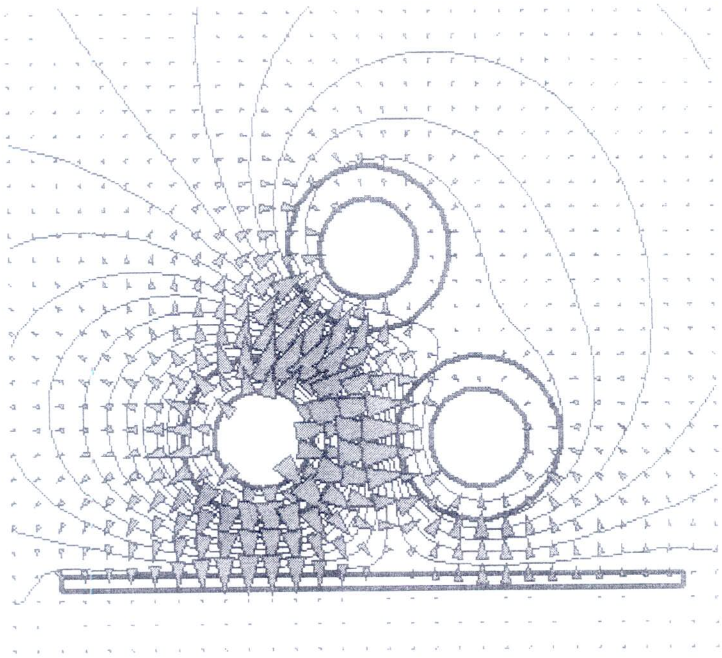
The 10th International IGTE Symposium on Numerical Field Calculation in Electrical Engineering

Abstracts



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Department for Fundamentals and Theory
in Electrical Engineering (IGTE)
Graz University of Technology

Content

Oral session O4-1 to O4-5 Wednesday, 18 September, 8:30 - 10:10

Invited lecture O4-6 Wednesday, 18 September, 10:30 - 11:10

Oral session O4-7 to O4-9 Wednesday, 18 September, 11:10 - 12:10

Poster session Wednesday, 18 September, 14:00 - 15:40

Different Aspects of Magnetic Field Computation in Electrical Machines

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Digest

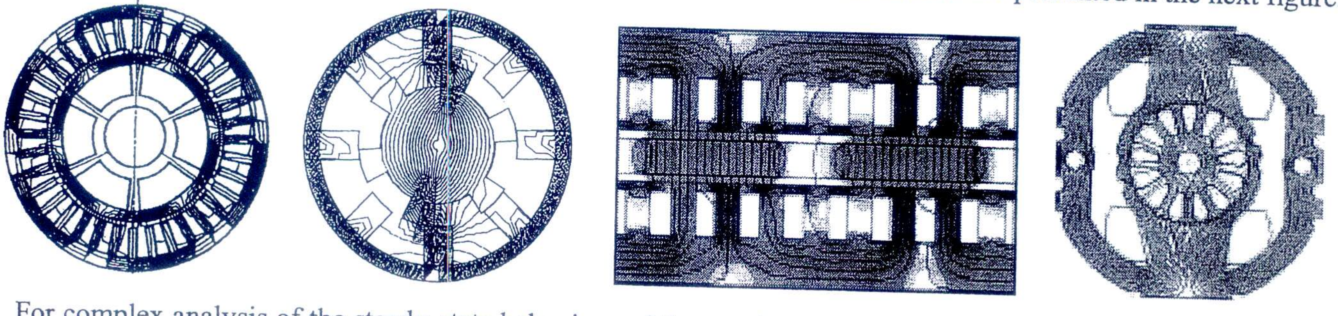
The Finite Element Method (FEM) in the recent years has been found as very attractive for the electromagnetic field computation and an analysis of compound configurations, as electrical machines and electromagnetic devices are. Some researchers are focussed on the 3D FEM application and the others prefer the use of 2D FEM. In the paper different aspects of both 3D and 2D numerical modelling for magnetic field computation in various types of electrical machines will be presented. A suitable mathematical model for nonlinear and iterative calculation of the magnetic field, by using finite element method (FEM) in the analysed domain of the electrical machine, will be given.

The application of three dimensional model enables to take into consideration the variety of configuration along the three axes, including the domain outside of the machine, too. The programme package FEM-3D will be used to perform automatically mesh generation of the finite elements in the 3D domain, calculation of the magnetic field distribution, as well as electromagnetic and electromechanical characteristics in electrical machines of different types. As practical examples, in the full paper will be considered two electrical machines synchronous type: brushless permanent magnet motor and switched reluctance motor. These motors are known as electronically controlled, so it is very important to have as exact as possible their parameters.

The appropriate geometrical and mathematical modelling of the compound motor configuration, especially in the three dimensional domain outside of the magnetic core where the windings end-regions are distributed, is performed by dividing the axial axis into several layers. For the purposes of three dimensional field modelling, the corresponding mathematical model for different types of excitation, suitable to FEM calculations, will be derived. At the same time, taking into account the magnetic anisotropy, if exist, and due to lamination of magnetic core, the different reluctivities along the coordinate axes will be taken into consideration. The mesh of finite elements, in every of the investigated objects, is particularly adjusted to convenient modelling of the movement of rotor. Calculations are carried out for various load currents and for different rotor angular positions to the selected referential axis.

However, some types of electrical machines have complex configuration along the axial length, so it is very tedious to model them in the three dimensional domain. In this case, the authors suggest, as more practical, to use the multi-sliced model of the machines, leading to the quasi three dimensional FEM computation of the magnetic field distribution. As examples, two types of special electrical motors will be considered. The first one is an axial field permanent magnet disc motor which configuration along the z-axis is consisted of two stators and one rotor carrying the permanent magnets. The other is a shaded pole induction motor, with rather skewing of the rotor bars, considerably effecting on the motor characteristics and its behaviour. In both cases, the configuration is divided into 5 layers.

After the nonlinear iterative calculations of the magnetic vector potential in the whole investigated 3D or 2D domain is accomplished, it is possible to get the magnetic field distribution in different axial cross-sections of the analysed machines. Some of the flux plots in the middle cross-sections of the motors are presented in the next figure.



For complex analysis of the steady-state behaviour of the previously mentioned electrical motors, it is necessary to compute both electromagnetical and electromechanical quantities. These characteristics will be used as an approach to the steady state analysis of the motors, as well as their performance under different load conditions and duties. In the full paper, the calculated characteristics will be presented on diagrams and they will be used for an extended and deepened analysis of the machine behaviour.

References:

[1] L. Petkovska, M. Cundev, G. Cvetkovski: *"FEM Modelling of Permanent Magnet Motors"*, Proceedings of XV Symposium on Electromagnetic Phenomena in Non-Linear Circuits - EPNC '98, pp. 55-58, Liege, Belgium, 1998.

[2] M. Cundev, L. Petkovska, V. Stoilkov: *"3D Magnetic Field Calculation in Compound Configurations"*, Proceedings of An International Conference on Advanced Computational Methods in Engineering - ACOMEN '98, pp. 457-464, Ghent, Belgium, 1998.