

ELL 400: Power System Protection
Indian Institute of Technology Delhi
Minor 2, Max Marks: 25, Time: 1 Hour
 Date: 26th March 2018

1. A 220 kV busbar has 8 lines connected to it. The switchgear connected to the busbar is designed to handle 5000 MVA at rated voltage. The CT ratio for high impedance differential protection scheme is chosen as 1000:1. The differential protection scheme is designed to remain stable till the through fault current equivalent to 5000 MVA. Assume the CT magnetizing current as 0.05 A, during all conditions. The relay pick-up value is 1.0 A. The lead wire resistance is 2Ω , while that of CT secondary is 0.7Ω . The resistance of relay coil is 1Ω .
 - a. What will be the minimum internal fault current (primary) detected by the scheme? (4 Marks)
 - b. Find out the value of stabilizing resistance. (3 Marks)
 - c. If the stabilizing resistance is doubled, what should be relay pick up value so that stability ratio remains the same? (4 Marks)

2. For a bolted fault with pre-fault power import condition, comment on the angle of swivel of fault characteristic. (2 Marks)

3. A three bus system has connection pattern as follows: Bus A is connected to Bus B. Bus B is further connected to Bus C and Bus D. Line A-B is 100 km length with impedance of $Z = 5\angle 88^\circ$ p.u.. Line B-D has length of 50 km with length of $Z = 7.5\angle 88^\circ$ p.u.. If Simple Impedance Relay is used and located at Bus A end, what should be its Zone 1 setting? (2 Marks)

4. The impedance seen from the relay side in a distance relay is 10 Ohms. CT ratio is 1000:1 and PT ratio is 100000:110. Determine the actual impedance. If line has resistance of 1 miliohm per km and a reactance of 20 miliohm per km, find the distance to fault. Assume single phase line and a bolted fault. (3 Marks)

5. State names of the distance relays that have directional feature associated with them. (1 Mark)

6. A three phase, delta-star, step-down transformer rated 7.5MVA, 33kV(Delta) to 11kV(Star) is protected using biased differential relaying scheme. Calculate what will be CT ratios on either side. The CT secondary rating is 5 A and the primary rating should be in the multiples of 50. What will be the spill circuit current under full load condition of transformer? (6 Marks)

-----ALL THE BEST!-----

$$I_{fmin} = I_{pu} = \frac{V_{set}}{R_{stab} + R_{coil}} = \frac{I_{sec} Z \bar{N} I_o}{N}$$

$$I_{fmin, sec} = I_{pu}$$

$$I_{fmin, pri} = \frac{I_{fmin, sec} - N I_o}{N I_{fent} Z}$$

$$I_{fpu} - N I_o = I_{fmin, sec}$$

$$I_{fmin} = \frac{V_{set}}{R_{stab} + R_{coil}} = \frac{(I_{fent} Z - N I_o) Z}{N}$$