

I'm not a bot



We explore optimization issues related to linear elliptic operators, examining the connection between this problem and two-phase optimal design (topology optimization). Under certain conditions, we show that the first eigenvalue is pseudo-concave with respect to the density-like parameter. This property allows for straightforward solution of maximization problems, while minimization problems can be addressed using extreme points (0-1 designs). Numerical experiments demonstrate the effectiveness of a simple projected gradient method in obtaining optimal solutions. Additionally, we consider bi-objective optimal control strategies for linear and semi-linear wave equations, employing Nash and Pareto equilibrium methods. We utilize FreeFem++ to transcribe theoretical problems into C++ code, incorporating spatial discretization through finite elements and temporal evolution via finite differences. Furthermore, we investigate the use of Phase Change Materials (PCMs) in thermal energy storage systems for refrigeration applications, such as medicine and food preservation. Our research employs the Enthalpy-Porosity Model to simulate PCM solidification and melting processes, providing a more accurate prediction than simpler methods while accounting for natural convection effects. Finally, we study Steklov eigenvalues and mixed Steklov Neumann eigenvalues on smooth bounded domains with spherical holes, focusing on explicit expressions and sharp upper bounds for these eigenvalues. From its center, we examine the Steklov eigenvalues on a concentric annular domain of the same volume as Ω . We then analyze the mixed Steklov Neumann eigenvalue problem for 4th order symmetric domains in $\mathbb{R}^n$ with a spherical hole, obtaining an upper bound for the first n nonzero eigenvalues. This approach highlights the significance of symmetry assumptions in our results. Numerical observations are made using FreeFEM++, and the findings are presented as conjectures. The periodicity cell is composed of parallel fibers with arbitrary cross-sections made of different anisotropic linear elastic materials. The methodology employs asymptotic homogenization (AH) to obtain effective properties and formulate local problems on the periodicity cell, which are then solved using domain decomposition (DD) and finite elements (FE). The numerical scheme computation using the finite element method was conducted with FreeFem++ software version 4.6. Three distinct cases were analyzed: an empty refrigerator without shelves, one with shelves, and another with loaded food items. For each scenario, the optimal configurations' velocity and temperature fields were examined to facilitate engineers in designing domestic frost-free refrigerators. The characterization of these physical parameters would be beneficial for their work. Elmer is a GPL-licensed multiphysics solver based on the Finite Element Method that includes modules for various disciplines such as fluid dynamics, structural mechanics, electromagnetics, heat transfer, acoustics, and others. It features a graphical user interface (ElmerGUI) capable of importing meshes in different file formats, setting up PDE systems, and exporting model data and results. The FeniCS project primarily focuses on solving Partial Differential Equations (PDEs) using the Finite Element Method (FEM). This encompasses various applications such as thermomechanics and electromagnetics. FeniCS provides Python and C++ interfaces, enabling straightforward definition and solution of problems. Models can be prototyped locally before being run on clusters with ease. The project offers DOLFINx, a high-level interface for Python and C++, which is documented here. FreeFEM is another library that employs the Finite Element Method for multi-physics simulation. It includes pre-built physics modules such as Navier-Stokes and thermodynamics, as well as its own scripting language for implementing new modules. FreeFEM contains mesh generation routines and is compatible with other open-source tools like Gmsh and Paraview. The Code-Aster project, developed by Electricité de France R&D in collaboration with universities and industry, focuses on solid mechanics and thermal behavior of linear and non-linear materials. It supports static and dynamic analysis, with application areas including fatigue, damage, fracture, and contact mechanics. The project includes modules for geomaterials, porous media, and multi-physics coupling. OpenFOAM is a GPL-licensed project centered around Computational Fluid Dynamics (CFD), which involves numerical methods such as Finite Element Methods. CFD covers various scientific and engineering applications, including heat transfer, thermodynamics, chemistry, and solids. The software includes mesh generation modules for simple or complex geometries and post-processing via ParaView. Problem definition and geometry creation are done through scripting. Deal.II is a modern C++ library for solving PDEs using the finite element method. It emphasizes adaptive mesh refinement, parallel computing, and high-order finite elements, making it suitable for high-performance applications. MOOSE Framework Overview The Moose framework is licensed under the LGPL (version 2.1 or later), allowing developers to access its features without additional costs. Although it lacks a native graphical user interface, users often pair it with external visualization tools like ParaView or VisIt for enhanced analysis capabilities.

Finite element method syllabus. Finite element software. Finite element method software. Free finite element analysis software. Finite element simulation.