The University of Sydney

School of Mathematics and Statistics

MATH4411, 2022

Computational Applied Mathematics

LECTURER: Prof Georg Gottwald (Carslaw 625, georg.gottwald@sydney.edu.au)

As this subject covers a variety of topics, a quiz will be an impractical gauge of preparedness. A solid background is required in linear algebra, calculus, Fourier analysis and PDEs.

You will also need to be fluent in a programming language of your choice (Python, MATLAB, C, Fortran, Julia etc.)

There will be three projects for this semester. The first and last projects are compulsory. There will then be a group of two projects: students have to choose one project from this group. There will be lectures on each project, and students will attend lectures for ALL projects. There will be a final exam testing the theory behind the lecture material.

The timetable as well as the deadlines for the project submission are likely to change, depending on the pace of the lectures. Similarly, the third project may change.

Weeks 1–3

Topic 1: Numerical integration of partial differential equations

References:

- *Numerical Methods for Wave Equations in Geophysical Fluid Dynamics*, Dale R. Durran, Springer (1999)
- *Numerical Recipes: The Art of Scientific Computing*, William H. Press, Saul A. Teukolsky, Brian P. Flannery, Cambridge University Press (2007)
- *Numerical Mathematics*, Alfio Quarteroni, Riccardo Sacco and Fausto Saleri, Springer (2006)

Project 1 is compulsory. The project must be handed in by Monday April 4th (23:59 pm).

Weeks 4–7

Lectures will concentrate on the following group of projects.

Topic 2: Symplectic Integrators for Hamiltonian Systems

References:

- *Geometric Numerical Integration*, E. Hairer, C. Lubich and G. Wanner, Springer (2004)
- *Simulating Hamiltonian Dynamics, B. Leimkuhler and S. Reich*, Cambridge University Press (2004)

Topic 3: Numerical Solution of Stochastic Differential Equations

References:

- *Numerical Solution of Stochastic Differential Equations*, P. Kloeden and E. Platen, Springer (2011)
- *An Introduction to Computational Stochastic PDEs*, G. Lord, C. Powell and T. Shardlow, Cambridge (2014)
- *Noise-Induced transitions*, W. Horsthemke and R. Lefever, Springer (2006)
- *An Algorithmic Introduction to Numerical Simulation of Stochastic Differential Equations*, D. J. Higham, SIAM Review Vol. 43, pp 525-546

Students will have started work on ONE of the Projects 2 or 3. The project must be handed in by Monday May 4th (23:59 pm).

Weeks 8–13

Lectures will concentrate on the third group of projects.

Topic 4: Applications of Singular Value Decomposition

Topic 5: Dynamic patterns and the Koopman operator

Topic 6: Machine learning

A reference list will be provided on Ed.

Students will have started work on the final project which covers topics 4-6. The project must be handed in by Monday May 23rd (23:59 pm).

Assessment will be by the three computer assignments worth 20% each, and by a two hour examination worth 40%. To pass the course 50% in the final exam is needed.