Finite Elements
DN2260 (x. 2D1260)
Fall ’07
4 cred. (6 ECTS)

Course home page ***- all info:***

http://www.csc.kth.se/utbildning/kth/kurser/DN2260/fem07/

Jesper Oppelstrup	Course admin, lectures
Sara Zahedi	Problem solving class
Murtazo Nazarov	Homework, labs

”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.”

Key:

- Error estimation - a priori & a posteriori
- Mesh adaption using a posteriori error estimates
- Mechanics of FE discretization

Coursework:

ProjA (Sep. 28) and ProjB (Oct. 19)	0.5
ProbA (Sep. 28) and ProbB (Oct. 19)	5 bonus exam cred.
Written exam, open book, 5 hr, Oct 25	0.5

Proj and Prob in groups of two. Submit
pdf to murtazo@nada.kth.se or
paper to CSC mailbox, Osq. B.2, bottom floor

Instruction:

9 2hr Lect., 7 2hr Ex., 6 2hr Lab sessions

Literature:
Computational Differential Equations,
K. Eriksson, D. Estep, P. Hansbo, C. Johnson
Studentlitteratur, ISBN ISBN 91-44-49311-8.
Price: approx. 410 kr at Kårens bokhandel.
plus
Hints to solutions, old exam papers, project PM, etc., on home page.

Overview of lectures

1. Introduction, function spaces, boundary value problems, weak formulation, Galerkin method, piecewise polynomials 1D (CDE (1-4),5-6;8.1)
2. Poisson 2D, FE mesh, piecewise polynomials 2D, (CDE 5.5;13;14.1-2,4;15.1)
3. Interpolation, error estimation, adaptivity (CDE 5,8,14,15)
4. FE algorithms and Puffin software; assembly, mapping, quadrature (CDE 15.1, Puffin mtrl.)
5. Initial value problems, heat equation, wave equation, stability, space-time FE (CDE 9,10,16,17)
6. Abstract problem, Lax-Milgram Theorem (CDE 7,8,21)
7. Adaptivity, a priori & a posteriori error estimation, duality
8. Convection-Diffusion, space-time FEM, stabilization (CDE 18,19);
9. Incompressible flow: The Navier-Stokes equations, overview/review.

History

David Hilbert
1863-1943

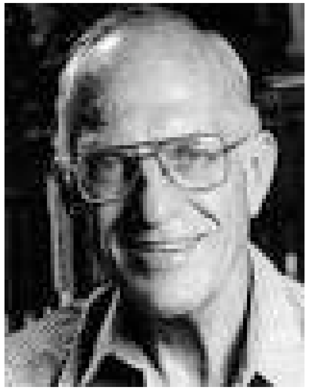
Boris G. Galerkin,
1871-1945

Sergei L. Sobolev
1908-1989

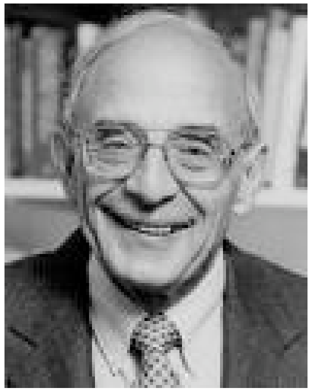
Claes Johnson

Ivo Babuska

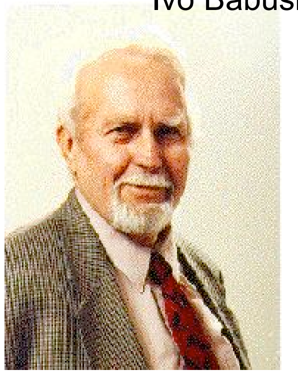
Richard Courant
1888-1972



Ray Clough



Ioannis Argyris



Olgierd C Zienkiewics

The Maxwell equations need special treatment:

1. curl curl, *not* div grad
2. ”Algebraic constraint”

   div **B** = 0, div **D** = 0

$$\nabla \times \mathbf{E} = -\mu\mu_0 \frac{\partial \mathbf{H}}{\partial t}$$

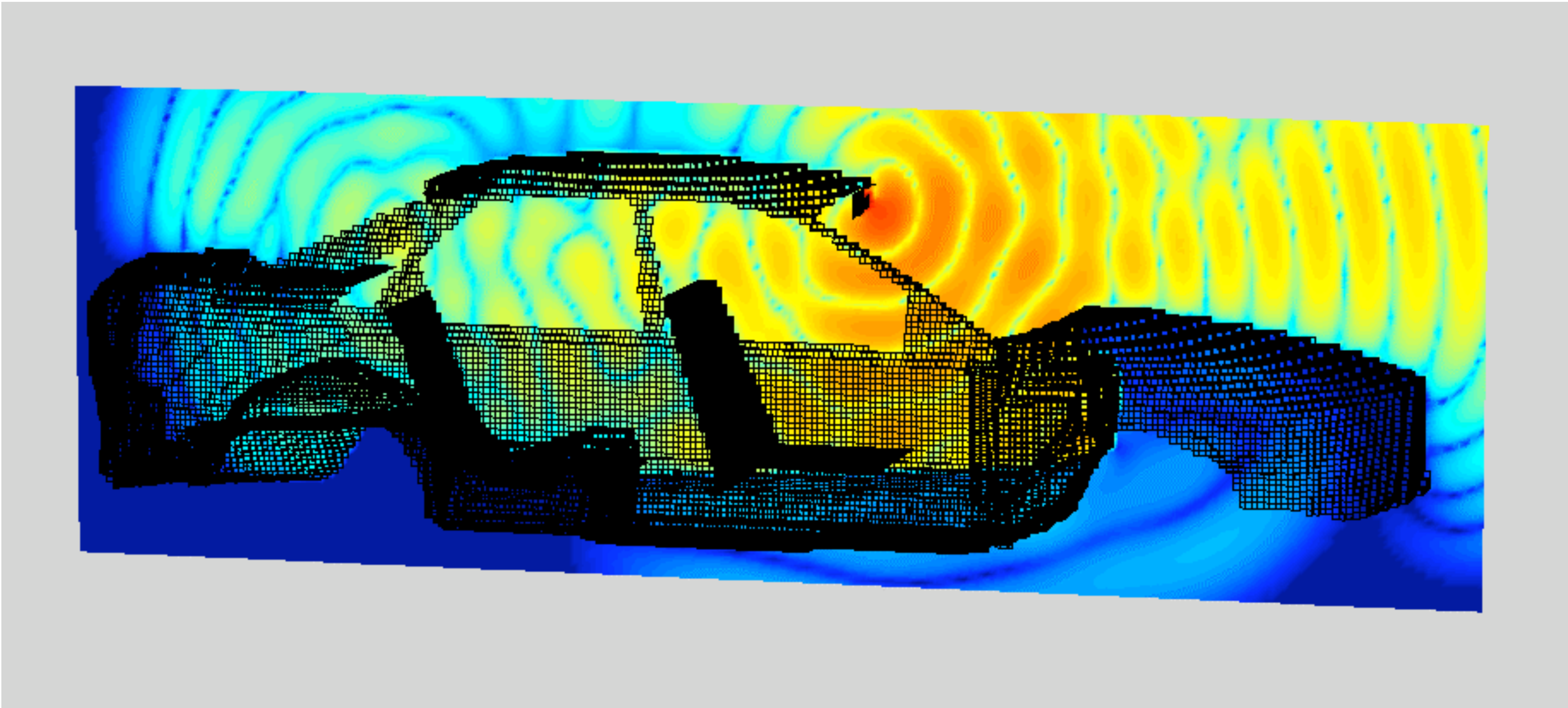
$$\nabla \times \mathbf{H} = \varepsilon\varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} + \mathbf{j}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \cdot \mathbf{D} = \rho$$

Maxwell simulator
(T.Rylander & al, CTU)

“There are three kinds of lies:
Lies, damn’ lies, and colorful computer pictures” (P.Colella)



Antenna in rear-view mirror: Directivity, EMC, …

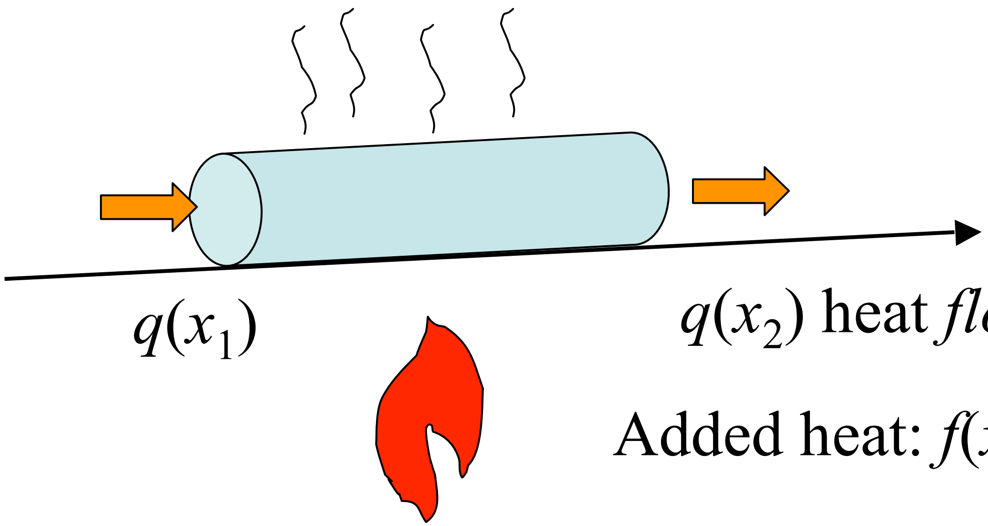
Boundary value problems, weak formulation, Galerkin method, piecewise polynomials 1D (CDE (1-4),5-6;8.1)

CDE Ch6.2: Steady heat conduction,

ambient temp. 0: Find temperature $u(x)$

Radiated heat: $H.u$ [W/m]

Note: usually, heat flux is W/m^2



Procedure

1. Derive differential equation
2. Define boundary conditions
3. Derive weak form and proper function space(s) V
4. Select approximation space V_h
5. Derive Galerkin discrete equations
6. Solve
7. Estimate error