

CONTENTS

Changes from Earlier Versions	3
1 Introduction	5
2 Discrete Ill-Posed Problems and their Regularization	9
2.1 Discrete Ill-Posed Problems	9
2.2 Regularization Methods	11
2.3 SVD and Generalized SVD	13
2.3.1 The Singular Value Decomposition	13
2.3.2 The Generalized Singular Value Decomposition	14
2.4 The Discrete Picard Condition and Filter Factors	16
2.5 The L-Curve	18
2.6 Transformation to Standard Form	21
2.6.1 Transformation for Direct Methods	21
2.6.2 Transformation for Iterative Methods	22
2.6.3 Norm Relations etc.	24
2.7 Direct Regularization Methods	25
2.7.1 Tikhonov Regularization	25
2.7.2 Least Squares with a Quadratic Constraint	25
2.7.3 TSVD, MTSVD, and TGSVD	26
2.7.4 Damped SVD/GSVD	27
2.7.5 Maximum Entropy Regularization	28
2.7.6 Truncated Total Least Squares	29
2.8 Iterative Regularization Methods	29
2.8.1 Conjugate Gradients and LSQR	29
2.8.2 Bidiagonalization with Regularization	32
2.8.3 The ν -Method	33
2.8.4 Extension to General-Form Problems	33
2.9 Methods for Choosing the Regularization Parameter	34
2.10 New Functions in Version 4.0	36

3	Regularization Tools Tutorial	39
3.1	The Discrete Picard Condition	39
3.2	Filter Factors	40
3.3	The L-Curve	41
3.4	Regularization Parameters	42
3.5	Standard Form Versus General Form	43
3.6	No Square Integrable Solution	46
4	Regularization Tools Reference	47
	Routines by Subject Area	47
	The Test Problems	50
	Alphabetical List of Routines	51
	Bibliography	121