

# Book Updates

(Last updated September 27, 2005)

From the Introduction of this text:

This text is not meant to replace traditional texts on numerical analysis, matrix algebra and partial differential equations. It does develop topics in these areas as is needed and also includes modeling and computation, and so, there is more breadth and less depth in these topics.

The text is organized so that students with multivariable calculus and elements of programming, physics and matrices can complete the first four chapters in approximately 24 75-minute lectures. One objective was to discuss three dimensional and nonlinear models in the fourth chapter. Therefore, many topics in the traditional courses related to numerical analysis, matrix algebra and partial differential equations have been deleted. This does raise some issues regarding “breath versus depth”, which I will try to discuss in the additional materials sections in this book update.

## Chapter 1.

### Errata

Page Number	Old Text	Corrected Text
12, line -16	step from increases	step increases from
48, table 1.6.2, row 3	1/40 1/60	1/40 1/80
48, table 1.6.2, row 4	1/40 1/80	1/40 1/160
46, line -7	Table 1.6.14	Table 1.6.2
46, line -5	Table 1.6.15	Table 1.6.3

### Clarifications

### Additional Material

The explicit method is used in sections 1.1-1.4 for one-space dimensional models. The implicit method is not discussed until section 4.5, and there the stability is not analyzed. This is due to the lack a matrix algebra prerequisite, which discusses eigenvalues and their role in iterative methods. Section 1.5 introduces two-dimensional models and graphical representations of solutions; this seems to be more interesting to the students and is early in the course. On the other hand, section 1.6 has convergence depicted in tables, graphs and theoretical analysis.

## Chapter 2.

### Errata

Page Number	Old Text	Corrected Text
52, example 1		Lost column “[ $x_1$ $x_2$ ] <sup>T</sup> ”
52, example 2		Lost column “[ $x_1$ $x_2$ ] <sup>T</sup> ”
53, example 5	row 1, column 3 was “1”	row 1, column 3 is “3”
54, eq. (2.1.4)	$du_0$	- $du_0$
61, line 8	$L = E_1 E_2$	$L = E_1^{-1} E_2^{-1}$
87, line 5	$\leq$	=

### Clarifications

In the examples on page 101 for the Jacobi and Gauss-Seidel methods the equations for  $i = 1, 2$  and  $3$  should be explicitly written. The  $3 \times 1$  vector notation is too terse for the first time exposure to these methods.

### Additional Material

Sections 2.1-2.3 introduce algebraic systems and the tridiagonal algorithm is described. Next the Schur complement is introduced and applied to two-space dimension problems. In section 2.5 the infinity norm is defined and used in the subsequent convergence analyses. The restriction to a single norm is somewhat limiting, but it still allows one give some stability analysis of the problem being considered in this text.

## Chapter 3.

### Errata

Page Number	Old Text	Corrected Text

### Clarifications

### Additional Material

Sections 3.5 and 3.6 give a very brief introduction to the conjugate gradient method. The author emphasizes the modeling aspects of the minimum energy description of the steady state membrane problem. This is used as motivation for the steepest descent, conjugate gradient and generalized minimum residual methods. Additional material can be found in Chapter 9

## Chapter 4.

### Errata

Page Number	Old Text	Corrected Text
160, eq. (4.3.2)	$-(K(u)u_x)_x$	$-(K(u)u_x)_x$

### Clarifications

Section 4.3 uses the PCG to approximate the solution of the linear solve in the Picard iterative method. The coefficient matrix  $A(u^m)$  may not be a symmetric positive definite matrix, and therefore, the convergence of the PCG may or may not happen (see Chapter 9). Fortunately, in this case the residual does tend to zero in small number of PCG iterations. The interested reader will find it instructive to replace the linear solve step by SOR or GMRES.

### Additional Material

Sections 4.1-4.3 discuss some elementary nonlinear problems. More complicated nonlinear problems are presented in Chapter 5. Three-dimensional problems are given in sections 4.4-4.5. Here the need for high performance computing is probed.

## Chapter 5.

### Errata

Page Number	Old Text	Corrected Text

### Clarifications

The three applications in this chapter are terse introductions to similar models with diffusion like terms. The author usually concludes the one semester course with a single lecture on each application. Often students have done additional projects on one of these important applications.

### Additional Material

Sections 5.3 and 5.4 contain a terse introduction to image restorations. Eight lectures on “The Mathematics of Visualization”, which only require multivariable calculus, can be found at the www site for Math 325 “An Introduction to Applied Mathematics” at NCSU:

<http://www4.ncsu.edu/eos/users/w/white/www/white/ma325.htm>

Students have found these lectures to be very interesting, and like this text there are a number of Matlab codes that illustrate image enhancement including lightness, contrast, blurring and sharpening. The rudiments of the fast Fourier transform and filters are introduced.

## Chapter 6.

### Errata

Page Number	Old Text	Corrected Text

## Clarifications

Chapter 6 along with the section 4.6 should be considered as an introduction to parallel computing. Several programming languages and parallel computers are described. Of course, these evolve and are soon outdated, so that this introduction soon becomes a historical narrative. Message passing interface, MPI, seems to have matured with a number of its subroutines being routinely used for parallel coding. Consequently, MPI is discussed at more length in the subsequent chapters.

## Additional Material

### Chapter 7.

#### Errata

Page Number	Old Text	Corrected Text
277, line 3	mpi_rev()	mpi_recv()
289, line -4	source	dest
299, line 6	mpi_pack(..., packarray,position,...)	mpi_pack(..., packarray,packcount,position,...)
299, line 15	count	packcount
299, line 16	mpi_unpack(..., locdata,position,...)	mpi_unpack(..., locdata,count,position,...)

## Clarifications

## Additional Material

### Chapter 8.

#### Errata

Page Number	Old Text	Corrected Text

## Clarifications

## Additional Material

### Chapter 9.

#### Errata

Page Number	Old Text	Corrected Text
346, line -1	$K_m \equiv \{ \dots \}$	$K_m = \{ \dots \}$
347, line 6	... this let	... this, let
349, line 7	$)A(x-x^0)$	$) A)(x-x^0)$
350, line 14	Theorem 9.1.1	Theorem 9.1.2
363, line 8	$[ \dots ] = [ \dots ] [ \dots r_{nm} ]$	$[ \dots ] = [ \dots ] [ \dots r_{mm} ]$
369, lines 3 and 4	$H(1:m,1:m)$	$H(1:m,1:m)$

## Clarifications

## Additional Material