LIST OF METHODS AND CONCEPTS FOR THE WRITTEN EXAM

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This is a list of concepts and methods introduced in the course DN1240 (numfcl10) as part of modules 1-5, and is a basis for the content of the written exam. Starred (*) items are considered hard/advanced.

1. METHODS

- Euler forward (for primitive functions, scalar ODEs and systems of ODEs) (M1, M3)
- Euler backward (for primitive functions, scalar ODEs and systems of ODEs) (M1, M3)
- Trapezoidal method (for primitive functions, scalar ODEs and systems of ODEs) (M1, M3)
- Trapezoidal rule (for computing integral values) (M2)
- Vertex quadrature rule in 2D (for computing integral values in 2D) (M2)
- Piecewise linear interpolation (M2)
- Fixed-point iteration method (M5)
- Newton's method (M5)
- Jacobi's method (M5)
- Steepest descent* (M5)
- Conjugate gradient* (M5)

2. CONCEPTS

- How to formulate a system of ODEs in vector/array form. (M4)
- Implicit time-stepping methods (M3, M5)
- Explicit time-stepping methods (M1, M3)
- Condition on time-step size based on condition for fixed-point iteration (M5)
- Time derivative/Numerical differentiation (M5)
- Order of convergence (M1, M3)
- Particle systems (spring and gravity) (M4)
- Piecewise linear functions as a linear combination of basis functions (M2)
- Contraction mapping (M5)
- Newton's method as a fixed-point iteration method (M5)

Simulation Technology Module.

- Interpolation errors (M2)
- Residual (M3, M4, M5)
- Error (all modules)
- Error estimates (M1, M2, M3, M4)
  - Quadrature errors (based on interpolation errors) (M2)
  - For Eulers method by halving the timestep (for both $\dot{u} = f(t)$ and for $\dot{u} = f(t, u)$) (M1, M3)
  - A posteriori error estimate for the Trapezoidal method* (M3, M4)
  - Stability factors S_c based on dual problem* (M4)
- Linearization (M4)
- Stability analysis based on linearization (scalar and system) (M4)
- Stability factors S_d based on linear stability (M4)

3. PROOFS

Here it is sufficient to understand the basic steps and ideas in the proofs.

- Interpolation error (M2)
- Energy conservation for the Trapezoidal method (M3)
- Fixed-point iteration/Contraction mapping (M5)
- Fundamental theorem based on halving time step (M1)
- Generalized fundamental theorem based on halving time step (step 1 and 2) (M3)