Exercise 6.5 – Computation of homopolar impedance of ungrounded MV networks

For the electrical distribution network represented in the figure below, you must:

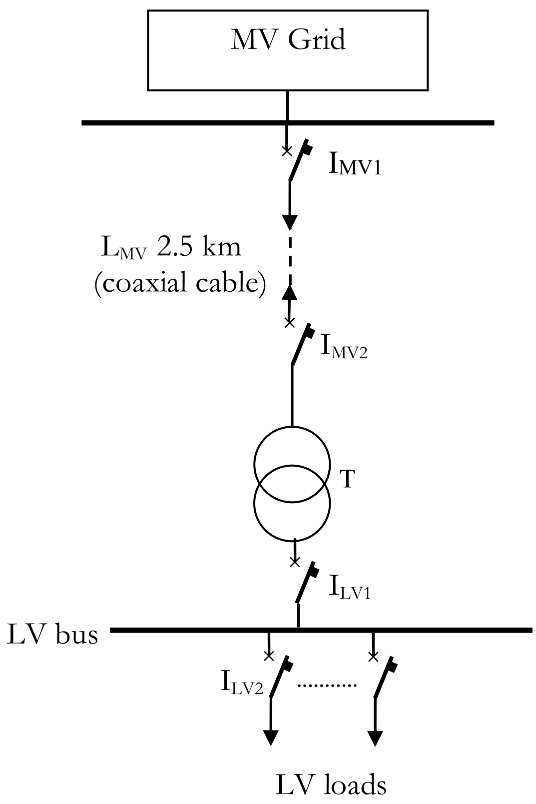
1. define and verify the characteristics of the medium-voltage (MV) cable L_{MV} (EPR insulation), considering a maximum intervention time of $t_{sc}^{I_{MV1}} = 300ms$ for circuit breaker I_{MV1} after a three-phase short circuit.
2. Determine the direct, inverse and homopolar impedances of the medium-voltage network without considering the presence of the cable L_{MV}.
3. Determine the homopolar impedance of the medium-voltage network considering the presence of the cable L_{MV} and re-compute the phase-to-ground short circuit current of the MV grid.

Medium-voltage grid data (MV grid):

- Nominal voltage: $V_n^{MV} = 20\ kV$
- Neutral: ungrounded
- Short-circuit power: $S_{sc}^{MV} = 500\ MVA$
- Phase-to-ground short circuit current of the MV grid: $I_{sc,ph-gnd}^{MV} = 75\ A$
- Ratio $R_{sc}^{MV}/X_{sc}^{MV} = 0$

MV/LV transformer T data:

- Nominal power: $S_n^T = 400\ kVA$
- Nominal transformer ratio: $V_{n1}^T/V_{n2}^T = 20/0.4\ kV$
- Winding connection: Delta (20 kV winding) – Star grounded (0.4 kV winding)
- Short circuit voltage $V_{sc}^T = 0{,}05pu$
- Short circuit copper losses $P_{sc}^T = 4.5\ kW$



Characteristics of medium voltage cables (20kV) with EPR insulation (Joule integral $K = 143\ \frac{A \cdot s^{\frac{1}{2}}}{mm^2}$).

Cross section [mm^2]	Resistance pul [Ω/km]	Reactance pul [Ω/km]	Shunt capacitance pul [μF/km]	Maximum Current [A]
25	0.929	0.15	0.18	157
35	0.670	0.14	0.17	190
50	0.495	0.13	0.19	228
70	0.344	0.13	0.21	284
95	0.248	0.12	0.23	346
120	0.198	0.12	0.25	399