



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

Ronan Perrussel, Clair Poignard, Victor Péron, Ruth V. Sabariego, Patrick Dular, Laurent Krähenbühl

► **To cite this version:**

Ronan Perrussel, Clair Poignard, Victor Péron, Ruth V. Sabariego, Patrick Dular, et al.. Asymptotic expansion for the magnetic potential in the eddy-current problem. 10th EMF, Apr 2016, Lyon, France. Proceedings of the 10th International Symposium on Electric and Magnetic Fields. <hal-01393362>

HAL Id: hal-01393362

<https://hal.archives-ouvertes.fr/hal-01393362>

Submitted on 12 Dec 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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

Ronan Perrussel¹, Clair Poignard², Victor Péron³,
Ruth Sabariego⁴, Patrick Dular⁵, Laurent Krähenbühl⁶

¹ Université de Toulouse, Laplace (CNRS UMR5213), INPT (France)

² INRIA Bordeaux, EPC MC2 (France), ³ Université de Pau (France)

⁴ KU Leuven, EnergyVille (Belgium) ⁵ Université de Liège (Belgique)

⁶ Université de Lyon, Ampère (CNRS UMR5005), ECL (France)

E-mail: perrussel@laplace.univ-tlse.fr

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, $f = 10\text{kHz}$ and $\mu_{\text{r}} = 1$ and right, $f = 10\text{Hz}$ and $\mu_{\text{r}} = 1000$).

