Finite element methods for electromagnetic problems

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The natural setting for the variational formulation of many electromagnetic problems in a bounded three dimensional domain Ω is the Hilbert space $H(\mathbf{curl}\,;\Omega)$ of vector functions $\mathbf{v}$ in $[L^2(\Omega)]^3$ with $\mathbf{curl}\,\mathbf{v}$ in $[L^2(\Omega)]^3$. We will start introducing the spaces of Nédélec finite elements that provide conforming approximations of $H(\mathbf{curl}\,;\Omega)$. Then we will focus on the time-harmonic eddy current problem: a simplified model, widely used in electrical engineering, obtained from Maxwell's equations by neglecting the electric displacement in the Ampère's law. We will consider two different formulations, the one in terms of the electric field and the one in terms of the magnetic field, and we will discuss the main issues of the finite element approximation of both formulations.

References

[1] A. Alonso and A. Valli, Eddy current approximation of Maxwell equations. Theory, algorithms and applications. MS&A. Modeling, Simulation and Applications, 4. Springer-Verlag Italia, Milan, 2010.

[2] A. Bermúdez, D. Gómez, and P. Salgado, Mathematical models and numerical simulation in electromagnetism. Unitext, 74. Springer-Verlag, Cham, 2014.

[3] P. Monk, Finite element methods for Maxwell's equations. Numerical Mathematics and Scientific Computation. Oxford University Press, New York, 2003.

[4] J.-C. Nédélec, *Mixed finite elements in* $\mathbb{R}^3$, Numer. Math. 35 (1980), pp. 315–341.

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