Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

M.P. van Schrojenstein Lantman

will give a presentation, entitled:

Efficient Multigrid Solution for Implicit High Order Compact Difference Schemes

Date: Friday June 27, 2014

Time: 14:00

Room: **Horst Building N.109**

Summary:
Many applications of computer simulations in engineering require efficient numerical solution methods for the class of elliptic partial differential equations (PDE). Examples of elliptic PDE's can be found in thin layer fluid-structure interaction problems. Applications of these interaction problems can be found, for instance, in the bearings of wind turbines, which are required to be durable while performing under a high load. Another example can be found in the interaction between joints in the human body.

Finite difference methods (FD) are often employed to discretise these elliptic PDE's to solve the problem numerically. The chosen finite difference scheme determines the accuracy of the solution on a given grid. High order implicit compact FD schemes approximate solutions better than standard FD, such that fewer grid points are needed to achieve solutions of the same accuracy. This suggests that the computational cost may be reduced by applying Compact FD schemes. Similar to FD these schemes can be optimised to possess good dispersion and dissipation characteristics.

The solution to the discretised elliptic PDE's is usually obtained iteratively by applying relaxation methods, such as Jacobi and Gauss-Seidel, accelerated by a full multigrid (FMG) algorithm. Combining these efficient solution methods with high order implicit compact difference schemes into a fast solver is not straightforward. Due to the implicit nature of the compact schemes, Gauss-Seidel relaxation is not feasible. An alternative relaxation method has been developed, which is a hybrid method combining Gauss-Seidel and Jacobi relaxation.

A fast and accurate computational method has been developed that solves problems in $O(N)$ operations, making use of high order compact FD schemes and employing an FMG algorithm. The solver has been applied to the Poisson equation and the elasticity equations, both in 2D, subject to various boundary conditions. Solving the elasticity equations with stress boundary conditions is a step towards solving fluid-structure interaction between thin layer flows and elastic objects.

Assessment committee:
Prof.dr.ir. H.W.M. Hoeijmakers (chairman)
Dr.ir. C.H. Venner (mentor)
Dr.ir. P.J. van Dijk
Dr.ir. E.T.A. van der Weide

Chairman,

d.d. _______________