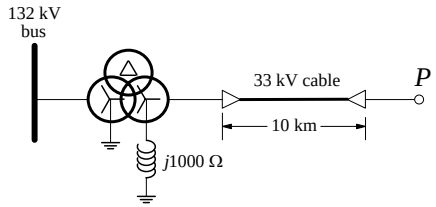
Exercises

1.

The sub-system shown below consists of a 132 / 33 kV transformer feeding into a 33 kV cable, 10 km long. The zero sequence capacitance of the cable is 330 pF/m. The series impedance of the cable and the transformer impedances are negligible in the context of this problem. The line voltage at the end of the cable is 33 kV.



Calculate the magnitude of the earth fault current at point *P* for:

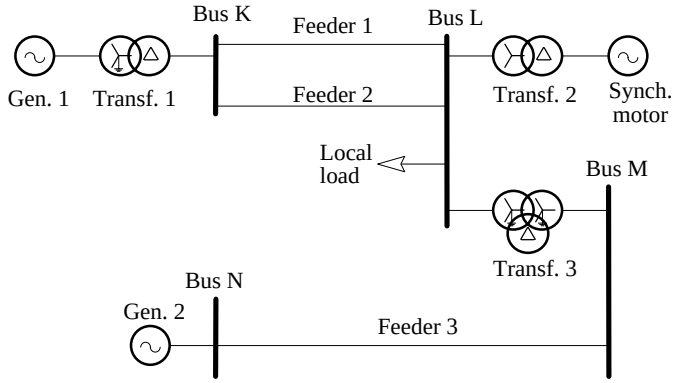
(a) the circuit as shown.

(b) the 33 kV neutral open-circuited.

(This exercise illustrates the principle of Petersen coil earthing.)

2.

In the power sub-system shown, the voltage magnitudes on Bus K and Bus L are 1.04 and 1.00 p.u. respectively. The over-excited synchronous motor consumes 3 MW and supplies 3 Mvar to Bus L.



A single-phase line-to-earth fault occurs at the mid-point of Feeder 2. Assuming zero fault impedance, and neglecting all resistances, calculate the following quantities (in amperes or volts) for the duration of the fault:

(a) the fault current

(b) all transformer neutral currents

(c) Generator 1 line currents

(d) circulating current in the delta winding of Transformer 3

(e) synchronous motor equivalent-star phase voltages

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System Data for Q2

All reactances are given on 100 MVA and nominal voltage bases.

Neutral earthing: Transformer 2 floating, all others solidly earthed.

Feeder 1: 66 kV $X_1 = 0.185$ p.u. $X_0 = 1.00$ p.u.

Feeder 2: 66 kV $X_1 = 0.185$ p.u. $X_0 = 1.00$ p.u.

Feeder 3: 220 kV $X_1 = 0.17$ p.u. $X_0 = 0.92$ p.u.

Transf. 1: 15 MVA, 22 kV / 6.6 kV, YNd11 $X_1 = 0.42$ p.u.

Transf. 2: 5 MVA, 22 kV / 6.6 kV, Yd11 $X_1 = 1.50$ p.u.

Transf. 3: 100 MVA, 220 kV / 22 kV / 11 kV, YN, yn, d1

Positive sequence reactances: $X_{HV} = 0.165$ p.u.

$X_{LV} = -0.0041$ p.u.

$X_{TV} = 0.159$ p.u.

Zero sequence reactances: $X_{HV} = 0.127$ p.u.

$X_{LV} = 0.0099$ p.u.

$X_{TV} = 0.120$ p.u.

Generator 1: 15 MVA, 6.6 kV $X'_d = 1.7$ p.u. $X_2 = 1.4$ p.u.

Generator 2: Represents the remainder of the system (very large).
Assume impedances are negligble

Synch. motor: 5 MVA, 6.6 kV $X'_d = 8.0$ p.u. $X_2 = 4.5$ p.u.