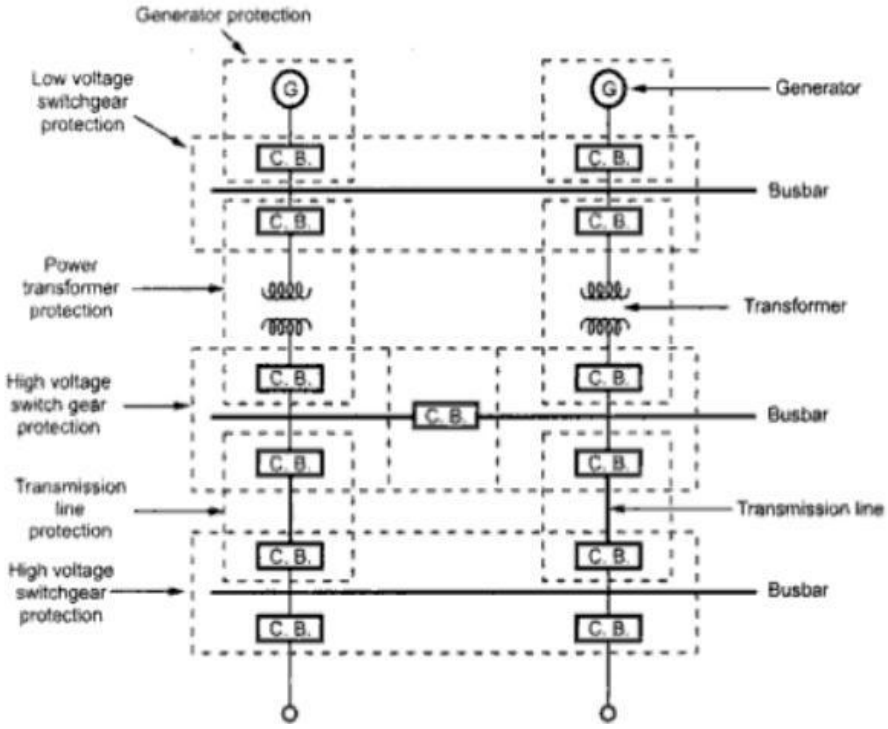



Fig. shows Overlapping zones in primary relaying It can be seen from the Fig. that the circuit breakers are located in the connections to each power system element. This provision makes it possible to disconnect only the faulty element from the system. Occasionally for economy in the number of circuit breakers, a breaker between the two adjacent sections may be omitted but in that Case both the power system are required to be disconnected for the failure in either of the two. Each protective zone has certain protective scheme and each scheme has number of protective systems.

**Primary and Backup Protection:** The protection provided by the protective relaying equipment can be categorized with two types as 1. Primary protection 2. Backup protection

The primary protection is the first line of defense and is responsible to protect all the power system elements from all the types of faults. The backup protection comes into play only when the primary protection fails.

The backup protection is provided as the main protection can fail due to many reasons like,

1. Failure in circuit breaker
2. Failure in protective relay
3. Failure in tripping circuit
4. Failure in d.c tripping voltage
5. Leas of voltage or current supply to the relay. Thus it the backup protection is absent and the main protection tails then there is a possibility of severe damage to the system. When the primary protection is made inoperative for the maintenance purpose, the backup protection acts like a main protection .The arrangement of back up protective scheme should be such that the failure in main protection should not the failure in bark up protection as well This is satisfied if back up relaying and primary relaying do not have anything common. Hence generally backup protection is located at different stations from the primary protection. Front the cast and economy point of sew. The backup protection is employed only for the protection against short circuit and not for any other abnormal conditions.

**Essential Qualities of Protective Relaying:**

Essential Qualities of Protective Relaying A protective relaying scheme should has certain important qualities Such an essential qualities of protective relaying are,

1. Reliability
2. Selectivity and Discrimination
3. Speed and Time
4. Sensitivity
5. Stability

6. Adequateness

7. Simplicity and Economy

Reliability A protective relaying should be reliable is its basic quality. It indicates the ability of the relay system to operate under the predetermined conditions. There are various components which go into the operation before a relay operates. Therefore every component and circuit which is involved in the operation of a relay plays an important role. The reliability of a protection system depends on the reliability of various components like circuit breakers, relays, current transformers potential transformers (P.T.si, cables, trip circuits etc. The proper maintenance also plans an important role in improving the reliable operation of the system. The reliability can not be expressed in the mathematical expressions but can be judged from the statistical data. The statically survey and records give good idea about the of the protective system.

**Classification of Protective Relays**

All the relays consist of one or more elements which gets energized and actuated by the electrical quantities of the circuit. Most of the relays used now a days are On-no-mechanical type which work on the principles of electromagnetic attraction and electromagnetic induction

**Electromagnetic Attraction Type Relays** The electromagnetic attraction type relays operate on the principle of attraction of an armature by the magnetic force produced by undesirable current or movement of plunger in a solenoid. These relays can be actuated ay a.c. or d.c. quantities. The various types of these relays are,

1 **Solenoid Type:** In this relay, the plunger or iron core moves into a solenoid and the operation of the relay depends on the movement of the plunger.

2. **Attracted Armature Type:** This relay operates on the current setting. When current in the circuit exceeds beyond the limit, the armature gets attracted low the magnetic force produced by the undesirable current the current rating of the circuit in which relay is connected plays an important role in the operation of the relay.

**3. Balanced Beam Type:** In this relay, the armature is fastened to a balanced beam for normal current, the beam remains horizontal hut when current exceeds, the armature gets attracted and beam gets tilted causing the required operation.

**Induction Type Relays** These relays work on the principle of an electromagnetic induction. The use of these relays is limited to a.c quantities. The various types of these relays are,

**1.Induction Disc Type:** In this relay, a metal disc is allowed to rotate between the two electromagnets. The electromagnets are energized by alternating currents. 11w two types of constructions used for this type are shaded pole type and watt-hour meter type.

2 .**Induction Cup Type**: In this relay electromagnets act as a stator and energized by relay coils.

**Directional Type Relays** These relays work on the direction of current or power in the circuit The various types of these relays are,

1. **Reverse Current Type:** The relay is actuated when the direction of the current is reversed or the phase of the current becomes more than the predetermined value.

2. **Reverse Power Type:** The relay is actuated when the phase displacement between applied voltage and current attains a specified value.

Relays Based on Timing In relays the time between instant of relay operation and instant at which tripping takes place can be controlled. This time is called operation time. Based on this, the time relays are classified as,

**Instantaneous Type:** In this type no time is lust between operation of Max-and tripping of contacts. No intentional time delay is provided.

**Definite Time tag Type:** In this type intentionally a definite time lag is provided between operation of relay and tripping of contact.

**Inverse Time Lag Type:** In this type, the operating time is approximately inversely proportional to the magnitude of the actuating quantity.