DW_JUT

DIPLOMA WALLAH

JHARKHAND UNIVERSITY OF TECHNOLOGY (JUT)

SAMPLE PAPER 2

Practice the sample paper covered both important questions and exam patterns

Subject: Switchgear and Protection (EEE303) **Full Marks: 70** **Time: 3 Hours**

Instructions:

- Question No. 1 is compulsory. (7 MCQs, 2 Marks each)
- Answer any FOUR questions from the remaining (Q.2 to Q.7).
- Q.2 to Q.6 carry 14 marks each (Divided into A and B, 7 Marks each).
- Q.7 consists of Short Notes (Answer any FOUR, 3.5 Marks each).

Q.1 Choose the correct option (Compulsory - 7 x 2 = 14 Marks)

i) The plug setting multiplier (PSM) of a relay is given by the ratio of:

a. Fault current to relay coil rating

b. Fault current in relay coil to pick-up current

c. Pick-up current to fault current

d. Rated secondary current to current setting

ii) SF6 gas is widely used in High Voltage circuit breakers because it is:

a. Highly flammable

b. Electronegative and has excellent arc quenching properties

c. Lighter than air

d. A good conductor of electricity

iii) What is the main purpose of an APFC panel in an industrial setup?

a. To control the speed of induction motors

b. To automatically improve the power factor of the system

c. To act as a backup power supply

d. To measure the high voltage faults

iv) To protect the stator windings of an alternator against phase-to-phase faults, which protection is commonly used?

a. Buchholz protection
b. Over-fluxing protection
c. Merz-Price differential protection
d. Distance protection

v) The making capacity of a circuit breaker is approximately equal to:

a. 2.55 times the symmetrical breaking capacity
b. 1.5 times the symmetrical breaking capacity
c. Equal to the symmetrical breaking capacity
d. 1.414 times the symmetrical breaking capacity

vi) For a 132kV transmission system, the most suitable type of earthing is:

a. Resistance earthing
b. Reactance earthing
c. Solid earthing
d. Peterson coil earthing

vii) Which of the following relays operates only when the current exceeds a predetermined value and power flows in a specific direction?

a. Non-directional overcurrent relay
b. Directional overcurrent relay
c. Thermal relay
d. Earth fault relay

Answer any FOUR questions from Q.2 to Q.7

Q.2 A) Describe the construction and working of an SF6 circuit breaker. Also, mention the merits, demerits, and applications of SF6 gas. *(8 Marks)*

Q.2 B) (Numerical) Determine the actual time of operation of a 5A, 3-second overcurrent relay having a current setting of 125% and a time setting multiplier (TSM) of 0.6. It is connected to a supply circuit through a 400/5 current transformer. The circuit carries a fault current of 4000A. Assume the time of operation from the standard curve is 3.5 seconds for the estimated value of PSM. *(6 Marks)*

Q.3 A) Discuss the construction, working principle, and application of an Induction type Electro-mechanical Over Current relay. *(7 Marks)*

Q.3 B) Draw and explain the block diagram of a static relay. Differentiate between static relays and electromagnetic relays. *(7 Marks)*

Q.4 A) Explain in detail the construction and working of Balanced Earth Fault Protection for Alternators. *(7 Marks)*

Q.4 B) Explain the need for power system protection. Mention the different types of protective devices used in a power system. *(7 Marks)*

Q.5 A) What is a Lightning Arrester? Discuss briefly its working principle. What is the difference between a Lightning Arrester and a Surge Absorber? *(7 Marks)*

Q.5 B) Explain briefly the working principle of a Miniature Circuit Breaker (MCB). How can you classify MCBs based on their tripping characteristics? *(7 Marks)*

Q.6 A) Describe Earth Fault / Leakage protection of a Transformer in detail. *(7 Marks)*

Q.6 B) Explain the following terms related to a fuse: Fusing Current, Fusing Factor, Cut-off Current, Pre-Arcing Time, Arcing Time, and Breaking Capacity. *(7 Marks)*

Q.7 Write short notes on any FOUR of the following (4 x 3.5 = 14 Marks)

A. Time Graded Over Current Protection on transmission line

B. APFC (Automatic Power Factor Control) Panel

C. Routine Tests of a Circuit Breaker

D. Thermal Overload Relays

E. Stator Inter Turn protection of Alternator

SOLUTIONS FOR SAMPLE PAPER 2

MCQ Answer Key

i) b, **ii)** b, **iii)** b, **iv)** c, **v)** a, **vi)** c, **vii)** b

Model Answers for Long Questions

Q.2 A) SF6 Circuit Breaker:

- **Construction & Working:** Consists of fixed and moving contacts housed in an arc interruption chamber filled with Sulfur Hexafluoride (SF6) gas at high pressure. When contacts separate during a fault, an arc is drawn. High-pressure SF6 gas is blasted onto the arc. Being highly electronegative, SF6 absorbs free electrons in the arc path, converting them into massive negative ions. This rapidly builds up the dielectric strength, extinguishing the arc at current zero.
- **Merits:** Excellent insulating and arc-quenching property, compact size, noiseless operation, non-flammable.
- **Demerits:** SF6 is a greenhouse gas, requires a sealing and monitoring mechanism to prevent gas leakage.
- **Applications:** Widely used in EHV (Extra High Voltage) systems (132kV to 765kV) and Gas Insulated Substations (GIS).

Q.2 B) Numerical on Relay Operating Time:

Given Data:
Relay rated current = 5A
Current setting = 125%
Time Setting Multiplier (TSM) = 0.6
CT Ratio = 400/5 = 80
Primary fault current = 4000A
Time from curve for calculated PSM = 3.5s

Step 1: Calculate Pick-up Current
$Pick\text{-}up\ Current = Rated\ Current \times Current\ Setting$
$Pick\text{-}up\ Current = 5A \times 1.25 = 6.25A$

Step 2: Calculate Fault Current in Relay Coil
$Fault\ Current\ (Secondary) = \frac{Primary\ Fault\ Current}{CT\ Ratio}$
$Fault\ Current = \frac{4000}{80} = 50A$

Step 3: Calculate Plug Setting Multiplier (PSM)
$PSM = \frac{Fault\ Current\ in\ Relay\ Coil}{Pick\text{-}up\ Current}$
$PSM = \frac{50}{6.25} = 8$

Step 4: Calculate Actual Operating Time
The curve gives the operating time for TSM = 1. The time given for PSM 8 is 3.5s.
$Actual\ Operating\ Time = Time\ from\ Curve \times TSM$
$Actual\ Operating\ Time = 3.5 \times 0.6 = 2.1\ seconds$

Q.3 A) Induction Type Electro-mechanical Over Current Relay:

Working Principle: It operates on the principle of electromagnetic induction, similar to an induction motor. It has an aluminum disc placed between an upper and lower electromagnet. Fluxes produced by these electromagnets induce eddy currents in the disc. The interaction between fluxes and eddy currents produces a driving torque. When the fault current exceeds the pick-up value, the driving torque overcomes the restraining spring torque, the disc rotates, and the moving contact closes the trip circuit.

Application: Extensively used for primary and backup protection of transmission lines, feeders, and transformers due to their reliable IDMT (Inverse Definite Minimum Time) characteristics.

Q.3 B) Static Relay vs Electromagnetic Relay:

Static Relay Block Diagram: Input from CT/PT -> Rectifier/Filter -> Measuring Unit (Comparators) -> Amplifier -> Output Unit (Trip coil).

Differences:
1. *Moving Parts:* Electromagnetic has moving parts (disc/armature); Static has no moving parts (uses solid-state electronics).
2. *Burden on CT:* High in electromagnetic; very low in static.
3. *Speed:* Static is much faster and more accurate.
4. *Maintenance:* Electromagnetic requires mechanical maintenance (springs/contacts); Static is maintenance-free but sensitive to voltage spikes.

Q.4 A) Balanced Earth Fault Protection for Alternators:

This scheme protects the stator windings against earth faults.
Current transformers are placed on the neutral side and the line side of each phase of the alternator. The secondary windings of the CTs for the same phase are connected in parallel to an earth fault relay. Under normal conditions or external faults, the current entering and leaving the phase winding is equal, so the secondary currents circulate between the CTs, and zero current flows through the relay.
During an internal earth fault, the balance is disturbed, a differential current flows through the operating coil, and the relay trips the alternator.

Q.5 A) Lightning Arrester vs Surge Absorber:

- **Working of LA:** A lightning arrester is connected between the line and earth. Under normal voltage, it acts as an insulator. When a high-voltage lightning surge arrives, its non-linear resistor (like ZnO) immediately breaks down, providing a low-impedance path to ground, discharging the surge energy safely, and then recovering its insulating property.

- **Difference:** A *Lightning Arrester* diverts high voltage surges to the ground. A *Surge Absorber* (like a capacitor or reactor) absorbs the energy of high-frequency oscillatory surges and reduces the steepness of the wavefront (RRRV) to protect equipment insulation.

Q.5 B) MCB (Miniature Circuit Breaker):

Working: It provides dual protection. It has a bimetallic strip for overload protection (heats up and bends over time) and a magnetic trip coil for short circuit protection (instantly pulls the latch when huge fault current flows).
Classification based on Tripping:
- Type B: Trips at 3-5 times full load current (FLC). Used for domestic/resistive loads.
- Type C: Trips at 5-10 times FLC. Used for commercial/inductive loads (motors, fluorescent lights).
- Type D: Trips at 10-20 times FLC. Used for heavy industrial loads like welding machines or transformers with high inrush currents.

Q.6 B) Fuse Terminologies:

- **Fusing Current:** The minimum value of current at which the fuse element melts.
- **Fusing Factor:** Ratio of minimum fusing current to the rated carrying current (always > 1).
- **Cut-off Current:** The maximum peak current reached before the fuse melts and cuts off the fault.
- **Pre-Arcing Time:** Time between the commencement of fault and the instant the arc is initiated.
- **Arcing Time:** Time between arc initiation and its final extinction.
- **Breaking Capacity:** The maximum fault current (RMS value) the fuse can safely interrupt without bursting.

Short Answer Solutions (Q.7)

A) Time Graded Over Current Protection: Used in radial feeders. Relays at the far end are set to operate instantly, while relays closer to the source are given an intentional time delay. This ensures only the relay nearest to the fault trips, providing discrimination.

B) APFC Panel: Automatic Power Factor Control panel uses a microcontroller to continuously monitor the reactive power of a plant. It automatically switches capacitor banks on or off in steps to maintain the power factor near unity, avoiding electricity board penalties.

C) Routine Tests of a Circuit Breaker: Conducted on every CB unit manufactured. Includes mechanical operation tests, contact resistance measurement, high voltage power frequency withstand tests on main circuits and control wiring.

D) Thermal Overload Relays: Works on the bending principle of a bimetallic strip when heated by excess current. Widely used with contactors in Motor Control Centers (MCC) to protect motors against prolonged overloads.

E) Stator Inter-Turn protection: Merz-Price differential protection cannot detect faults between turns of the *same* phase. Therefore, cross-differential protection is used where the stator phase winding is split into two parallel paths, and the difference in current between these paths operates the relay.
