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TIME INTEGRATION METHODS FOR SINGLE AND MULTI-PHYSICAL PROBLEMS

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ABSTRACT

The numerical treatment of transient problems in the space-time domain is an important issue. Apart from the typical approach of separating the spatial discretization, for example by means of finite elements, and applying time discretization schemes on the resulting system of differential and/or differential-algebraic equations, Galerkin methods follow a different line. In some situation they are related to Runge-Kutta schemes as well, and, thus, the methods of separating the spatial and temporal discretization. All these methods can be drawn on dynamical systems, transient heat equations, quasi-static problems with constitutive models of evolutionary type, etc. Open problems, in view of efficiency and accuracy, are coupled systems because the order of accuracy is not always the same for different variables. Order reduction can be observed for non-linear and mixed boundary conditions for various schemes. Moreover, acceleration techniques, for instance particular Gauss-Seidel schemes or parallelization for distributed systems are required to provide efficient simulations. A further aspect is seen at problems with different time scales, for example in coupled diffusion applications, physically multi-scale situations, or coupled problems, where one part is driven by high-frequency physics (mechanical or electro-mechanical). All proposals treating subjects of time integration are welcome. Examples are:

- high-order time integration methods for ODEs and DAEs emanating from the discretization of elliptic-, parabolic- and hyperbolic-type of PDEs,
- numerical schemes that preserve the structure of the underlying problem (incompressibility, energy, angular momentum, …),
- efficient time integration of coupled systems (FSI, thermo-mechanical coupling, electro-mechanics, chemo-mechanics, …),
- treatment of constitutive models (both smooth problems and/or with case distinctions),
- error estimation and step-size control techniques,
- large scale simulations,
- high-frequency applications,
- multi-scale in time.