

MATLAB SOLUTIONS TO THE CHEMICAL ENGINEERING PROBLEM SET

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INTRODUCTION

These solutions are for a set of numerical problems in chemical engineering. The problems were developed by Professor Michael B. Cutlip of the University of Connecticut and Professor Mordechai Shacham of Ben-Gurion University of the Negev for the ASEE Chemical Engineering Summer School held in Snowbird, Utah in August, 1997. The problem statements are provided in another document.¹ Professors Cutlip and Shacham provided a document which shows how to solve the problems using POLYMATH, Professor Eric Nuttall of the University of New Mexico provided solutions using Mathematica and Professor J. J. Hwalek provided solutions using Mathcad. After the conference, Professor Ross Taylor provided solutions in Maple, and Edward Rosen provided solutions in EXCEL. This paper gives the solution in MATLAB. All documents and solutions are available from <http://www.che.utexas/cache>.

These solutions are obtained using the version 5.0 of MATLAB Pro. Minor changes are needed to the files when using version 4.0 of MATLAB, mainly in the command giving the limits of integration when solving ordinary differential equations. The appropriate commands (changes from MATLAB 5.0) are given in the files as comments. The program MATLAB runs by executing commands, which can call files called m-files. Given below are the commands and m-files. The m-files are also available on a diskette. For ease in interpreting the text below, text is printed in Times font, whereas the MATLAB files are printed in Geneva font. Each problem is solved by setting the path for MATLAB (most easily done by opening the appropriate m-file, and issuing the command Prob_X. The m-file Prob_X.m may call other m-files, which are described below and are on the diskette. In the description below, any line beginning with a % is a comment.

The authors thank Professor Larry Ricker for helpful comments on the first draft of this paper.

¹ Copyright by the authors, 1997. Material can be copied for educational purposes in chemical engineering departments. Otherwise permission must be obtained from the authors.

² Joseph Brule just obtained his B.S. degree. Tae Han is a current undergraduate. Dr. John Widmann a recent Ph.D. graduate, and Bruce Finlayson is the Rehrberg Professor and Chair.

³ "The Use of Mathematical Software packages in Chemical Engineering", Michael B. Cutlip, John J. Hwalek, Eric H. Nuttall, Mordechai Shacham, Workshop Material from Session 12, Chemical Engineering Summer School, Snowbird, Utah, Aug., 1997.

Matlab Solutions To The Chemical Engineering Problem Set

**Kevin D. Dorfman, Prodrimos
Daoutidis**



Matlab Solutions To The Chemical Engineering Problem Set:

Numerical Methods with Chemical Engineering Applications Kevin D. Dorfman, Prodromos Daoutidis, 2017-01-11

Designed primarily for undergraduates but also graduates and practitioners this textbook integrates numerical methods and programming with applications from chemical engineering Combining mathematical rigor with an informal writing style it thoroughly introduces the theory underlying numerical methods its translation into MATLAB programs and its use for solving realistic problems Specific topics covered include accuracy convergence and numerical stability as well as stiffness and ill conditioning MATLAB codes are developed from scratch and their implementation is explained in detail all while assuming limited programming knowledge All scripts employed are downloadable and built in MATLAB functions are discussed and contextualised Numerous examples and homework problems from simple questions to extended case studies accompany the text allowing students to develop a deep appreciation for the range of real chemical engineering problems that can be solved using numerical methods This is the ideal resource for a single semester course on numerical methods as well as other chemical engineering courses taught over multiple semesters

Numerical Methods for Chemical Engineering Kenneth J. Beers, 2007 Applications of numerical mathematics and scientific computing to chemical engineering

Numerical Methods for Chemical Engineers with MATLAB Applications A. Constantinides, Navid Mostoufi, 1999 Master numerical methods using MATLAB today's leading software for problem solving This complete guide to numerical methods in chemical engineering is the first to take full advantage of MATLAB's powerful calculation environment Every chapter contains several examples using general MATLAB functions that implement the method and can also be applied to many other problems in the same category The authors begin by introducing the solution of nonlinear equations using several standard approaches including methods of successive substitution and linear interpolation the Wegstein method the Newton Raphson method the Eigenvalue method and synthetic division algorithms With these fundamentals in hand they move on to simultaneous linear algebraic equations covering matrix and vector operations Cramer's rule Gauss methods the Jacobi method and the characteristic value problem Additional coverage includes Finite difference methods and interpolation of equally and unequally spaced points Numerical differentiation and integration including differentiation by backward forward and central finite differences Newton Cotes formulas and the Gauss Quadrature Two detailed chapters on ordinary and partial differential equations Linear and nonlinear regression analyses including least squares estimated vector of parameters method of steepest descent Gauss Newton method Marquardt Method Newton Method and multiple nonlinear regression The numerical methods covered here represent virtually all of those commonly used by practicing chemical engineers The focus on MATLAB enables readers to accomplish more with less complexity than was possible with traditional FORTRAN For those unfamiliar with MATLAB a brief introduction is provided as an Appendix Over 60 MATLAB examples methods and function scripts are covered and all of them are included on the book's CD

Problem Solving in Chemical and Biochemical

Engineering with POLYMATH, Excel, and MATLAB Michael B. Cutlip, Mordechai Shacham, 2008 Problem Solving in Chemical and Biochemical Engineering with POLYMATH Excel and MATLAB Second Edition is a valuable resource and companion that integrates the use of numerical problem solving in the three most widely used software packages POLYMATH Microsoft Excel and MATLAB Recently developed POLYMATH capabilities allow the automatic creation of Excel spreadsheets and the generation of MATLAB code for problem solutions Students and professional engineers will appreciate the ease with which problems can be entered into POLYMATH and then solved independently in all three software packages while taking full advantage of the unique capabilities within each package The book includes more than 170 problems requiring numerical solutions This greatly expanded and revised second edition includes new chapters on getting started with and using Excel and MATLAB It also places special emphasis on biochemical engineering with a major chapter on the subject and with the integration of biochemical problems throughout the book

General Topics and Subject Areas Organized by Chapter

Introduction to Problem Solving with Mathematical Software Packages Basic Principles and Calculations Regression and Correlation of Data Introduction to Problem Solving with Excel Introduction to Problem Solving with MATLAB Advanced Problem Solving Techniques Thermodynamics Fluid Mechanics Heat Transfer Mass Transfer Chemical Reaction Engineering Phase Equilibrium and Distillation Process Dynamics and Control Biochemical Engineering Practical Aspects of Problem Solving Capabilities Simultaneous Linear Equations Simultaneous Nonlinear Equations Linear Multiple Linear and Nonlinear Regressions with Statistical Analyses Partial Differential Equations Using the Numerical Method of Lines Curve Fitting by Polynomials with Statistical Analysis Simultaneous Ordinary Differential Equations Including Problems Involving Stiff Systems Differential Algebraic Equations and Parameter Estimation in Systems of Ordinary Differential Equations The Book s Web Site <http://www.problemsolvingbook.com> Provides solved and partially solved problem files for all three software packages plus additional materials Describes discounted purchase options for educational version of POLYMATH available to book purchasers Includes detailed selected problem solutions in Maple Mathcad and Mathematica

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 *Applied Mathematical Methods for Chemical Engineers* Norman W. Loney,2016-03-09 This book uses worked examples to showcase several mathematical methods that are essential to solving real world process engineering problems The third edition includes additional examples related to process control Bessel Functions and contemporary areas such as drug delivery The author inserts more depth on specific applications such as nonhomogeneous cases of separation of variables adds a section on special types of matrices such as upper and lower triangular matrices incorporates examples related to biomedical engineering applications and expands the problem sets of numerous chapters **Introduction to Chemical Engineering Computing** Bruce A. Finlayson,2014-03-05 Step by step instructions enable chemical engineers to master key software programs and solve complex problems Today both students and professionals in chemical engineering must solve increasingly complex problems dealing with refineries fuel cells microreactors and pharmaceutical plants to name a few With this book as their guide readers learn to solve these problems using their computers and Excel MATLAB Aspen Plus and COMSOL Multiphysics Moreover they learn how to check their solutions and validate their results to make sure they have solved the problems correctly Now in its Second Edition *Introduction to Chemical Engineering Computing* is based on the author s firsthand teaching experience As a result the emphasis is on problem solving Simple introductions help readers become conversant with each program and then tackle a broad range of problems in chemical engineering including Equations of state Chemical reaction equilibria Mass balances with recycle streams Thermodynamics and simulation of mass transfer equipment Process simulation Fluid flow in two and three dimensions All the chapters contain clear instructions figures and examples to guide readers through all the programs and types of chemical engineering problems Problems at the end of each chapter ranging from simple to difficult allow readers to gradually build their skills whether they solve the problems themselves or in teams In addition the book s accompanying website lists the core principles learned from each problem both from a chemical engineering and a computational perspective Covering a broad range of disciplines and problems within chemical engineering *Introduction to Chemical Engineering Computing* is recommended for both undergraduate and graduate students as well as practicing engineers who want to know how to choose the right computer software program and tackle almost any chemical engineering problem *Solving Problems in Scientific Computing Using Maple and MATLAB®* Walter Gander,Jiri Hrebicek,2004-06-07 Teaches problem solving using two of the most important mathematical software packages Maple and MATLAB This new edition contains five completely new chapters covering new developments *Proceedings of Sixth International Conference on Soft Computing for Problem Solving* Kusum Deep,Jagdish Chand Bansal,Kedar Nath Das,Arvind Kumar Lal,Harish Garg,Atulya K. Nagar,Millie Pant,2017-02-22 This two volume book gathers the proceedings of the Sixth International Conference on Soft Computing for Problem Solving SocProS 2016 offering a collection of research

papers presented during the conference at Thapar University Patiala India Providing a veritable treasure trove for scientists and researchers working in the field of soft computing it highlights the latest developments in the broad area of Computational Intelligence and explores both theoretical and practical aspects using fuzzy logic artificial neural networks evolutionary algorithms swarm intelligence soft computing computational intelligence etc

Chemical Engineering Computation with MATLAB® Yeong Koo Yeo,2017-08-01 Most problems encountered in chemical engineering are sophisticated and interdisciplinary Thus it is important for today s engineering students researchers and professionals to be proficient in the use of software tools for problem solving MATLAB is one such tool that is distinguished by the ability to perform calculations in vector matrix form a large library of built in functions strong structural language and a rich set of graphical visualization tools Furthermore MATLAB integrates computations visualization and programming in an intuitive user friendly environment Chemical Engineering Computation with MATLAB presents basic to advanced levels of problem solving techniques using MATLAB as the computation environment The book provides examples and problems extracted from core chemical engineering subject areas and presents a basic instruction in the use of MATLAB for problem solving It provides many examples and exercises and extensive problem solving instruction and solutions for various problems Solutions are developed using fundamental principles to construct mathematical models and an equation oriented approach is used to generate numerical results A wealth of examples demonstrate the implementation of various problem solving approaches and methodologies for problem formulation problem solving analysis and presentation as well as visualization and documentation of results This book also provides aid with advanced problems that are often encountered in graduate research and industrial operations such as nonlinear regression parameter estimation in differential systems two point boundary value problems and partial differential equations and optimization

Chemical Engineering Progress ,2008

Chemical Engineering Education ,2004 **Innovations in Engineering Education** ,2005 Basic Principles and Calculations in Chemical Engineering David M. Himmelblau,James B. Riggs,2012-05-31 The Number One Guide to Chemical Engineering Principles Techniques Calculations and Applications Now Even More Current Efficient and Practical Basic Principles and Calculations in Chemical Engineering Eighth Edition goes far beyond traditional introductory chemical engineering topics presenting applications that reflect the full scope of contemporary chemical petroleum and environmental engineering Celebrating its fiftieth Anniversary as the field s leading practical introduction it has been extensively updated and reorganized to cover today s principles and calculations more efficiently and to present far more coverage of bioengineering nanoengineering and green engineering Offering a strong foundation of skills and knowledge for successful study and practice it guides students through formulating and solving material and energy balance problems as well as describing gases liquids and vapors Throughout the authors introduce efficient consistent student friendly methods for solving problems analyzing data and gaining a conceptual application based understanding of modern chemical engineering

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Numerical Techniques for Chemical and Biological Engineers Using MATLAB® Said S.E.H. Elnashaie, Frank Uhlig, Chadia Affane, 2007 This book addresses the bifurcation characteristics of chemical and biological processes as the general case and treats systems with a unique steady as special cases Back cover

Advanced Research on Industry, Information System and Material Engineering, IISME2011 Helen Zhang, Gang Shen, David Jin, 2011-02-21 Selected peer reviewed papers from the 2011 International Conference on Industry Information System and Material Engineering IISME 2011 April 16 17 2011 Guangzhou China

MATLAB Applications in Chemical Engineering Chyi-Tsong Chen, 2022-05-20 This book addresses the applications of MATLAB and Simulink in the solution of chemical engineering problems By classifying the problems into seven different categories the author organizes this book as follows Chapter One Solution of a System of Linear Equations Chapter Two Solution of Nonlinear Equations Chapter Three Interpolation Differentiation and Integration Chapter Four Numerical Solution of Ordinary Differential Equations Chapter Five Numerical solution of Partial Differential Equations Chapter Six Process Optimization Chapter Seven Parameter Estimation Each chapter is arranged in four major parts In the first part the basic problem patterns that can be solved with MATLAB are presented The second part describes how to apply MATLAB commands to solve the formulated problems in the field of chemical engineering In the third and the fourth parts exercises and summary of MATLAB instructions are provided respectively The description of the chemical engineering example follows the sequence of problem formulation model analysis MATLAB program design execution results and discussion In this way learners are first aware of the basic problem patterns and the underlying chemical engineering principles followed by further familiarizing themselves with the relevant MATLAB instructions and programming skills Readers are encouraged to do exercises to practice their problem solving skills and deepen the fundamental knowledge of chemical engineering and relevant application problems The table of contents is listed below

Chapter 1 Solution of a System of Linear Equations 1 1 1 Properties of linear equation systems and the relevant MATLAB commands 1 1 2 Chemical engineering examples 10 1 3 Exercises 43 1 4 Summary of the MATLAB commands related to this chapter 48

Chapter 2 Solution of Nonlinear Equations 51 2 1 Relevant MATLAB commands and the Simulink solution interface 51 2 2 Chemical engineering examples 70 2 3 Exercises 103 2 4 Summary of MATLAB commands related to this chapter 122

Chapter 3 Interpolation Differentiation and Integration 125 3 1 Interpolation commands in MATLAB 125 3 2 Numerical differentiation 131 3 3 Numerical integration 153 3 4 Chemical engineering examples 157 3 5 Exercises 183 3 6 Summary of the MATLAB commands related to this chapter 195

Chapter 4 Numerical Solution of Ordinary Differential Equations 197 4 1 Initial value problems for ordinary differential equations 197 4 2 Higher order ordinary differential equations 222 4 3 Stiff differential equations 227 4 4 Differential algebraic equation system 232 4 5 Boundary valued ordinary differential equations 236 4 6 Chemical engineering examples 254 4 7 Exercises 285 4 8 Summary of the MATLAB commands related to this chapter 308

Chapter 5 Numerical Solution of Partial Differential Equations 311 5 1 Classifications

of PDEs 311 5 2 The MATLAB PDE toolbox 316 5 3 Chemical engineering examples 341 5 4 Exercises 388 5 5 Summary of the MATLAB commands related to this chapter 397 Chapter 6 Process Optimization 399 6 1 The optimization problem and the relevant MATLAB commands 399 6 2 Chemical engineering examples 448 6 3 Exercises 481 6 4 Summary of the MATLAB commands related to this chapter 501 Chapter 7 Parameter Estimation 503 7 1 Parameter estimation using the least squares method 503 7 2 Chemical engineering examples 517 7 3 Exercises 549 7 4 Summary of the MATLAB commands related to this chapter 560 References 563 Index 569

Introductory Chemical Engineering Thermodynamics J.
Richard Elliott, Carl T. Lira, 2012-02-06 A Practical Up to Date Introduction to Applied Thermodynamics Including Coverage of Process Simulation Models and an Introduction to Biological Systems Introductory Chemical Engineering Thermodynamics Second Edition helps readers master the fundamentals of applied thermodynamics as practiced today with extensive development of molecular perspectives that enables adaptation to fields including biological systems environmental applications and nanotechnology This text is distinctive in making molecular perspectives accessible at the introductory level and connecting properties with practical implications Features of the second edition include Hierarchical instruction with increasing levels of detail Content requiring deeper levels of theory is clearly delineated in separate sections and chapters Early introduction to the overall perspective of composite systems like distillation columns reactive processes and biological systems Learning objectives problem solving strategies for energy balances and phase equilibria chapter summaries and important equations for every chapter Extensive practical examples especially coverage of non ideal mixtures which include water contamination via hydrocarbons polymer blending recycling oxygenated fuels hydrogen bonding osmotic pressure electrolyte solutions zwitterions and biological molecules and other contemporary issues Supporting software in formats for both MATLAB and spreadsheets Online supplemental sections and resources including instructor slides ConcepTests coursecast videos and other useful resources

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Table of Contents Matlab Solutions To The Chemical Engineering Problem Set

1. Understanding the eBook Matlab Solutions To The Chemical Engineering Problem Set
 - The Rise of Digital Reading Matlab Solutions To The Chemical Engineering Problem Set
 - Advantages of eBooks Over Traditional Books
2. Identifying Matlab Solutions To The Chemical Engineering Problem Set
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Matlab Solutions To The Chemical Engineering Problem Set
 - User-Friendly Interface
4. Exploring eBook Recommendations from Matlab Solutions To The Chemical Engineering Problem Set
 - Personalized Recommendations
 - Matlab Solutions To The Chemical Engineering Problem Set User Reviews and Ratings
 - Matlab Solutions To The Chemical Engineering Problem Set and Bestseller Lists

5. Accessing Matlab Solutions To The Chemical Engineering Problem Set Free and Paid eBooks
 - Matlab Solutions To The Chemical Engineering Problem Set Public Domain eBooks
 - Matlab Solutions To The Chemical Engineering Problem Set eBook Subscription Services
 - Matlab Solutions To The Chemical Engineering Problem Set Budget-Friendly Options
6. Navigating Matlab Solutions To The Chemical Engineering Problem Set eBook Formats
 - ePub, PDF, MOBI, and More
 - Matlab Solutions To The Chemical Engineering Problem Set Compatibility with Devices
 - Matlab Solutions To The Chemical Engineering Problem Set Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Matlab Solutions To The Chemical Engineering Problem Set
 - Highlighting and Note-Taking Matlab Solutions To The Chemical Engineering Problem Set
 - Interactive Elements Matlab Solutions To The Chemical Engineering Problem Set
8. Staying Engaged with Matlab Solutions To The Chemical Engineering Problem Set
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Matlab Solutions To The Chemical Engineering Problem Set
9. Balancing eBooks and Physical Books Matlab Solutions To The Chemical Engineering Problem Set
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Matlab Solutions To The Chemical Engineering Problem Set
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Matlab Solutions To The Chemical Engineering Problem Set
 - Setting Reading Goals Matlab Solutions To The Chemical Engineering Problem Set
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Matlab Solutions To The Chemical Engineering Problem Set
 - Fact-Checking eBook Content of Matlab Solutions To The Chemical Engineering Problem Set
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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