

2D Heat Equation Modeled by Crank-Nicolson Method

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1 The Heat Equation

$$\frac{\partial U}{\partial t} - \alpha \frac{\partial^2 U}{\partial x^2} = 0 \qquad \frac{\partial U}{\partial t} - \alpha \nabla^2 \mathbf{x} = 0$$

The system I chose to study was that of a hot object in a cold medium, and document the time progression of various cases. This system is fairly straight forward to relate to as it a situation we frequently encounter in daily life. Heat transfer follows a few classical rules:

- Heat flows from hot to cold (Hight T to low T)
 - Heat flows at rate proportional to the spacial 2nd derivative. This rate is α
 - A change in heat results in a change in T
- $$\Delta T = mc_p Q$$
- Total heat energy must be conserved.

Such systems in general are equilibrium seeking, non-oscillatory systems which approach the equilibrium state (constant T) asymptotically as time progresses.

In my system we consider a grid of 100x100 particles with $m = C_p = 1$ and constant α across the whole grid. While this system is rather simplistic, it still allows us to model and solve many complex and interesting distributions of heat features.

Heat Equation Cylinder Matlab Code Crank Nicolson

Tien-Mo Shih



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Proceedings of International Joint Conference on Advances in Computational Intelligence Mohammad Shorif Uddin, Jagdish Chand Bansal, 2021-05-17 This book gathers outstanding research papers presented at the International Joint Conference on Advances in Computational Intelligence IJCACI 2020 organized by Daffodil International University DIU and Jahangirnagar University JU in Bangladesh and South Asian University SAU in India These proceedings present novel contributions in the areas of computational intelligence and offer valuable reference material for advanced research The topics covered include collective intelligence soft computing optimization cloud computing machine learning intelligent software robotics data science data security big data analytics and signal and natural language processing *Control of Crank-Nicolson Noise in the Numerical Solution of the Heat Conduction Equation* W. L. Wood, 1976 *Transform solution of the heat equation for an insulated composite cylinder* Jerry Vaughn Kahlbau, 1957 **Application of the Hughes-LIU Algorithm to the 2-dimensional Heat Equation**, 1982 *Solutions to the Heat Equation in Cylindrical Coordinates* Linda L. Kelley, 1984 *Concurrent Implementation of the Crank-Nicolson Method for Heat Transfer Analysis*, 1985

Steady-state Temperature Solution for a Heat-generating Circular Cylinder Cooled by a Ring of Equal Holes John C. Rowley, J. B. Payne, 1961 An analytical solution is presented to the steady state heat conduction equation for a heat generating circular region which is cooled by a ring of equal holes spaced uniformly on a circle concentric with the boundary of the cylinder The solution is based upon a class of harmonic functions previously defined by Howland Numerical results are presented in the form of dimensionless curves for the particular examples of a uniform heat generation within the region with cooling at the holes and insulated outer boundary and b the shape factor or conductance for this geometry *Travelling Wave Solutions of the Heat Equation in an Unbounded Cylinder with a Non-Linear Boundary Condition* Mads Kyed, 2005

Advanced Mathematics and Mechanics Applications Using MATLAB David Halpern, Howard B. Wilson, Louis H. Turcotte, 2002-09-17 Advanced Mathematics and Mechanics Applications Using MATLAB Third Edition features extensive revisions that bring this best selling text in line with MATLAB 6 x especially its graphics and animation capabilities It incorporates material on time dependent solutions of linear partial differential equations a chapter on eigenvalue problems and more than 300 pages of MATLAB solutions to important applications The authors provide an abundance of additional physical examples related to heat conduction inviscid fluid flow geometrical properties stress analysis and multi dimensional optimizations The source code for all of the programs presented is freely available for download from the CRC website

Computational Heat Transfer Yogesh Jaluria, 2002-11-21 This new edition updated the material by expanding coverage of certain topics adding new examples and problems removing outdated material and adding a computer disk which will be included with each book Professor Jaluria and Torrance have structured a text addressing both finite difference and finite element methods comparing a number of applicable methods **Application of the Hughes-Liu Algorithm to the**

2-Dimensional Heat Equation National Aeronautics and Space Administration (NASA),2018-08-14 An implicit explicit algorithm for the solution of transient problems in structural dynamics is described The method involved dividing the finite elements into implicit and explicit groups while automatically satisfying the conditions This algorithm is applied to the solution of the linear transient two dimensional heat equation subject to an initial condition derived from the solution of a steady state problem over an L shaped region made up of a good conductor and an insulating material Using the IIT PRIME computer with virtual memory a FORTRAN computer program code was developed to make accuracy stability and cost comparisons among the fully explicit Euler the Hughes Liu and the fully implicit Crank Nicholson algorithms The Hughes Liu claim that the explicit group governs the stability of the entire region while maintaining the unconditional stability of the implicit group is illustrated Malkus D S and Reichmann P I and Haftka R T Unspecified Center NASA CR 3599 NAS 1 26 3599 NAG1 224 NSG 1266 The Heat Diffusion Equation Haneul Choi,2025-04-27 Feel the pulse of temperature shifting through metal soil and living matter then command it with code This definitive textbook fuses rigorous thermal science with modern Python programming equipping you to Grasp Core Physics Energy conservation thermal conductivity and transient conduction distilled into clear intuitive explanations Conquer Analytical Techniques Separation of variables Laplace transforms Green s functions and error function solutions presented step by step Master Numerical Power Build and compare explicit implicit Crank Nicolson finite element and finite volume solvers with fully annotated NumPy SciPy scripts Bridge Theory to Practice Apply models to cooling fins multilayer composites geothermal probes and food processing with real engineering data sets Accelerate Learning 120 worked examples exercise sets and Python code turn abstract equations into interactive insight Optimize Designs Leverage dimensional analysis Biot Fourier numbers and parameter sweeps to guide material selection and geometry decisions Future Proof Your Skills Modular code snippets integrate seamlessly with CFD workflows machine learning pipelines and HPC clusters Whether you re a mechanical engineer tightening heat exchanger specs a physicist probing transient diffusion or a data scientist expanding into scientific computing this hands on guide delivers the complete toolbox for solving and simulating heat transfer problems fast accurately and confidently

Heat Transfer Tien-Mo Shih,2016-12-31 Solution and Interpolation of One-dimensional Heat Equation by Using Cran-nicolson, Cubic Spline and Cubic B-Spline Wan Khadijah Wan Sulaiman,2013

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