UNIT I - PROTECTION SCHEMES

Part A

1. How does the over voltage surge affect the power system?

The over voltage of the power system leads to insulation breakdown of the equipments. It causes the line insulation to flash over and may also damage the nearby transformer, generators and the other equipment connected to the line.

2. What are symmetrical components?

It is a mathematical tool to resolve unbalanced components into balanced components.The symmetrical components of three phase system are,i)Positive sequence components.ii) i)Negative sequence components iii) i)Zero sequence components.

3. Define negative sequence component.

It has three vectors equal in magnitude and displaced from each other by an angle 120 degrees and has the phase sequence in opposite to its original phasors.

4. State the essential qualities of protection.

i)Reliability ii) Selectivity iii)Fastness of operation and iv) Discrimination.

5. Give the consequences of short circuit.

Whenever short-circuit occurs, the current flowing through the coil increases to an enormous value. If protective relays are present, a heavy current also flows through the relay coil, causing it to operate by closing its contacts. The trip circuit is then closed, the circuit breaker opens and the fault is isolated from the rest of the system. Also, a low voltage may be created which may damage systems connected to the supply.

6. What is the need of relay coordination?

The operation of a relay should be fast and selective, i.e., it should isolate the fault in the shortest possible time causing minimum disturbance to the system. Also, if a relay fails to operate, there should be sufficiently quick backup protection so that the rest of the system is protected. By coordinating relays, faults can always be isolated quickly without serious disturbance to the rest of the system.

7. Define energizing quantity.

The electrical quantity i.e., current or voltage either alone or in combination with other electrical quantities required for the functioning of the relay.

8. Define protected zone.

Protected zones are those which are directly protected by a protective system such as relays, fuses or switchgears. If a fault occurring in a zone can be immediately detected and isolated by a protection scheme dedicated to that particular zone.

9. What are the various faults that would affect an alternator?

i)Phase to phase faults ii) Phase to earth faults iii) Inter turn faults iv) Earth faults v)Fault between turns vi) Loss of excitation due to fuel failure vii) Over speed viii) Loss of drive ix) Vacuum failure resulting in condenser pressure rise, resulting in shattering of the turbine low pressure casing.

10. State the significance of double line fault.

It has no zero sequence component and the positive and negative sequence networks are connected in parallel.

11. What is primary protection?

Primary protection is the protection in which the fault occurring in a line will be cleared by its own relay and circuit breaker. It serves as the first line of defense.

12. What are the different types of earthing ? (Apr/May 2015)

i) Resistive earthing ii) Reactance earthing iii) Resonant earthing

13. State the significance of single line to ground fault.

In single line to ground fault all the sequence networks are connected in series. All the sequence currents are equal and the fault current magnitude is three times its sequence currents.

14. Differentiate between a fuse and a circuit breaker.

Fuse is a low current interrupting device. It is a copper or an aluminum wire. Circuit breaker is a high current interrupting device and it act as a switch under normal operating conditions.

15. What is surge absorber? How do they differ from surge diverter? (Nov/Dec 2011)

Surge absorber is a device designed to protect electrical equipment from transient high voltage to limit the duration and amplitude of the following current. Surge diverter discharges the impulse surge to the earth and dissipates energy in the form of heat.

16. Define the term "insulation coordination" (Nov/Dec 2011)

Grading of withstand level of apparatus/equipment with the protective levels of surge arresters and co-ordination at entire voltage level and various other voltage levels.

17. What are the various types of faults occurring in a power system? (May/June 2012)(May/June 2014)

SERIES FAULT: a) One open conductor fault b) Two open conductor fault

SHUNT FAULT: (a) Symmetrical or balanced fault (i) Three phase Fault(LLLG)

(b) Unsymmetrical or unbalanced fault (i) Line to line fault(LL)(ii) Line to ground fault (LG)(iii) Double line to ground fault.(LLG).

18. How are arcing grounds avoided? (May/June 2012)

The presence of inductive and capacitive currents in the isolated neutral system leads to formation of arcs called as arcing grounds. Arcing grounds are avoided by earthing.

19. What are the effects of power system faults? (Nov/Dec 2012)

Increase in current above rated value, Insulation failure, Equipment damage.

20. What is back up protection? (Nov/Dec 2012)

Back up protection is the second line of defense, which operates if the primary protection fails to activate within a definite time delay.

21. What is meant by pick-up current? (May/June 2013)(Nov/Dec 2014)

The minimum current at which the relay armature is attracted to close the trip circuit is called pick-up current.

22. Write the sources of fault power. (Nov/Dec 2013)

The fault power can be originated from the generation or transmission or from the distribution side. Also the fault power can be from external sources like lightning.

23. List out the duties of fault limiting reactors. (Nov/Dec 2013)

The duties of fault limiting reactors are to limit the fault current and to eliminate the arcing ground.

24. What are the functions of protective relays? (May/June 2013) (Apr/May 2015)

To detect the fault and initiate the operation of the circuit breaker to isolate the defective element from the rest of the system, thereby protecting the system from damages consequent to the fault.

25. What is the necessity for earthing? (Nov/Dec 2014) (May/June 2014) (Nov/Dec 2015)

When earthing is provided it ensures the safety of personnel against electrical shocks and avoids accidents. The potential of earthed body does not reach to dangerously high value above earth since it is connected to earth. Also the earth fault current flows through the earthing and may cause operation of fuse or an earth relay.

26. What is the difference between short circuit and overload? (Nov/Dec 2015)

On the occurrence of short circuit, the voltage at the point of fault falls to zero and the current in the network increases abnormally to a higher value. But in the case of overload reduction in the terminal voltage of the equipment occurs but the voltage will never fall to zero. Similarly the current also increases to a higher value but not as high as in the case of short circuit.

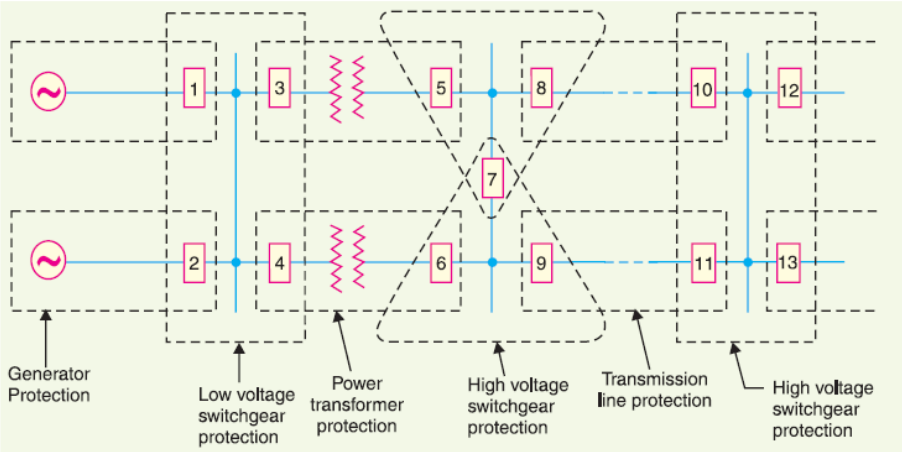
27. What is a protection zone? (Apr/May 2015)

To limit the extent of the power system that is disconnected when a fault occurs, protection is arranged in zones. Ideally, the zones of protection should overlap, so that no part of the power system is left unprotected.

Part B.

1. **What do you understand by a zone of protection? Discuss various zones of protection.(Nov/Dec 2015)**

- Necessity for primary and secondary backup in distance protection. (4)
- Schematic diagram depicting different zones of protection (4)
- Explanation (8)



The system can be divided into the following protection zones

a. generators
b. low-tension switchgear
c. transformers
d. high-tension switchgear
e. Transmission lines.

2. **(i) Discuss briefly the role of protective relays in a modern power system. (Nov/ Dec 2012)**
   a. Overview of modern power system and nature of faults.
   b. Various protective relays used in power system.
   c. Significance of each relay related to faults in their respective components (E.G Transformer – Bucholz relay etc...)

(ii)Describe the essential qualities of protective relaying system (10)(May/June 2012) (Dec 2014)

- Description of protection scheme (2)
- Statement of protection problem (2)
- Various requirements to look for in a protection scheme. (4)
- Qualities of protection schemes (8)

A protection apparatus has three main functions/duties:
1. Safeguard the entire system to maintain continuity of supply
2. Minimize damage and repair costs where it senses fault
3. Ensure safety of personnel.

These requirements are necessary, firstly for early detection and localization of faults, and secondly for prompt removal of faulty equipment from service.

In order to carry out the above duties, protection must have the following qualities:

• *Selectivity*: • *Stability*
• *Sensitivity*: • *Speed*::
• *Dependable*:
• *Secure*: It must *not* trip when it is not supposed to security standards.
Cost

3. **Briefly discuss the operation of the following: (Nov/Dec 2014) (May/June 2012)**
i)Surge absorbers and surge diverters ii) Petersons coil **(Apr/May 2015)**

a. Surge absorbers and surge diverters (8)
   - Diagram along with explanation for each (4)

b. Petersons coil (8)
   - Diagram along with explanation (8)

Surge absorber is a device designed to protect electrical equipment from transient high voltage to limit the duration and amplitude of the following current. Surge diverter discharges the impulse surge to the earth and dissipates energy in the form of heat.

4. **What are the causes of over voltages? Explain the protection against over voltages due to lightning and switching surges.** (16) **(May/June 2013)**

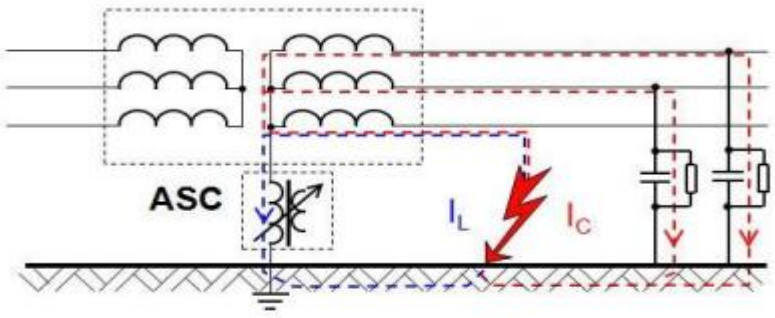
Phenomenon of Overvoltages. (2)
Causes of Overvoltages on conductors (Lightning and Switching Surges) (4)
Description of each protective device along with respective diagrams. (10)

5. **Write short notes on the following:**
i)Various principles of power system protection ii) Power system earthing iii)Insulation co-ordination (May/June 2013)(May/June 2014)
   i. Various principles of power system protection (6)
      - Explain the various principles (6)
   ii. Power system earthing (5)
      - Definition of earthing (2)
      - Various earthing schemes with diagram (3)
      Refer to Ques no 8.
   iii. Insulation co-ordination (5)
      - Definition (2)
      - Basic Concepts (3)

6.i) **Discuss the importance of the protective scheme employed against lightning and switching surges.(ii) Enumerate the basic ideas of insulation coordination. (Nov/Dec 2013)(May/June 2014) (Apr/May 2015)**
Causes of Overvoltages on conductors (Lightning and Switching Surges)
Description of each protective device along with respective diagrams. (8)
Enumerate the basic ideas of insulation coordination.
   - Definition
   - Basic Concepts with diagram

7.i)**Explain the essential qualities of protection.ii)Briefly explain the various methods of overvoltage protection of overhead transmission line (May/June 2014) (Nov/Dec 2011)**
Description of protection scheme
Statement of protection problem
Various requirements to look for in a protection scheme.
Qualities of protection schemes

8. **What is a Peterson coil? Explain the protective function performed by this device with necessary diagram. (Nov/Dec 2014)**



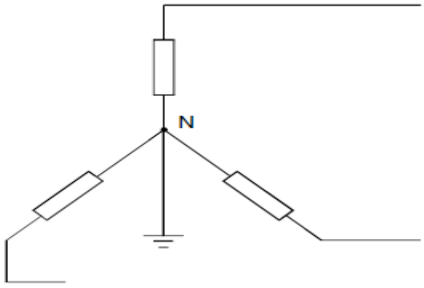
Compensated system where $-I_L=I_C$.

A modern steplessly adjustable Petersen coil consists of an iron-cored reactor connected between the star point of the substation transformer and earth in a three-phase system. In the event of a fault, the capacitive earth fault current (IC) is now neutralised by the current in the reactor as this is equal in magnitude, but 180 degrees out-ofphase.

9. **Discuss and compare various methods of neutral earthing?**
   a. Solid Grounding

b. Resistance Grounding
c. Reactance Grounding
d. Peterson Coil
(Each 4 marks)

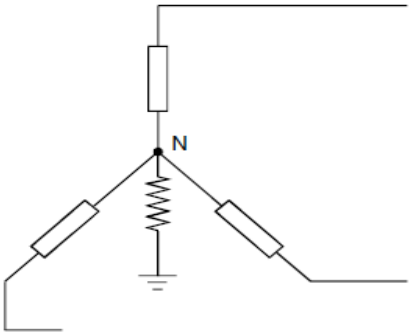
Solid earthing



Resistance earthing

Mainly used below 33 kV.

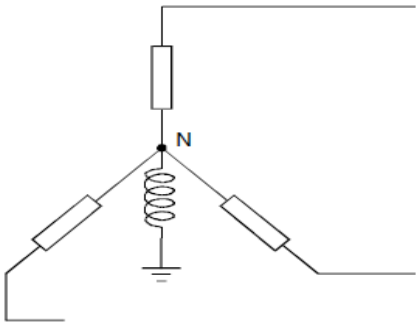
Value is such as to limit an earth fault current to between 1 and 2 times full load rating of the transformer. Alternatively, to twice the normal rating of the largest feeder, whichever is greater.



Reactance earthing

A reactor is connected between the transformer neutral and earth:

Values of reactance are approximately the same as used for resistance earthing. To achieve the same value as the resistor, the design of the reactor is smaller and thus cheaper.



10. **Classify the different types of faults in power system. Which of these are more frequent? (Nov/Dec 2015)**
Symmetrical and Unsymmetrical Faults,
Unsymmetrical Faults - LG, LL and LLG faults. Explanations.