2- Power System Protection

- Sensing the presence of fault.
- Fault calculation to get the current resulting. (Analysis of faults and its calculation should give an idea to use a protective element to the power system part).
- How to remove the faulty line from the network.

These can be done automatically using automatic protective system.

The power system parts needs protection are:

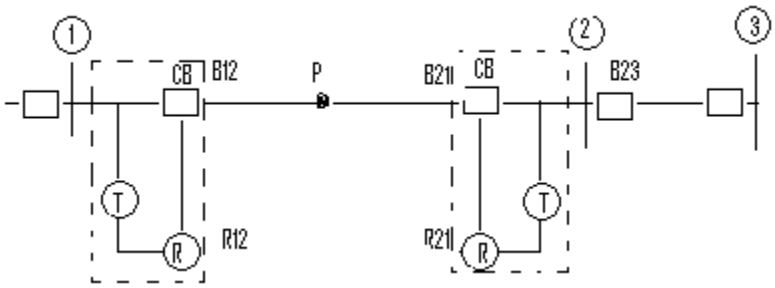
1- Generation
2- Transformers.
3- Transmission line.
4- Buses.
5- Distribution.
6- Utilization (motors and other static loads).

The important requirements for system protection:

1- Reliability.
2- Selectivity.
3- Speed of operation.
4- Simplicity.
5- Economy.

Fault : is any abnormal states, so that faults is general consist of short circuit as well as open circuit. Short circuits are the greater concern than open circuit.

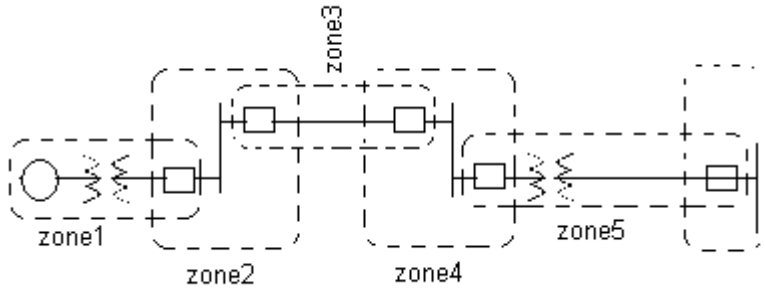
The main elements of protection system:



1- Circuit-breaker. (C.B) or (B).
   It has two functions:
   a- To isolate faulty equipments, so that the others parts of power system can continue to operate successfully.
   b- To limit damage in equipment due to overheating and mechanical forces.
2- Transducer (current or voltage transformer).(T)
   Transducer: provide the input to the relay
3- Relays. (R).
   Sense the fault and cause the circuit breaker trip circuit to be energized and the breaker to open their contacts.
4- Fuses. (F).

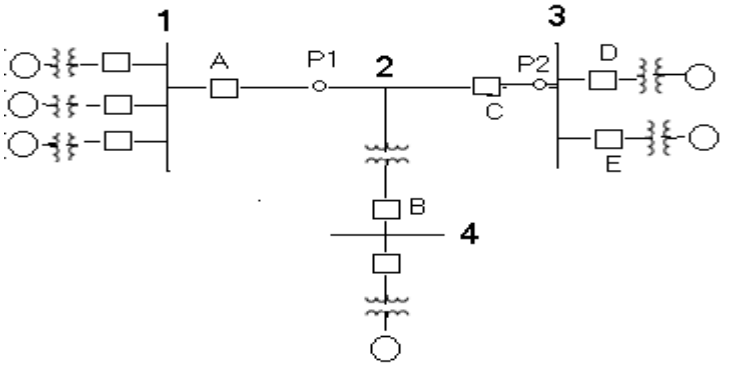
Zones of protection:

The concept of zones defines the reliability requirements for different protection system. In the figure below, each zone contain one or more power system components in addition to two circuit breakers.

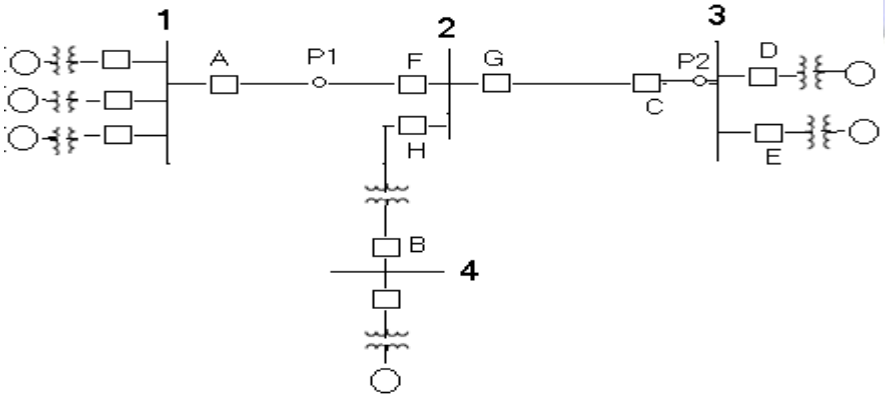


For a fault anywhere within that zone the protection system responsible for that zone takes action to isolate everything within that zone. The circuit breakers help define the boundaries of the zone of protection. By overlapping neighboring zones no part of the power system is let without protection.

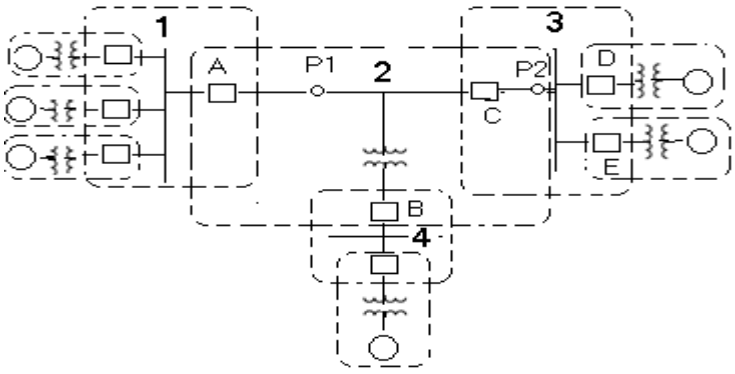
Example: the power system in figure. A): what are the zones of protection should be divided and which circuit breakers will open for faults at P1 and P2



B): if three circuit breakers are added at point 2 as in fig. below, what are the zones of protection should be divided and which circuit breakers will open for faults at P1 and P2



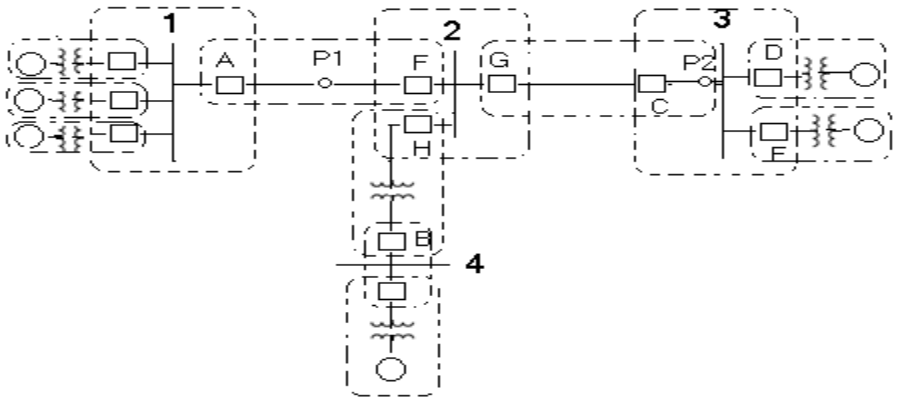
Solution:A)



Fault at P1: breakers will operate are (A, B, and C)

Fault at P2: breakers will operate are (A, B, C, D, and E)

B):



Fault at P1: breakers will operate are (A, and F)

Fault at P2: breakers will operate are (G, C, D, and E)

<u>Transducer:</u>

It is the device which provides the input to the relay. Currents and voltages of the protected power equipment are converted by current and voltage transformers to low levels for relay operation. These reduced levels are necessary for two reasons:

1- The lower level input to the relays ensures that the physical hardware used to construct the relays will be quite small and thus less expensive.
2- The personnel who work with the relays will be working in a safe environment.

Power delivered by these transformers is rather modest. Since the load connected to them consists only of relays and meters that may be in use at a given time.