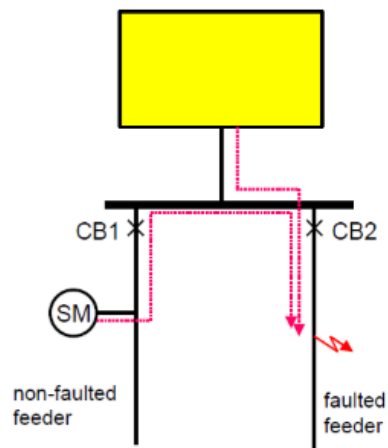


Tutorial 4 DG and Protection, Power Quality

- 1) What is the main protection for conventional distribution network without a distribution network?
- 2) Brief explain how the following DGs can affect the protection configuration of a distribution network:
 - a) Synchronous generator
 - b) Induction generator
 - c) Power electronics based PV generation
- 3) A DG of a hydro generator is installed to the established conventional distribution network, which is indicated as the figure below. Briefly explain how the indicated fault can cause an undesirable trip after a DG is installed at the indicated location.



- 4) Explain how Rate of Change of Frequency (ROCOF) relay can be used as an anti-islanding protection technique.
- 5) Briefly explain how Vector Shift (VS) relay can be used as an anti-islanding protection technique.
- 6) A synchronous generator is powering a 12kV feeder during an islanding operation. The power rating of the generator is 1.5 MVA and the total equivalent impedance between the emf to the feeder is 0.25 p.u. over a distance of 2 km. The distributed capacitance along the distribution line is 500 nF/km. Calculate the natural resonance frequency in such system. (assume the impedance is purely inductive)
- 7) Explain how wind turbines can affect the power quality in terms of voltage variation.
- 8) Consider a weak medium-voltage network, supplied by a 10 MVA, 10% transformer. A 2 MVA induction generator (magnetizing reactance 4 p.u.; total leakage reactance 0.2 p.u.; both based on 2MVA) is connected to this medium-voltage network through a 2 MVA, 5% generator transformer. A switched capacitor bank is installed at the medium-voltage feeder close to the point of connection to compensate for the reactive power consumption of the generator.
 - (i) Calculate the reactive power at no load
 - (ii) Calculate the reactive power at full load.
 - (iii) Calculate the range of capacitance connected to MV network and corresponding resonance frequencies.
 - (iv) For which harmonic order there is a risk of resonance? Calculate the size of capacitance for which the resonance will occur in the calculated harmonic.