

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 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 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

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Solutions Manual to accompany An Introduction to Numerical Methods and Analysis James F. Epperson, 2021-09-15 A solutions manual to accompany An Introduction to Numerical Methods and Analysis Third Edition An Introduction to Numerical Methods and Analysis helps students gain a solid understanding of a wide range of numerical approximation methods for solving problems of mathematical analysis Designed for entry level courses on the subject this popular textbook maximizes teaching flexibility by first covering basic topics before gradually moving to more advanced material in each chapter and section Throughout the text students are provided clear and accessible guidance on a wide range of numerical methods and analysis techniques including root finding numerical integration interpolation solution of systems of equations and many others This fully revised third edition contains new sections on higher order difference methods the bisection and inertia method for computing eigenvalues of a symmetric matrix a completely re written section on different methods for Poisson equations and spectral methods for higher dimensional problems New problem sets ranging in difficulty from simple computations to challenging derivations and proofs are complemented by computer programming exercises illustrative examples and sample code This acclaimed textbook Explains how to both construct and evaluate approximations for accuracy and performance Covers both elementary concepts and tools and higher level methods and solutions Features new and updated material reflecting new trends and applications in the field Contains an introduction to key concepts a calculus review an updated primer on computer arithmetic a brief 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 The Numerical Analysis Problem Solver Research and Education Association,1993 **Problem Solving in Chemical Engineering with Numerical Methods** Michael B. Cutlip,Mordechai Shacham,1999 A companion book including interactive software for students and professional engineers who want to utilize problem solving software to effectively and efficiently obtain solutions to realistic and complex problems An Invaluable reference book that discusses and Illustrates practical numerical problem solving in the core subject areas of Chemical Engineering Problem Solving in Chemical Engineering with Numerical Methods provides an extensive selection of problems that require numerical solutions from throughout the core subject areas of chemical engineering Many are completely solved or partially solved using POLYMATH as the representative mathematical problem solving software Ten representative problems are also solved by Excel Maple Mathcad MATLAB and Mathematica All problems are clearly organized and all necessary data are provided Key equations are presented or derived Practical aspects of efficient and effective numerical problem solving are emphasized Many complete solutions are provided within the text and on the CD ROM for use in problem solving exercises BOOK JACKET Title Summary field provided by Blackwell North America Inc All Rights Reserved 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 *Numerical Analysis in Engineering* Rama B. Bhat,Snehashish Chakraverty,2004 This text deals with the methods of obtaining numerical solutions to engineering problems The topics discussed are those that are normally covered in undergraduate engineering programs This includes an introduction to digital computers function representation using Taylor s series error considerations in iterative type computations searching for roots of equations in a single variable solution of simultaneous equations function approximation and interpolation numerical integration and differentiation matrix eigenvalue problems solution of nonlinear system of equations and solution of ordinary and partial differential equations *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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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 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

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

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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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