DD2365 ADVANCED COMPUTATION IN FLUID MECHANICS

DD2365 EXAMINATION: THURSDAY JUNE 1, 2017, 14:00-19:00

The examination consists of two part: Part A and Part B. Each part gives 50p, which gives 100p in total: 40p for grade E, 50p for grade D, 60p for grade C, 70p for grade B, and 80p for grade A. To pass the exam a minimum of 20p on each Part A and Part B is needed.

Part A: Answer the following questions below. Be careful to define all mathematical variables and finite element spaces properly.

(1) Define the Reynolds number.
(2) Starting from the Navier-Stokes equations for incompressible flow, derive the non-dimensional Navier-Stokes equations with the only parameter being the Reynolds number.
(3) Derive the discrete (matrix) system corresponding to mixed a FEM method of the Stokes equations.
(4) Define the Taylor-Hood finite elements.
(5) State the Navier-Stokes equations in weak (variational) form using the weak residual.
(6) Formulate a stabilized finite element method for the Navier-Stokes equations.
(7) Formulate a semi-discretization of the time-dependent Navier-Stokes equations using the θ-method in time and a stabilized finite element method in space.
(8) What is an adaptive finite element method? What is a refinement criterion? What is a stopping criterion?
(9) Formulate the adjoint (dual) Navier-Stokes equations.
(10) Derive an a posteriori error estimate for a finite element solution of the Navier-Stokes equations using the adjoint (dual) problem.

(Note: the examination continues on the next page)

Part B: Describe your project under the following headings. You can refer to your computational results as if they were available to the reader.

(1) Background (What is the state of the art in the area of your project?)
(2) Research question (What is the research question of your project?)
(3) Method (What method did you use in your project?)
(4) Results (Describe the results of your computational studies.)
(5) Discussion (Describe how your results connect to your research question and the state of the art. Was your method appropriate? How would you like to continue if you had more time to work on the project?)