SF2561 Finite Element Methods: Fall 2014

Johan Hoffman

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The goal of this course is to give basic knowledge of the theory and practice of the finite element method and its application to the partial differential equations of physics and engineering sciences. The purpose is to give a balanced combination of theoretical and practical skills. The theoretical part is mainly concerned with the derivation of finite element formulations, estimating the discretization error, and use these error estimates to adaptively refine the mesh. The practical part deals with algorithms and computer implementation of finite element methods: such as matrix and vector assembly algorithms, and numerical integration over finite elements.

Course Homepage

All relevant information for the course is available at the course homepage: such as this project pm, lecture plan, extra problems with solutions, old exams, etc. Note that the homepage will change during the course, so be sure to check back regularly for up to date information:

`https://www.kth.se/social/course/SF2561/page/the-finite-element-method-sf2561-fall/`

Course announcements will be communicated through KTH Social, and through Twitter using the hashtag: `#kthfem2014`

Teacher

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Examination

The total grade of this course will be given by the written exam.

- **Written exam (grade A-F)** : Thursday October 30, 8-13 (E32).
- **Laboratory work (Pass/Fail)**: The laboratory work should be carried out individually or in groups of two, in any case individual reports should be handed in. Report A should be submitted by Friday October 3, and Report B by Friday October 17. Part A and B consist of a set of compulsory problems, and a set of non-compulsory problems that give bonus points for the written exam if submitted in time for the deadline (submissions after the deadline give no bonus points). Maximally 5 bonus points can be obtained for lab.

2 sets of problems generate maximum 5 bonus points for the written exam if handed in by Friday September 26 (Problem set A) and by Friday October 10 (Problem set B). Submissions after the deadline give no bonus points:

- **Problem set A**: 8.13, 15.19, 15.20, 15.21, 15.22
- **Problem set B**: 8.22, 15.45(a,b), 15.48, 15.49, 21.8

Literature

Course book: *Computational Differential Equations* (CDE), by K. Eriksson, D. Estep, P. Hansbo, C. Johnson. Studentlitteratur, ISBN ISBN 91-44-49311-8. Available at Kårens bokhandel, Bokus, Studentlitteratur, etc.

Preliminary course plan

Week 1

- Lecture 1 (Mon Sep 1, 13-15, V01): FEM for 1D boundary value problem [CDE 1-4,6,8.1]
- Lecture 2 (Tue Sep 2, 13-15, E32): FEM for 2D boundary value problem [CDE 5.5,(7),13,14.1-14.2,14.4,15.1]

Week 2

- Lecture 3 (Mon Sep 8, 15-17, E32): Boundary conditions, adaptive mesh refinement [CDE 15.1,15.3,15.4]
- Lab 1 (Fri Sep 12, 13-15, 5O1Spe): Implementation of 1D FEM [Matlab/Octave]

Week 3

- Lecture 4 (Tue Sep 16, 15-17, E32): Error estimation [CDE 5,8.2-8.6,14.2,15.2-15.3]
- Exercise 1 (Wed Sep 17, 10-12, D41)
- Lab 2 (Fri Sep 19, 13-15, 5O2Spo): Implementation of 2D FEM [Puffin]

Week 4

- Lecture 5 (Thu Sep 25, 14-16, L51): Duality, a posteriori error estimation [CDE 15.5]
- Lecture 6 (Fri Sep 26, 14-16, E35): Abstract problem, well-posedness [CDE 21,12]
- Deadline (Fri Sep 26) : Problem set A

Week 5

- Lecture 7 (Mon Sep 29, 10-12, D34): Initial value problem [CDE 9.1-9.2,16,17,(9.3-9.5,10)]
- Exercise 2 (Tue Sep 30, 10-12, E32)
- Deadline (Fri Oct 3) : Lab Report A

Week 6

- Exercise 3 (Wed Oct 8, 8-10, V21)
- Lecture 8 (Thu Oct 9, 10-12, V23): Convection-diffusion-reaction, space-time FEM, stabilized FEM [CDE 18,19]
- Exercise 4 (Fri Oct 10, 13-15, E51)
- Deadline (Fri Oct 10) : Problem set B

Week 7

- Lecture 9 (Mon Oct 13, 10-12, E36): Course review and outlook
- Exercise 5 (Wed Oct 15, 8-10, V01)
- Exercise 6 (Fri Oct 17, 13-15, D34)
- Deadline (Fri Oct 17) : Lab Report B

Week 8

- Preparation for written exam

Week 9

- Written exam (Thu Oct 30, 8-13, E32)