

# FEniCS Course

## Overview

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*Lecturer*

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KAUST, Nov 4–6 2012



FENICS  
PROJECT

# Course outline

- L00** Introduction to FEM
- L01** Introduction to FEniCS (Day 1)
- L02** Static linear PDEs (Day 1)
- L03** Static nonlinear PDEs (Day 2)
- L04** Time-dependent PDEs (Day 3)
- L05** Happy hacking: Tools, tips and coding practices
- L06** Static hyperelasticity
- L07** Dynamic hyperelasticity
- L08** The Stokes problem
- L09** Incompressible Navier–Stokes
- L10** Discontinuous Galerkin methods for elliptic equations
- L11** A posteriori error estimates and adaptivity

Lectures can be downloaded from

<http://fenicsproject.org/pub/course/>



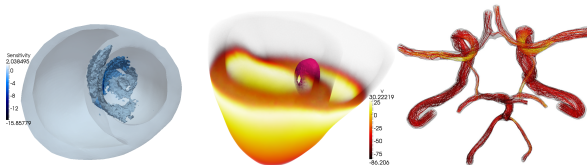
**The FEniCS Project is a collection of open-source software components aimed at the numerical solution of partial differential equations using finite element methods.**

## Key distinguishing features

- FEniCS (Python/C++) code is quick to write and easy to read.
- 'Any' finite element formulation of 'any' partial differential equation can be coded.
- Automated code generation is heavily used under the hood to create efficient, specialized, low-level code.
- Performance – implicit problems with over 200M degrees of freedom have been solved in minutes.

# FEniCS can be, and has been, used for a wide range of equations and applications

Reaction-diffusion equations; Stokes with or without nonlinear viscosity; compressible and incompressible Navier–Stokes; RANS turbulence models; shallow water equations; Bidomain equations; nonlinear and linear elasticity; nonlinear and linear viscoelasticity; Schrödinger; Biot's equations for porous media, fracture mechanics, electromagnetism, liquid crystals including liquid crystal elastomers, combustion, ... and coupled systems of the above, ...



for simulating blood flow, computing calcium release in cardiac tissue, computing the cardiac potential in the heart, simulating mantle convection, simulating melting ice sheets, computing the optimal placement of tidal turbines, simulating and reconstructing tsunamis, simulating the flow of cerebrospinal fluid and the deformation of the spinal cord, simulating waveguides, ...

Sounds great, but how do I find my way through the jungle?



# Three survival advices



Use the right Python  
tools



Explore the  
documentation



Ask, report and  
request

## Documentation for FEniCS 1.0.0

Our documentation includes a book, a collection of documented demo programs, and complete references for the FEniCS application programming interface (API). Note that the FEniCS API is documented separately for each FEniCS component. The most important interfaces are those of the C++/Python problem solving environment [DOLFIN](#) and the form language [UFL](#).

(This page accesses the FEniCS 1.0.0 documentation. Not the version you are looking for? See [all versions](#).)

### The FEniCS Tutorial

A good starting point for new users is the [FEniCS Tutorial](#). The tutorial will help you get quickly up and running with solving differential equations in FEniCS. The tutorial focuses exclusively on the FEniCS Python interface, since this is the simplest approach to exploring FEniCS for beginners.

### The FEniCS Book



*The FEniCS Book, Automated Solution of Differential Equations by the Finite Element Method*, is a comprehensive (700 pages) book documenting the mathematical methodology behind the FEniCS Project and the software developed as part of the FEniCS Project. The FEniCS Tutorial is included as the opening chapter of the FEniCS Book.

### The FEniCS Manual

The [FEniCS Manual](#) is a 200-page excerpt from the FEniCS Book, including the FEniCS Tutorial, an introduction to the finite element method and documentation of DOLFIN and UFL.

### Demos

A simple way to build your first FEniCS application is to copy and modify one of the existing demos:

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[Documented DOLFIN demos \(Python\)](#)

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[Documented DOLFIN demos \(C++\)](#)

The demos are *already installed on your system* or can be found in the [demo](#) directory of the DOLFIN source tree.

### Quick Programmer's References

Some of the classes and functions in DOLFIN are more frequently used than others. To learn more about these, take a look at the

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This page contains links to all FENICS projects on Launchpad for convenience.

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<a href="#">FENICS Project</a>	<a href="#">Get Answers</a>	<a href="#">Report Bugs</a>	<a href="#">(Join Team and) Email Support</a>	<a href="#">Browse List Archives</a>

### Core components


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<a href="#">FFC</a>	<a href="#">Get Answers</a>	<a href="#">Report Bugs</a>	<a href="#">(Join Team and) Email Support</a>	<a href="#">Browse List Archives</a>
<a href="#">FIAT</a>	<a href="#">Get Answers</a>	<a href="#">Report Bugs</a>	<a href="#">(Join Team and) Email Support</a>	<a href="#">Browse List Archives</a>
<a href="#">Instant</a>	<a href="#">Get Answers</a>	<a href="#">Report Bugs</a>	<a href="#">(Join Team and) Email Support</a>	<a href="#">Browse List Archives</a>
<a href="#">UFC</a>	<a href="#">Get Answers</a>	<a href="#">Report Bugs</a>	<a href="#">(Join Team and) Email Support</a>	<a href="#">Browse List Archives</a>
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[http://fenicsproject.org/support/launchpad\\_pages.html](http://fenicsproject.org/support/launchpad_pages.html)

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### Questions for DOLFIN













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by relevancy ▾

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Status

☒ Open ☒ Needs information ☒ Answered ☒ Solved ☐ Expired ☐ Invalid

Summary	Created	Submitter	Assignee	Status
 201835 <a href="#">PeriodicBC crashing on coordinates I don't have</a>	2012-06-29	 Stav Gold	—	Answered
 201782 <a href="#">Error in gradient calculation along axes</a>	2012-06-29	 K. Hoffmann	—	Open
 201696 <a href="#">Properties of the goal function in non-linear problems</a>	2012-06-28	 Daniel Bare	—	Solved
 201639 <a href="#">listing dofs of a Facet</a>	2012-06-27	 Nguyen Van Dang	—	Open
 201638 <a href="#">Boundary conditions for more than one variable</a>	2012-06-27	 minak	—	Answered
 201548 <a href="#">Using PETSc command line options</a>	2012-06-26	 M. Sussman	—	Solved

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Answer contacts for DOLFIN  
 DOLFIN Team

<https://answers.launchpad.net/dolfin>

# Installation



Official packages for Debian and Ubuntu



Drag and drop installation on Mac OS X



Binary installer for Windows



Automated installation from source

<http://fenicsproject.org/download/>

# Let's get started and remember:

- Lectures can be downloaded from  
`http://fenicsproject.org/pub/course/lectures`
- Data for exercises can be downloaded from  
`http://fenicsproject.org/pub/course/data`
- Solutions for exercises can be downloaded from  
`http://fenicsproject.org/pub/course/src`  
(Secret password needed!)