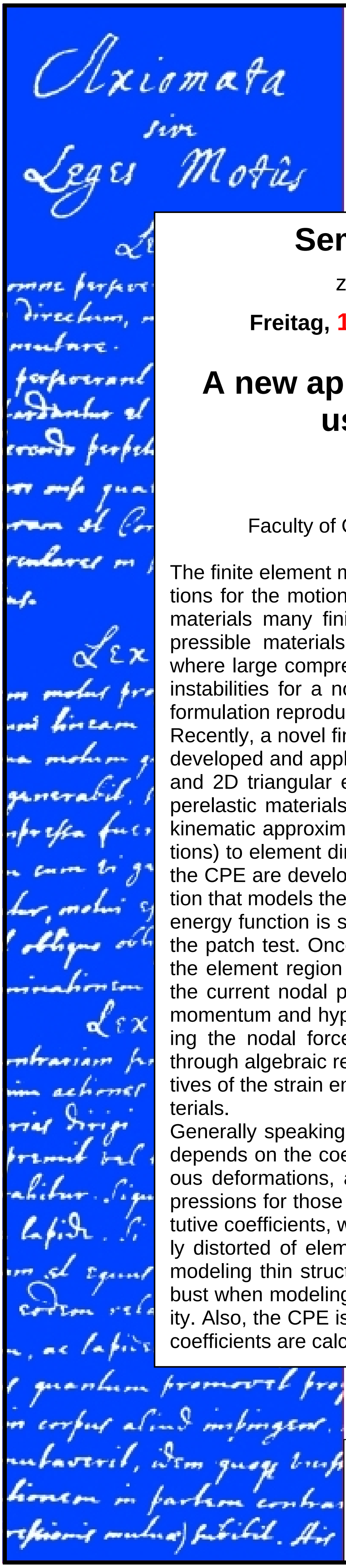

Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Freitag, 10.02.2017, 09:00 Uhr, Egerlandstr. 5, Raum 0.044

A new approach for finite elements formulation using the Cosserat point theory

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The finite element method has been used to solve the nonlinear partial differential equations for the motion of continua for decades. However, even for nonlinear hyperelastic materials many finite elements either predict inaccurate response for nearly incompressible materials or they exhibit undesirable instabilities, especially for problems where large compression and bending are coupled. In addition, some elements exhibit instabilities for a nonlinear form of the patch test, which checks whether an element formulation reproduces homogeneous solutions exactly or not.

Recently, a novel finite element technology based on the theory of a Cosserat point was developed and applied in the formulation of a 3D brick, 2D quadrilateral, 3D tetrahedral, and 2D triangular elements for the numerical solution of problems with nonlinear hyperelastic materials. In contrast with standard finite element methods, in the CPE the kinematic approximation is only used to connect nodal director vectors (i.e. nodal positions) to element director vectors. Specifically, the hyperelastic constitutive equations of the CPE are developed by treating the element as a structure with a strain energy function that models the response of the structure to all modes of deformation. The strain energy function is suitably restricted so that the element satisfies a nonlinear version of the patch test. Once the strain energy of the CPE has been specified, integration over the element region is not required and the response of the CPE is hyperelastic. Also, the current nodal positions of an element are determined by balance laws of director momentum and hyperelastic constitutive equations for intrinsic director couples specifying the nodal forces, which are related to derivatives of the strain energy function through algebraic relations in a similar manner to the relationship of the stress to derivatives of the strain energy function in the full three-dimensional theory of hyperelastic materials.

Generally speaking, the accuracy of the CPE to bending and torsion of thin structures depends on the coefficients of the strain energy function that controls the inhomogeneous deformations, and therefore, special care should be taken in developing the expressions for those coefficients. A new methodology for the determination of the constitutive coefficients, which can be applied for any elastic material and as well as for initially distorted of elements will be presented. The resulting 3D brick CPE is accurate in modeling thin structures while using unstructured coarse meshes, and as well it is robust when modeling structures that undergo large deformations without losing its stability. Also, the CPE is efficient from the computational point of view, since the constitutive coefficients are calculated only once for each element.

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