Roll No.

# ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

## B.E. / B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, May.2025

### DEPARTMENT OF ELECTRICAL AND ELECRONICS ENGINEERING
### Semester VI
### EE5603 PROTECTION AND SWITCHGEAR
(Regulation 2019)

Time: 3hrs                                                                           Max.Marks: 100

| CO 1 | Ability to analyze different types of faults and their effects on the power system and understand the practical significance of protection zones |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| CO 2 | Understanding the basic principles, construction and characteristics of different Electromagnetic relays |
| CO 3 | Ability to protect different power equipment like transformer, generator etc., against various electrical faults |
| CO 4 | Understanding different aspects of static relays and numerical protection schemes |
| CO 5 | Able to understand the principles, construction, selection and problems associated with Different types of circuit breaker |

**BL – Bloom's Taxonomy Levels**

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analyzing, L5 - Evaluating, L6 - Creating)

## PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

| Q. No | Questions | Marks | CO | BL |
|-------|-----------|-------|-----|-----|
| 1 | Justify overlapping in zones of protection schemes for power systems. | 2 | CO1 | L2 |
| 2 | Define unsymmetrical faults. | 2 | CO1 | L1 |
| 3 | Draw the characteristics of an directional over current relay on an R-X diagram | 2 | CO2 | L2 |
| 4 | What is the operating principle of Time- Distance Impedance Relay. | 2 | CO2 | L2 |
| 5 | Star-connected, 3-phase, 10 MVA, 6·6 kV alternator is protected by circulating current protection, the star point being earthed via a resistance **r**. Estimate the value of earthing resistor if 85% of the stator winding is protected against earth faults. Assume an earth fault setting of 20%. Neglect the impedance of the alternator winding. | 2 | CO3 | L2 |
| 6 | Draw the connections of Merz-Price voltage balance scheme for all the three phases of the line protection . | 2 | CO3 | L2 |
| 7 | Give the block diagram of time current static relay | 2 | CO4 | L2 |
| 8 | Enlist the advantages of numeric relays | 2 | CO4 | L2 |
| 9 | How does oil help in arc extinction | 2 | CO5 | L2 |
| 10 | Why is current interruption easier in an a.c. circuit than in a d.c. circuit ? | 2 | CO5 | L2 |

## PART- B (5 x 13 = 65 Marks)

| Q. No | Questions | Marks | CO | BL |
|-------|-----------|-------|-----|-----|
| 11 (a) (i) | Obtain the expression for fault current and voltages in case of Double line to Ground fault by symmetrical component method | 8 | CO1 | L3 |
| (ii) | The estimated short-circuit MVA at the bus-bars of a generating station **A** is 1500MVA and of another station **B** is 1200MVA. The generated voltage at each station is 33kV. If these stations are interconnected through a line | 5 | CO1 | L5 |

| | | | | |
|---|---|---|---|---|
| | having a reactance of 1Ω and negligible resistance, calculate the possible short-circuit MVA at both stations | | | |
| | | | | |
| | OR | | | |
| 11 (b) (i) | A balanced star connected load takes 90 A from a balanced 3-phase, 4-wire supply. If the fuses in the Y and B phases are removed, find the symmetrical components of the line currents (i) before the fuses are removed (ii) after the fuses are removed | 5 | CO1 | L5 |
| (ii) | Obtain the expression for fault current and voltages in case of Single line to Ground fault by symmetrical component method | 8 | CO1 | L3 |
| | | | | |
| 12 (a) | With neat diagram explain the working principle of an induction type power relay and hence derive an expression for torque equation | 13 | CO2 | L3 |
| | OR | | | |
| 12 (b) | Explain in detail the operation and different types of impedance relays. | 13 | CO2 | L3 |
| | | | | |
| 13(a)(i) | Analyze with case studies the efficacy of differential protection scheme in Alternators. | 8 | CO3 | L4 |
| (ii) | The neutral point of 25 MVA, 11 kV alternator is grounded through a resistance of 5 Ω, the relay is set to operate when there is an out of balance current of 2A. The CTs used have a ratio of 1000/5. (neglect reactance of alternator) Calculate (i) the percentage of stator winding protected against an earth fault (ii) the minimum value of earthing resistance to protect 95% of the winding | 5 | CO3 | L5 |
| | OR | | | |
| 13(b)(i) | Analyze the different faults and protection schemes adopted against in Transformers. | 8 | CO3 | L4 |
| (ii) | A 3-phase transformer having line-voltage ratio of 0·4 kV/11kV is connected in star-delta and protective transformers on the 400 V side have a current ratio of 500/5. What must be the ratio of the protective transformers on the 11 kV side ? | 5 | CO3 | L5 |
| | | | | |
| 14 (a) | Synthesize the various distance relays using static comparators. | 13 | CO4 | L4 |
| | OR | | | |
| 14 (b) (i) | Obtain the duality relation between amplitude and phase comparators. | 10 | CO4 | L4 |
| (ii) | Give the flowchart for numerical protection of Transformers. | 3 | CO4 | L4 |
| | | | | |
| 15 (a) | Analyze the arcing phenomena and arc extinction in oil and vacuum circuit breakers. | (8+7) | CO5 | L4 |
| | OR | | | |
| 15 (b) | Analyze the current chopping in air circuit breakers and thus obtain an expression for 'R' to damp high frequency re-striking voltage transients. | 13 | CO5 | L4 |

## PART- C (1 x 15 = 15 Marks)
(Q.No.16 is compulsory)

| Q. No | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 16. | Analyze the possibility of Numerical protection for the different types of fault in the Electrical Laboratory and suggest an alternative protection scheme against each fault. | 15 | CO4 | L6 |