Faculty of Science

NUMN30, Numerical Analysis: Iterative Solution of Large Scale Systems in Scientific Computing, 7.5 credits

Numerisk analys: Iterativ lösning av storskaliga system i beräkningsteknik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2016-03-14 to be valid from 2016-03-14, spring semester 2016.

General Information

The course is an elective course for second-cycle studies for a Degree of Master of Science (120 credits) in mathematics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

Knowledge and understanding

On completion of the course, the student should be able to:

- account for basic iterative methods for linear and nonlinear equations and the mathematical differences between them
- describe the structure of Jacobian-free Newton-Krylov methods
- describe multi-grid methods and their use on some model problems.

Competence and skills

On completion of the course, the student should be able to:

- implement an inexact Jacobian-free Newton-Krylov method
- implement a multi-grid method and apply it on model problems
- implement basic iterative solution methods
- analyse a given linear or nonlinear system and decide which solution method is appropriate.

Course content

- How large-scale linear and nonlinear systems arise in Scientific Computing
- Rate of convergence
- Termination criteria
- Basic iterative methods for linear and nonlinear equations (Fixed Point Methods, Newton's Method, Inexact Newton's Method, methods of Newton type) as well as their convergence properties and weaknesses
- Linear systems
- Krylov subspaces and Generalized Minimum RESidual Method (GMRES)
- GMRES with preconditioning
- Jacobian-free Newton-Krylov methods
- Multi-grid methods in one and two dimensions
- Multi-grid methods for nonstandard equations and for nonlinear systems

Course design

The teaching consists of lectures, problem solving classes and supervision of a computational project.

Assessment

The examination consists of a computational project with written report, a take-home examination followed by an oral examination. The oral examination may be taken only by those students who have passed on the take-home examination and can give a number of bonus points. A student who fails at the oral examination will have to pass on a new take-home exam.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
The final grade is based to 50% on the project reports and to 50% on the examination (take-home examination plus oral examination).

Entry requirements

For admission to the course, knowledge equivalent to 90 credits in Mathematics and Numerical Analysis, including the course NUMN12 Numerical Methods for Differential Equations, is required.

Subcourses in NUMN30, Numerical Analysis: Iterative Solution of Large Scale Systems in Scientific Computing

Applies from V16

1601 Project, 7,5 hp
Grading scale: Fail, Pass, Pass with distinction
1602 Take-home exam, 0,0 hp
Grading scale: Fail, Pass, Pass with distinction
1603 Oral exam, 0,0 hp
Grading scale: Fail, Pass