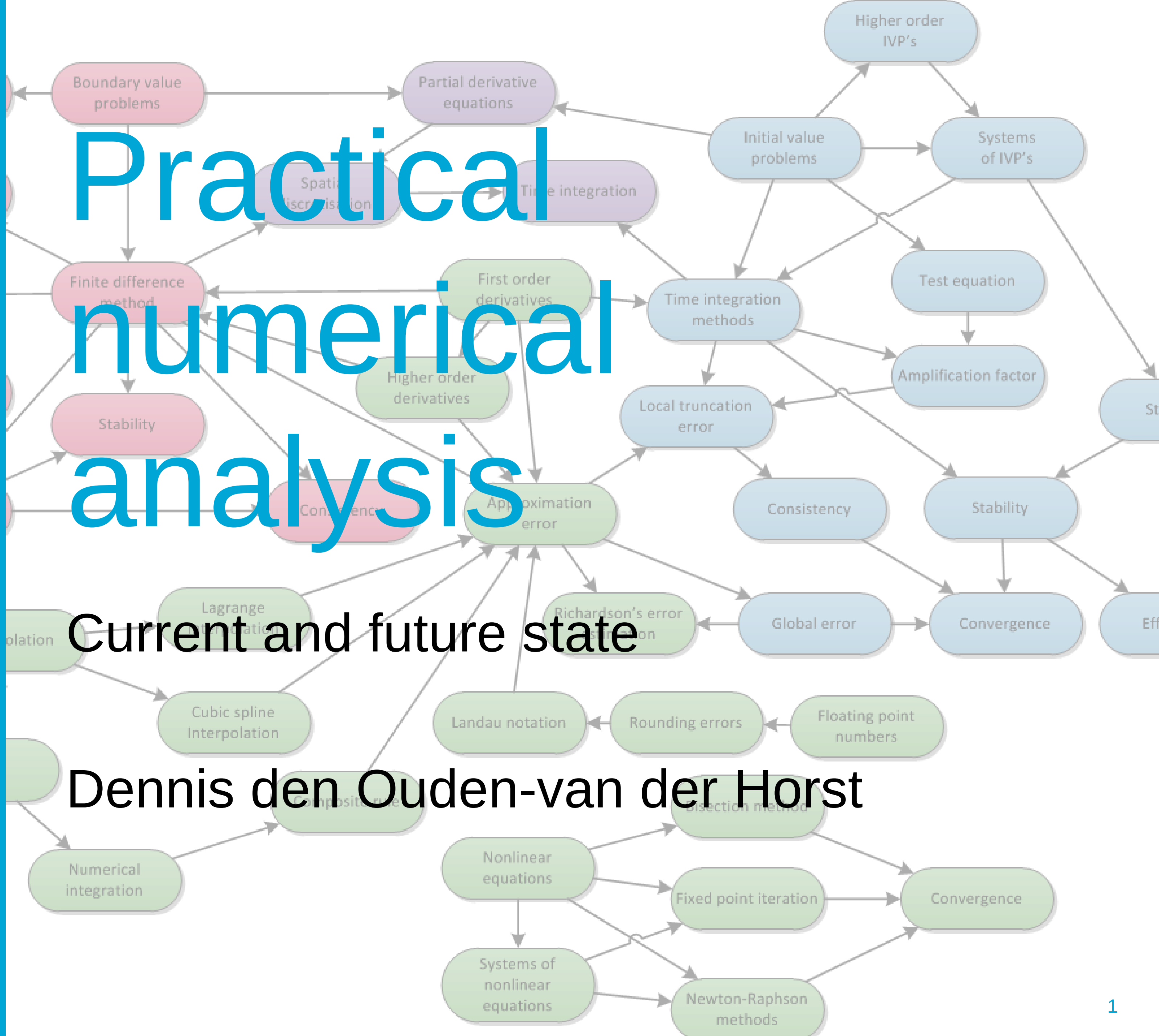
Practical numerical analysis

Current and future state

Dennis den Ouden-van der Horst



Content

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Context

Q2	Earth Sciences Bachelor	**100**
	Bridging minor Applied Mathematics	**20**
	Free elective	**20**
Q4	Mechanical Engineering Bachelor	**450**
	Maritime Engineering Bachelor	**50**
	Bridging Programme 3mE	**80**

Hint: Let Q denote the amplification factor of Modified Euler. Numerical stability is guaranteed if

$|Q(h\lambda_j)| \leq$

Give an upper bound for the time step h, if at least 10 time steps per smallest period need to be taken

the scaled external force u/k_1 in one figure for this value of Ω. It seems that the two forces that are working on mass m_1 cancel each other out for this value of Ω. Can you express this Ω in terms of m_2, k_1 and k_2? Does this cancellation of forces occur for every initial value?

Here, λ_j refer

8. Let us denote t

$\Lambda_h = \{h\lambda_j$

Make a graph
axis must be s
and y for the
these points or

9. Transport (dra
the stability re
the resulting p
answer to ques

Hint: With z
$|Q(z)| \leq 1$. The
complex point

Remark: Stud
consult the Bri
example can b

10. Next, we inve

$h \leq 1.0$

leads to a stabl
the appendix (

It will be clear tha

11. Eigenvalues o

$e^{i\omega t} = \cos$

in the solution
rise to a comp
the contributio
term will introduce a period $T = 2\pi/\Omega$ in the problem, with Ω in the range presented in (3).

l method? Present
confine yourself to

fixed time t (say
e step $2h$. Let us
of the error E in

method.

swers the
of the Matlab

me interval
rmat.

nterval [0, 40].
nguish one main
system will

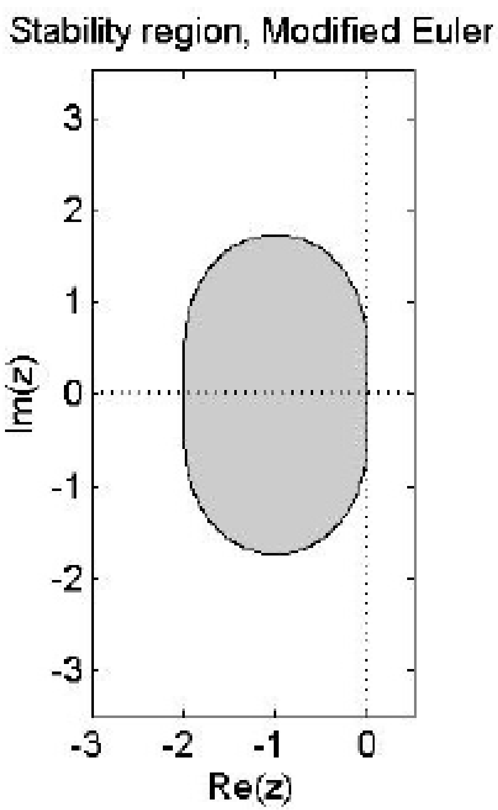
sitions computed
$= 0.2$.

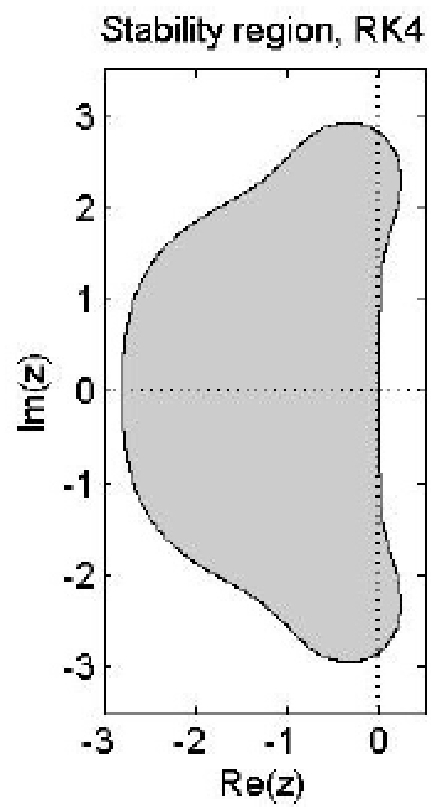
erval [0, 40].
question 15. In

working on mass

the time interval
[0, 40]. For which value of Ω is the maximum almost equal to zero? Plot the positions and

Appendix: Stability regions of Modified Euler and RK4.





Problem description

A spring-mass system consists of two masses, m_1 and m_2, which can only move horizontally (see the picture below). The masses are connected by means of a spring with spring constant k_1. The left mass is also connected to the wall by means of a spring with spring constant k_2. A periodic force u is working on the right mass with amplitude 3 Newton and frequency Ω. The positions (deviations from rest) of the masses m_1 and m_2 will be denoted by x_1 and x_2 respectively. The influence of gravity will be neglected. We are

Assignment 3

To have an accurate estimate for Ω, the errors in your solutions should not be too large. To determine an appropriate time step Δt, answer the following questions:

- Find a formula based on Richardsons extrapolation which estimates the error in the numerical solution at $t = 1$ using only numerical solutions.
- Use this formula to find a value for the time step Δt such that the absolute errors in x_1 and x_2 are less than 10^{-5}. Use $\Omega = 5$ in your calculations¶. Make sure $1/\Delta t$ is an integer.

Assignment 4

Using the value for Δt you found in the previous assignments, answer the research question. That is, find the answer to the question:

What is the lowest value of $\Omega > 0$ such that $|x_1(t)|$ for $t \in [0, 40]$ is as low as possible?

10.0	-1.3114e-01	-9.8071e-02

Hint: To be able to choose an ... e system of second-order differential equations to a system of first-order differential equations.

To be able to perform this practical assignment, knowledge and understanding of Chapters 3 and 6 of the book are required. After performing the assignments, you must write a report.

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Discussion

Feedback and questions on the future state are welcomed.

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