Questions of lab 3

# Electrodynamic analysis

## Computational domain

Due to all the shielding, no electric field should get outside of the outer bounds of the cable, thus a Dirichlet boundary condition with value zero is applied to the outer boundary of the cable.

## Maximum field strength

* No defect: Max value at conductor screen: 9.33 KV/mm, at core screen: 4.6 KV/mm
* Defect 5mm distance : Max value at conductor screen: 9.5 KV/mm, at core screen 4.5 KV/mm
* Defect 2mm distance : Max value at defect (close to conductor screen): 11.2 KV/mm, at core screen: 4.5 KV/mm

## Varying mesh

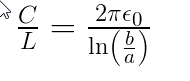
* Courser mesh: electric field, field shows artifacts due to mesh size, some fields between the conductors are not present => loss of small effects due to mesh size

Capacitance changes other global quantities remain the same

* Finer mesh: better approximation of electric field in the conductor when comparing to the paper

Capacitance seems to converge to 0.57 µF/km per conductor

## Capacitance

Analytical:  result = 0.15µF/km, assumptions: length of conductors infinite, modelled as two concentric cylinders with a homogenous isolator in between (here XLPE) so the semiconductors are negated. Assume no capacitance between conductors or outer steel cover.

## Simplification

It seems that there are no electrical effects outside of the inner steel casing, so the domain could be reduced to outer bound of the inner steel casing. (But this would give a more complicated boundary) The three conductors must be modelled together so their interaction can be modelled properly (since symmetry can’t be used as the imposed currents have different phase)

# Electro-magnetodynamic analysis

## Computational domain

Since this is a MVP problem, normally transformation to inifinity is required to get the best solution, but since we expect that almost all flux will remain inside the cable due to the steel shielding, a circle around the cable with 5 times the radius of the cable is taken as boundary to approximate the infinity shell (because above the cable, another material is present, air, so a true infinity transformation cannot be performed).

## Losses

Aluminium: 5.115 W/m  
Steel armour: 0.821155 W/m  
Steel pipe: 0.443502 W/m

## Resistance

0.0886726 Ω/m

## per-unit inductance

0.32766 mH/km

## Varying mesh

Courser: some artefacts around the conductors in the induction field => less precise modelling around conductors. Global quantities don’t change much

Finer: No real change => mesh is optimal

## Simplification

No simplification possible since the induction at the border of the cable is not zero.

# Coupled problem

### Computational domain

Large enough so the temperatures can drop to ambient within the domain, here a 3m by 3m area is considered where 1.8m is above ground and 2.7m under ground. Larger underground since soil has a smaller heat capacity than air thus heats up in a larger area than air.

## Linear

Temperature: not much different if courser or finer

Temp limits: max 71.5°C => within parameters (70-90°C)

Max temp ground-air => about 33°C

## Non Linear

### Convergence

10 iterations, finer mesh: same, coarser: same (if still good results)

### Losses

Aluminium: 4.84583 W/m  
Steel armour: 0.961247 W/m  
Steel pipe: 0.520584 W/m

### Resistance

0.103212 Ω/m

### per-unit inductance

0.340687 mH/km

### Temperature

Temp limits: max 80.8°C => within parameters (70-90°C)

Max temp ground-air => about 35°C