Multiphysics Problems in Electrical Engineering: Fundamental Basics and Industrial Applications

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Fundamental basics of pure and applied research in the area of analysis and design of innovative electromagnetic devices (modern induction heaters, novel electromagnetic actuators for modern electrical apparatus, rotating electrical machines, electrophysical devices, welding machines, etc.) are developed: • general theoretical principles of coupled (multiphysical) analysis of electromagnetic devices taking into account main interactions of interrelated electromagnetic, thermal and mechanical phenomena are proposed; • an improved classification of coupled (multiphysical) phenomena and their graphical representation are developed; • a list of interrelated physical phenomena and effects to be taken into account in numerical analysis of electromagnetic devices is proposed; • a list of main parameters to be recommended as outcomes of the multiphysical numerical simulation of different electromagnetic devices from practical points of view is elaborated.

On this base: • novel effective numerical algorithms for various nonlinear problems computer simulation are proposed, validated and implemented in applied computer codes; • effective applied 2D and 3D computer codes for the Finite Element Analysis of various electromagnetic devices are written and validated; • a lot of applied problems of practical interest regarding modern electrical engineering devices are numerically solved; • investigations of the influences of various interrrelated physical phenomena (material properties temperature dependences, thermal radiation, conditions of convective heat transfer, contact phenomena, etc.) on the accuracy of the electromagnetic, thermal and structural analyses are conducted; • important practical recommendations on the choice of rational structures, materials and operation modes of electromagnetic devices under consideration are proposed and implemented in industry.