Aalto-yliopisto
Teknillinen korkeakoulu

Exercise Session 11

Power systems

Question 1

In an isolated neutral network there is a high-resistance 1-phase earth fault. The network's earth capacitance is C_0, voltage U and the fault resistance is R_f. Derive expressions for

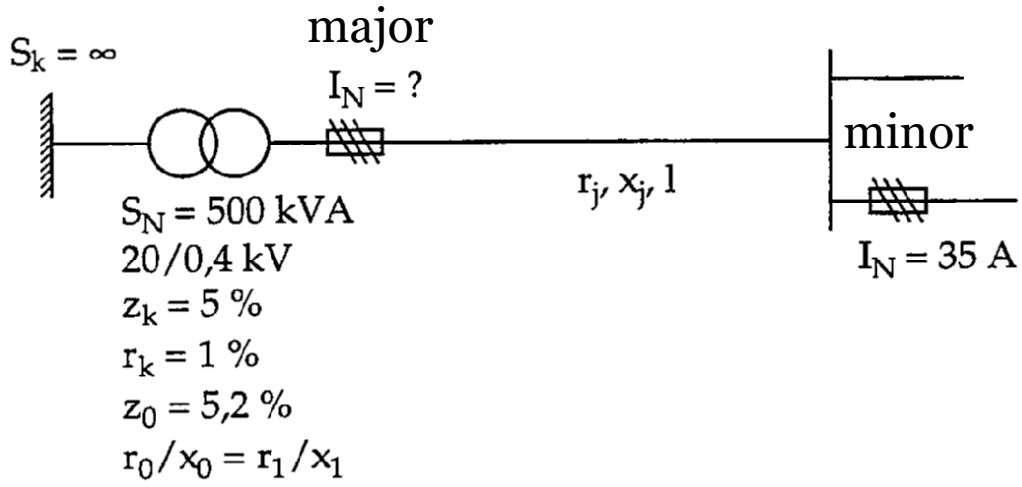
a) earth fault current
b) neutral point voltage
c) faulty phase's voltage
d) healthy phases' voltage

Question 2

Show that in an isolated neutral network, that has an earth capacitance c_0 = 6.13 nF/km, the zero resistance earth fault current can be approximately expressed as:

$I_e = \frac{U \times l}{300}$, where [U] = 1 kV, [I_e] = 1 A, [l] = 1 km

Question 3



Choose the smallest possible fuse to the transformer's low-voltage side so that the protection is selective considering the I_N = 35 A fuse. The two cases are:

1) l = 150 m, x_j = 0.075 Ω/km, r_j = 0.103 Ω/km
2) l = 600 m, x_j = 0.104 Ω/km, r_j = 0.868 Ω/km

Selectivity can be considered sufficient when the major fuse's melting time is at least ten times the melting time of the minor fuse plus the maximum arcing time (10 ms). When we have short melting times (t<1 ms), fusing is selective enough when the major fuse's melting energy I^2t_S is at least three times the minor fuse's operation energy I^2t_a. The melting times and energies are presented in the following pictures.

Question 4

In a 20 kV overhead line network the zero sequence capacitance is 6 nF/km per phase. At a secondary substation occurs a single phase to earth fault. Grounding resistance is 20 Ω. Total length of lines is 300 km.

a) Calculate the earth fault current and the voltage in the grounded parts.

b) How quick should the relay trip to meet the safety requirements

c) If ground fault current is reduced be a compensation coil, how big a coil is needed