Instructions: (1) All Questions are compulsory.

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

1. (A) Attempt any THREE of the following: 3 × 4 = 12

   (a) Draw the symbol and state the function of:
      (i) Isolator
      (ii) Circuit breaker
      (iii) Earthing switch
      (iv) Lightning Arrester

   (b) Write any eight causes of fault occurrence in the power system.

   (c) Define the terms related to Protective Relay:
      (i) Selectivity
      (ii) Sensitivity
      (iii) Reliability
      (iv) Speed

   (d) State the External and Internal causes of over-voltages.

(B) Attempt any ONE of the following: 1 × 6 = 6

   (a) Two 11 kV, 3φ; 3000 kVA generators having subtransient reactance of 15% operate in parallel. Generators supply power to the transmission line through 6000 kVA transformer of ratio 11/22 kV and with a leakage reactance of 5%. Find fault current and fault MVA for 3-phase fault on
      (i) H.T. Side
      (ii) L.T. Side of transformer

P.T.O.
(b) A 3φ transformer having line voltage ratio of 0.4 kV/11 kV is connected Star/Delta and Protective transformers on the 0.4 kV side have a current ratio of 500/5. What must be ratio of the protective transformers on 11 kV side? Draw a neat circuit diagram and indicate the given values at appropriate places.

2. Attempt any FOUR of the following: $4 \times 4 = 16$

(a) Compare the fuse and MCCB on the basis of speed of operation, cost, construction and replacement strategy.

(b) State the factors to be considered while selecting MCCB for motor protection.

(c) Write the principle of distance relaying and mention the part of power system at which this type of protection is used.

(d) Suggest the type of protection for the following abnormalities/faults on alternator:
   (i) Thermal overloading
   (ii) Stator winding faults
   (iii) Earth faults on rotor winding
   (iv) Inter-turn fault

(e) Distinguish between ‘equipment earthing’ and ‘neutral earthing’.

(f) Draw a typical waveform of lightning surge and explain it in detail.

3. Attempt any FOUR of the following: $4 \times 4 = 16$

(a) Specification of a circuit breaker is given below:
   1500 Amp; 1000 MVA; 33 kV; 3-phase, 3 secs.
   Determine:
   (i) Rated symmetrical braking current
   (ii) Rated making current
   (iii) Rated normal current
   (iv) Short time Rating

(b) Describe with neat sketch the arc extinction in SF$_6$ circuit breaker.

(c) Define the terms related to protective relaying:
   (i) Time setting multiplier
   (ii) Pick up current
   (iii) Reset current
   (iv) PSM
(d) Why is restricted earth fault protection provided for Δ/Y power transformer? Draw the circuit diagram showing restricted earth fault protection for a Δ/Y power transformer.

(e) What are the difficulties experienced while protecting the transformer by differential protection scheme? How are they overcome?

4. (A) Attempt any THREE of the following: $3 \times 4 = 12$

(a) Draw the construction diagram of ELCB and explain how ELCB gives protection against earth leakage fault.

(b) A 20 MVA, 11 kV, 3-phase star-connected alternator is protected by differential protection scheme. The star point is earthed through a resistance of 5 Ω. If CTS have a ratio of 1000/5 and the relay is set to operate when there is an output balance current of 1.5 Amp. Calculate the % of each phase of stator winding which is left unprotected.

(c) Describe with a neat connection diagram the operation of differential protection scheme provided for busbars.

(d) What are the harmful effects of travelling waves and name the protective devices used for protection against travelling waves.

(B) Attempt any ONE of the following: $1 \times 6 = 6$

(a) (i) Describe the behaviour of 3-phase Induction Motor under single phasing. 3

(ii) Describe with circuit diagram the working of single phase preventer. 3

(b) Describe with neat diagram, the time graded overcurrent protection of transmission line. State its drawbacks.

5. Attempt any FOUR of the following: $4 \times 4 = 16$

(a) Explain the arc extinction methods in circuit breaker.

(b) Describe with neat sketch the principle of operation of vacuum circuit breaker.

(c) Describe with neat sketch the operation of Induction type Directional overcurrent Relay.
(d) What is ‘burden’ of CT? How is it specified? Why the secondary of a CT should not be open circuited when energised?

(e) Describe with block diagram the operation of microprocessor based overcurrent relay.

(f) State the four advantages of static overcurrent relay over electromagnetic relay.

6. Attempt any FOUR of the following: $4 \times 4 = 16$

(a) With a neat sketch, explain the operation of voltage balanced differential Relay.

(b) How are the negative phase sequence currents setup in an alternator? Suggest the protective scheme for the same.

(c) Suggest the type of protection necessary for following abnormal condition/fault in case of power transformer:
   (i) Over heating
   (ii) Faults in tap changer
   (iii) Earth faults
   (iv) Inter-turn fault

(d) What are the limitations of Buchholz relay in case of transformer protection? State the guidelines for the Installation of Buchholz relay on transformer.

(e) What are the requirements of transmission line protection? Also write about any two abnormalities occur in transmission lines.