

# Summary of course and the final exam

Morten Hjorth-Jensen Email [morten.hjorth-jensen@fys.uio.no](mailto:morten.hjorth-jensen@fys.uio.no)<sup>1,2</sup>

Department of Physics and Center of Mathematics for Applications, University of Oslo<sup>1</sup>

National Superconducting Cyclotron Laboratory, Michigan State University<sup>2</sup>

Spring 2016

© 1999-2016, Morten Hjorth-Jensen Email [morten.hjorth-jensen@fys.uio.no](mailto:morten.hjorth-jensen@fys.uio.no). Released under CC

Attribution-NonCommercial 4.0 license

# Learning outcomes

Our ideal about knowledge on computational science

Does that match the experiences you have made this semester?



©Zits Partnership

## Topics we have covered this year

- ▶ Linear algebra and eigenvalue problems. (Lecture notes chapters 6.1-6.5 and 7.1-7.5 and projects 1 and 2).
- ▶ Ordinary differential equations (Lecture notes chapter 8 and projects 3 and 4 )
- ▶ Partial differential equations (Lecture notes chapter 10 and project 4)
- ▶ Monte Carlo methods in physics (Lecture notes chapters 11, 12 and 13, project 4)

## Linear algebra and eigenvalue problems, chapters 6.1-6.5 and 7.1-7.5

- ▶ Know Gaussian elimination and LU decomposition (project 1)
- ▶ How to solve linear equations (project 1)
- ▶ How to obtain the inverse and the determinant of a real symmetric matrix
- ▶ Cubic spline
- ▶ Tridiagonal matrix decomposition (project 1)
- ▶ Householder's tridiagonalization technique and finding eigenvalues based on this
- ▶ Jacobi's method for finding eigenvalues (project 2)

# Monte Carlo methods in physics (Chapters 11, 12 and 13)

- ▶ Random walks and Markov chains
- ▶ Metropolis algorithm (project 4)
- ▶ Applications to statistical physics systems (project 4)

## Ordinary differential equations (Chapter 8)

- ▶ Euler's method and improved Euler's method, truncation errors (projects 3 and 4)
- ▶ Runge Kutta methods, 2nd and 4th order, truncation errors (projects 3 and 4)
- ▶ Leap-frog and Verlet algorithm (projects 3 and 4)
- ▶ How to implement and solve a second-order differential equation, both linear and non-linear.
- ▶ How to make your equations dimensionless.

## Partial differential equations, chapter 10

- ▶ Set up diffusion, Poisson and wave equations up to 2 spatial dimensions and time
- ▶ Set up the mathematical model and algorithms for these equations, with boundary and initial conditions. The stability conditions for the diffusion equation.
- ▶ Explicit, implicit and Crank-Nicolson schemes, and how to solve them. Remember that they result in triangular matrices (project 4).
- ▶ Diffusion equation in two dimensions.

# Final presentation

- ▶ Introduction with motivation
- ▶ Give a short overview of the theory and numerical algorithms employed
- ▶ Discuss the implementation of your algorithm and how you verified it and validated it
- ▶ Present and discuss your results
- ▶ Summary, conclusions and perspectives
- ▶ Anything else you think is important. Useful to have backup slides

In total your talk should have a duration of 20-25 minutes, but longer is also ok. The style for the final presentation follows very much the way the lay out your reports.



What? Me worry?



**One week  
before exams**



**Two days  
before exams**



**After exams**

**MAD**®

# Computational science courses at MSU

- ▶ PHY905 section 004 High-Performance computing
- ▶ New department offers degrees in Computational Science and many new courses
- ▶ See special courses offered now
- ▶ Undergraduate courses
- ▶ Graduate courses

Best wishes to you all and thanks so much for your efforts  
this semester

