

Example 1

A liquid-liquid extraction process conducted in the Electrochemical Materials Laboratory involved the extraction of nickel from the aqueous phase into an organic phase. A typical set of experimental data from the laboratory is given below.

Ni aqueous phase, a (g/l)	2	2.5	3
Ni organic phase, g (g/l)	8.57	10	12

Assuming g is the amount of Ni in the organic phase and a is the amount of Ni in the aqueous phase, the quadratic interpolant that estimates g is given by

$$g = x_1 a^2 + x_2 a + x_3, \quad 2 \leq a \leq 3$$

The solution for the unknowns x_1 , x_2 , and x_3 is given by

$$\begin{bmatrix} 4 & 2 & 1 \\ 6.25 & 2.5 & 1 \\ 9 & 3 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 8.57 \\ 10 \\ 12 \end{bmatrix}$$

Find the values of x_1 , x_2 , and x_3 using the Gauss-Seidel method. Estimate the amount of nickel in the organic phase when 2.3 g/l is in the aqueous phase using quadratic interpolation. Use

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

as the initial guess and conduct two iterations.

Solution:-

Rewriting the equations gives

$$\begin{aligned} x_1 &= \frac{8.57 - 2x_2 - x_3}{4} \\ x_2 &= \frac{10 - 6.25x_1 - x_3}{2.5} \\ x_3 &= \frac{12 - 9x_1 - 3x_2}{1} \end{aligned}$$

Iteration #1

Given the initial guess of the solution vector as

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David F. Griffiths, Desmond J. Higham



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Numerical Methods M. K. Jain, Satteluri R. K. Iyengar, R. K. Jain, 2007 Is An Outline Series Containing Brief Text Of Numerical Solution Of Transcendental And Polynomial Equations System Of Linear Algebraic Equations And Eigenvalue Problems Interpolation And Approximation Differentiation And Integration Ordinary Differential Equations And Complete Solutions To About 300 Problems Most Of These Problems Are Given As Unsolved Problems In The Authors Earlier Book User Friendly Turbo Pascal Programs For Commonly Used Numerical Methods Are Given In The Appendix This Book Can Be Used As A Text Help Book Both By Teachers And Students Numerical Analysis Problem Solver Research and Education Association, 1983-01-01 The Problem Solvers are an exceptional series of books that are thorough unusually well organized and structured in such a way that they can be used with any text No other series of study and solution guides has come close to the Problem Solvers in usefulness quality and effectiveness Educators consider the Problem Solvers the most effective series of study aids on the market Students regard them as most helpful for their school work and studies With these books students do not merely memorize the subject matter they really get to understand it Each Problem Solver is over 1 000 pages yet each saves hours of time in studying and finding solutions to problems These solutions are worked out in step by step detail thoroughly and clearly Each book is fully indexed for locating specific problems rapidly An essential subject for students in mathematics computer science engineering and science The 19 chapters cover basic as well as advanced methods of numerical analysis A large number of related applications are included Numerical Methods J. Douglas Faires, Richard L. Burden, 1998 This text emphasizes the intelligent application of approximation techniques to the type of problems that commonly occur in engineering and the physical sciences The authors provide a sophisticated introduction to various appropriate approximation techniques they show students why the methods work what type of errors to expect and when an application might lead to difficulties and they provide information about the availability of high quality software for numerical approximation routines The techniques covered in this text are essentially the same as those covered in the Sixth Edition of these authors top selling Numerical Analysis text but the emphasis is much different In Numerical Methods Second Edition full mathematical justifications are provided only if they are concise and add to the understanding of the methods The emphasis is placed on describing each technique from an implementation standpoint and on convincing the student that the method is reasonable both mathematically and computationally **Numerical Methods with Worked Examples** Chris Woodford, C. Woodford, Chris Phillips, 1997-08-31 This book is for students following a module in numerical methods numerical techniques or numerical analysis It approaches the subject from a pragmatic viewpoint appropriate for the modern student The theory is kept to a minimum commensurate with comprehensive coverage of the subject and it contains abundant worked examples which provide easy understanding through a clear and concise theoretical treatment

Numerical Analysis with Applications in Mechanics and Engineering Petre Teodorescu, Nicolae-Doru Stanescu, Nicolae

Pandrea,2013-06-04 NUMERICAL ANALYSIS WITH APPLICATIONS IN MECHANICS AND ENGINEERING A much needed guide on how to use numerical methods to solve practical engineering problems Bridging the gap between mathematics and engineering Numerical Analysis with Applications in Mechanics and Engineering arms readers with powerful tools for solving real world problems in mechanics physics and civil and mechanical engineering Unlike most books on numerical analysis this outstanding work links theory and application explains the mathematics in simple engineering terms and clearly demonstrates how to use numerical methods to obtain solutions and interpret results Each chapter is devoted to a unique analytical methodology including a detailed theoretical presentation and emphasis on practical computation Ample numerical examples and applications round out the discussion illustrating how to work out specific problems of mechanics physics or engineering Readers will learn the core purpose of each technique develop hands on problem solving skills and get a complete picture of the studied phenomenon Coverage includes How to deal with errors in numerical analysis Approaches for solving problems in linear and nonlinear systems Methods of interpolation and approximation of functions Formulas and calculations for numerical differentiation and integration Integration of ordinary and partial differential equations Optimization methods and solutions for programming problems Numerical Analysis with Applications in Mechanics and Engineering is a one of a kind guide for engineers using mathematical models and methods as well as for physicists and mathematicians interested in engineering problems Numerical Methods for Ordinary Differential Equations David F. Griffiths,Desmond J. Higham,2010-11-11 Numerical Methods for Ordinary Differential Equations is a self contained introduction to a fundamental field of numerical analysis and scientific computation Written for undergraduate students with a mathematical background this book focuses on the analysis of numerical methods without losing sight of the practical nature of the subject It covers the topics traditionally treated in a first course but also highlights new and emerging themes Chapters are broken down into lecture sized pieces motivated and illustrated by numerous theoretical and computational examples Over 200 exercises are provided and these are starred according to their degree of difficulty Solutions to all exercises are available to authorized instructors The book covers key foundation topics o Taylor series methods o Runge Kutta methods o Linear multistep methods o Convergence o Stability and a range of modern themes o Adaptive stepsize selection o Long term dynamics o Modified equations o Geometric integration o Stochastic differential equations The prerequisite of a basic university level calculus class is assumed although appropriate background results are also summarized in appendices A dedicated website for the book containing extra information can be found via www.springer.com

Numerical Methods for the Solution of Ill-Posed Problems A.N. Tikhonov,A. Goncharsky,V.V. Stepanov,Anatoly G. Yagola,2013-03-09 Many problems in science technology and engineering are posed in the form of operator equations of the first kind with the operator and RHS approximately known But such problems often turn out to be ill posed having no solution or a non unique solution and or an unstable solution Non existence and non uniqueness can usually be overcome by

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history of scientific computing a survey of computer languages and software and a revised literature review Includes an appendix of proofs of selected theorems and author hosted companion website with additional exercises application models and supplemental resources

Numerical Solutions of Boundary Value Problems for Ordinary Differential Equations A.K. Aziz, 2014-05-10 Numerical Solutions of Boundary Value Problems for Ordinary Differential Equations covers the proceedings of the 1974 Symposium by the same title held at the University of Maryland Baltimore Country Campus This symposium aims to bring together a number of numerical analysis involved in research in both theoretical and practical aspects of this field This text is organized into three parts encompassing 15 chapters Part I reviews the initial and boundary value problems Part II explores a large number of important results of both theoretical and practical nature of the field including discussions of the smooth and local interpolant with small K th derivative the occurrence and solution of boundary value reaction systems the posteriori error estimates and boundary problem solvers for first order systems based on deferred corrections Part III highlights the practical applications of the boundary value problems specifically a high order finite difference method for the solution of two point boundary value problems on a uniform mesh This book will prove useful to mathematicians engineers and physicists

[Explorations In Numerical Analysis: Python Edition](#) James V Lambers, Amber C Sumner Mooney, Vivian Ashley Montiforte, 2021-01-14 This textbook is intended to introduce advanced undergraduate and early career graduate students to the field of numerical analysis This field pertains to the design analysis and implementation of algorithms for the approximate solution of mathematical problems that arise in applications spanning science and engineering and are not practical to solve using analytical techniques such as those taught in courses in calculus linear algebra or differential equations Topics covered include computer arithmetic error analysis solution of systems of linear equations least squares problems eigenvalue problems nonlinear equations optimization polynomial interpolation and approximation numerical differentiation and integration ordinary differential equations and partial differential equations For each problem considered the presentation includes the derivation of solution techniques analysis of their efficiency accuracy and robustness and details of their implementation illustrated through the Python programming language This text is suitable for a year long sequence in numerical analysis and can also be used for a one semester course in numerical linear algebra

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Numerical Analysis Using R Graham W. Griffiths, 2016-04-26 This book presents the latest numerical solutions to initial value problems and boundary value problems described by ODEs and PDEs The author offers practical methods that can be adapted to solve wide ranges of problems and illustrates them in the increasingly popular open source computer language R allowing integration with more statistically based methods The book begins with standard techniques followed by an overview of high resolution flux limiters and WENO to solve problems with solutions exhibiting high gradient phenomena Meshless methods using radial basis functions are then discussed in the context of scattered data interpolation and the solution of PDEs on irregular grids Three detailed case studies demonstrate how numerical methods can be used to tackle very different complex problems With its focus on practical solutions to real world problems this book will be useful to students and practitioners in all areas of science and engineering especially those using R Numerical Analysis of Systems of Ordinary and Stochastic Differential Equations Sergej S. Artemiev, Tatjana A. Averina, 1997 This book deals with numerical analysis of systems of both ordinary and stochastic differential equations The first chapter is devoted to numerical solution problems of the Cauchy problem for stiff ordinary differential equation ODE systems by Rosenbrock type methods RTMs Here general solutions of consistency equations are obtained which lead to the construction of RTMs from the first to the fourth order The second chapter deals with statistical simulation problems of the solution of the Cauchy problem for stochastic differential equation SDE systems The mean square convergence theorem is considered as well as Taylor expansions of numerical solutions Also included are applications of numerical methods of SDE solutions to partial differential

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