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Geometrically nonlinear finite element modelling of linear elastic truss structures

This document presents the homework related to the mini-course entitled '*Geometrically nonlinear finite element modelling of linear elastic truss structures*', given at PROPEC of UFOP between 17th and 21st of June 2013.
You will be evaluated based on the interactive discussions we had during the computer labworks (20%) and based on this homework (80%) to be submitted by the **1st August 2013**. The final note is the weighted average of these two contributions. The homework is to be done in group work; one group is composed of two students.
The answer to the questions asked below should be sent via email to pberke@ulb.ac.be in a PDF format. You are free to write your document in English or in Portuguese language. Scanned hand-written notes are also accepted in order to save your time used for typesetting an electronic document. Your email should include the MatLab input file you create for *Task 3*. The total volume limit of the answer document including your answers for all of the three tasks is **10 pages**.

Task 1 (25% of homework note)

Draw the flowchart of the nonlinear finite element code you received ('*mainNL.m*'). Explain also the conditions that allow leaving the iteration loop and what 'step refinement' serves for.
Identify the input parameters that are necessary for running a computation using this code. Explain how they are used and what their function is. Base your answer on any input file you ran successfully.

Task 2 (25% of homework note)

Identify the differences between the linear and the nonlinear truss finite element you programmed during the computer labworks: compare how the *internal force vector* and the *stiffness matrix* are derived. Explain where the geometrical nonlinearity appears in the formulation.

Task 3 (50% of homework note)

Choose a plane frame or a 3D truss structure to study, for which its geometrically nonlinear behaviour plays/played an important role. Do the complete nonlinear modelling procedure starting from (i) the choice of the structure through (ii) the setup of the numerical model (geometry, loads and boundary conditions, displacement or force driven computation, etc.) up to (iii) the analysis of the computed structural response. Systematically justify your modelling choices and assumptions and explain the computational results with a critical mind (do numerical predictions correspond to what you expected?).
If your time allows, please choose an existing truss structure of practical interest (e.g. documented collapsed/damaged structure). Note that you will *NOT* be penalized if you present a more academic case, but the structures already studied in detail computationally during the computer labworks are not accepted.