Asymptotic expansion for the magnetic potential in the eddy-current problem

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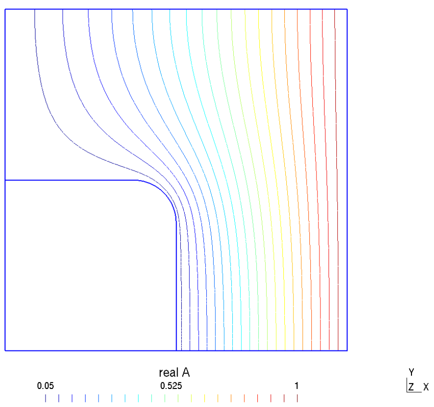
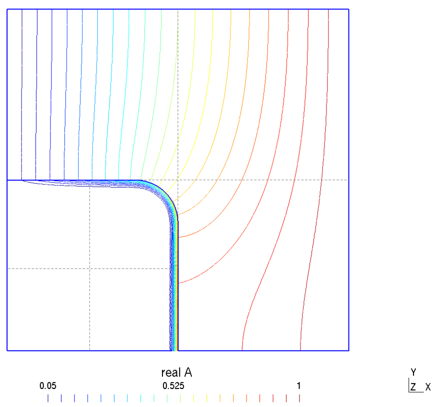
Asymptotics consist in formal series of the solution to a problem which involves a small parameter. When truncated at a certain order, this finite sum provides an approximation of the exact solution with a given accuracy, and the coefficients of this sum are solutions to elementary problems that do not depend on the small parameter. This parameter can be for instance the thickness of the domain or a small or high conductivity coefficient. The asymptotic expansion is a useful tool to obtain approximate expressions of the solution to the so-called Eddy Current problem, which describes the magnetic potential in a material composed by a dielectric material surrounding a conductor.

However such expansions are derivatives consuming, in the sense that to go further in the expansion, it is necessary to compute the higher derivatives of the first orders terms, and it also requires a precise knowledge of the geometry, since derivatives of the parameterization of the interface dielectric/conductor are involved. From the numerical point of view, this can lead to instabilities which may restrict or prevent a direct use of the asymptotic expansion.

This mathematical approach complements our previous works on “delta-parametrization”. In particular, we will show that several expansions can be involved when considering magnetic conductors depending on the product of the relative permeability of the conductor by the penetration depth. As an example, for the same geometry, boundary conditions and penetration depth we obtain two “very” distinct behaviours (left, f = 10kHz and mur = 1 and right, f = 10Hz and mur = 1000).





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