

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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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 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

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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 settling for generalised solutions leading to the need to develop regularising algorithms The theory of ill posed problems has advanced greatly since A N Tikhonov laid its foundations the Russian original of this book 1990 rapidly becoming a classical monograph on the topic The present edition has been completely updated to consider linear ill posed problems with or without a priori constraints non negativity monotonicity convexity etc Besides the theoretical material the book also contains a FORTRAN program library Audience Postgraduate students of physics mathematics chemistry economics engineering Engineers and scientists interested in data processing and the theory of ill posed 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

An Introduction to Numerical Methods and Analysis, Solutions Manual James F. Epperson, 2014-08-28 A solutions manual to accompany *An Introduction to Numerical Methods and Analysis* Second Edition *An Introduction to Numerical Methods and Analysis* Second Edition reflects the latest trends in the field includes new material and revised exercises and offers a unique emphasis on applications The author clearly explains how to both construct and evaluate approximations for accuracy and performance which are key skills in a variety of fields A wide range of higher level methods and solutions including new topics such as the roots of polynomials spectral collocation finite element ideas and Clenshaw Curtis quadrature are presented from an introductory perspective and the Second Edition also features Chapters and sections that begin with basic elementary material followed by gradual coverage of more advanced material Exercises ranging from simple hand computations to challenging derivations and minor proofs to programming exercises Widespread exposure and utilization of MATLAB An appendix that contains proofs of various theorems and other material

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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 The Numerical Analysis Problem Solver Research and Education Association,1993 *Handbook of Numerical Analysis* Philippe G. Ciarlet, Jacques-Louis Lions,1990 This series of volumes covers all the major aspects of numerical analysis serving as the basic reference work on the subject Each volume concentrates on one to three particular topics Each article written by an expert is an in depth survey reflecting up to date trends in the field and is essentially self contained The handbook will cover the basic methods of numerical analysis under the following general headings solution of equations in R^n finite difference methods finite element methods techniques of scientific computing optimization theory and systems science It will also cover the numerical solution of actual problems of contemporary interest in applied mathematics under the following headings numerical methods for fluids numerical methods for solids and specific applications including meteorology seismology petroleum mechanics and celestial mechanics **Explorations In Numerical Analysis** James V Lambers, Amber C Sumner Mooney, 2018-09-17 This textbook introduces 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 error analysis computer arithmetic solution of systems of linear equations least squares problems eigenvalue problems polynomial interpolation and approximation numerical differentiation and integration nonlinear equations optimization 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 MATLAB 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 Studies in Numerical Analysis 2 Numerical Solutions of Nonlinear Problems a Collection of Papers Presented at Symposia in Numeial United States, 1970 **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

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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 equations and to analysis and synthesis problems of automated control of stochastic systems

Topics in Numerical Analysis G. Alefeld, Xiaojun Chen, 2001-09-11 This collection of papers on numerical analysis with special emphasis on nonlinear problems covers a broad spectrum of fields Several papers are involved in applying numerical methods for proving the existence of solutions of nonlinear problems e g of boundary problems or of obstacle problems Naturally the solution of linear and nonlinear problems by iterative methods is the subject of a couple of papers Here topics like the fast verification of solutions of monotone matrix

equations the convergence of linear asynchronous iteration with spectral radius of modulus one or aggregation and disaggregation methods for p cyclic Markov chains are treated On the other hand papers involved in optimization problems can be found Nearly all fields of modern numerical analysis are touched by at least one paper

Numerical Approximation Methods Harold Cohen, 2011-12-10 This book presents numerical and other approximation techniques for solving various types of mathematical problems that cannot be solved analytically In addition to well known methods it contains some non standard approximation techniques that are now formally collected as well as original methods developed by the author that do not appear in the literature This book contains an extensive treatment of approximate solutions to various types of integral equations a topic that is not often discussed in detail There are detailed analyses of ordinary and partial differential equations and descriptions of methods for estimating the values of integrals that are presented in a level of detail that will suggest techniques that will be useful for developing methods for approximating solutions to problems outside of this text The book is intended for researchers who must approximate solutions to problems that cannot be solved analytically It is also appropriate for students taking courses in numerical approximation techniques

An Introduction to Numerical Analysis, 2nd Ed Kendall E. Atkinson, 2008-09 Market_Desc Mathematics Students Instructors About The Book This Second Edition of a standard numerical analysis text retains organization of the original edition but all sections have been revised some extensively and bibliographies have been updated New topics covered include optimization trigonometric interpolation and the fast Fourier transform numerical differentiation the method of lines boundary value problems the conjugate gradient method and the least squares solutions of systems of linear equations

Numerical Methods Mahinder Kumar Jain, S. R. K. Iyengar, Rajinder Kumar Jain, 1994

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