Project 3

NUMN26/FMNN05: Simulation Tools

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This describes the third bigger programming project in the course, devoted to two special purpose ODE methods algorithms.
You are supposed to work in groups. This assignment has 6 tasks.

Task 1

Study Newmark's method and the HHT method from your lecture notes. Distinguish three cases:

- The implicit method with damping: $C \neq 0$
- The implicit method without damping: $C = 0$
- The explicit method: $C = 0$, $\beta = 0$ and $\gamma = 1/2$

Task 2

Design a new problem class `Explicit_Problem_2nd`, derived from the `Explicit_Problem` class, that reflects the second order ODEs considered in this course unit. This problem class should be made in such a way that these problems can be solved by standard methods as well.

Task 3

Extend Assimulo by implementing Newmark's method and the HHT method. To do so, derive a class `2nd_Order` from `Explicit_ODE`, which should serve as a base class for `Newmark` and `HHT`.

Task 4

Solve the elastic pendulum from Project 1 using the explicit version of Newmark's method. Test your code by comparing its results with classical methods.

Task 5

Download and run the elastodynamic problem `elastodyn.py`.

Task 6

Replace the Assimulo solvers with your own implementations of the Newmark and HHT methods. Note: This may require writing a new `rhs` or extracting the mass and stiffness matrices from the `elastodynamic_beam` class:

```
Beam = elastodynamic_beam(dx, T=tend)
M = Beam.Mass_mat
K = Beam.Stiffness_mat
C = Beam.Damping_mat # Remark: You need to set eta_M and eta_K
f = Beam.F
```

Examine the function `rhs` to see how to stop the forcing $f(t)$.

Lycka till!