

SYMPOSIUM ON NUMERICAL MATHEMATICS

DURBAN, 18,19 & 20 JULY 1978



computer science department
university of natal
durban

SYMPOSIUM ON NUMERICAL MATHEMATICS

DURBAN, 18, 19 & 20 JULY 1978

ISBN 0-86980-174-0

Report number CS.07.03.07.78

Published by the Computer Science Department,
University of Natal, Durban 1978.

PREFACE

For the three days 18th - 20th July, 1978 over 35 people from four countries attended the fourth Symposium on Numerical Mathematics held at the University of Natal, Durban under the auspices of the Computer Science Department. These proceedings are published as a record of the papers presented, the intention being that these will eventually be published in final form elsewhere. In order to speed up the publication of the proceedings all papers and abstracts are published in the form in which they were received from authors.

Invited papers were read by Professor A.R. Mitchell, University of Dundee, Scotland, Professor P. Rabinowitz, The Weizman Institute of Science, Rehovot, Israel and Professor W. Wetterling, Technische Hogeschool Twente, Enschede, Netherlands. The support of IBM South Africa, the South African Mathematical Society and the South African Council for Scientific and Industrial Research, the University of the Witwatersrand and the University of Natal for making these invitations possible is gratefully acknowledged.

The assistance of Mrs. Pat Duminy of the Publicity Office of the University of Natal and Mrs. Thea Dixon of the Computer Science Department in organising the symposium is greatly appreciated.

G.R. Joubert.

PARTICIPANTS

- S. Adali (CSIR, Pretoria)
 M.L. Baart (CSIR, Pretoria)
 G.N. Bakkes (University of the Orange Free State, Bloemfontein)
 J.F. Botha (University of the Orange Free State, Bloemfontein)
 M. Brannigan (CSIR, Pretoria)
 G.B. Brundrit (University of Cape Town, Cape Town)
 K.N. Greggor (CSIR, Pretoria)
 J.W. Hearne (University of Zululand, Kwa-Dlangezwa)
 W.D. Heiss (CSIR, Pretoria)
 B.M. Herbst (University of the Orange Free State, Bloemfontein)
 T. Hoption (University of Natal, Durban)
 D.A. Hunter (University of Natal, Pietermaritzburg)
 G.R. Joubert (University of Natal, Durban)
 D.P. Laurie (CSIR, Pretoria)
 M.W. Mackay (University of Natal, Durban)
 J. MacKinnon (University of Stellenbosch, Stellenbosch)
 D.H. Martin (CSIR, Pretoria)
 A.R. Mitchell (University of Dundee, Scotland)
 J.J. Murphy (Ucor, Pelindaba)
 I.M. Navon (CSIR, Pretoria)
 J.D. Neethling (AEB, Pretoria)
 A.P. Peirce (University of the Orange Free State, Bloemfontein)
 S. Piper (University of Natal, Durban)
 P. Rabinowitz (The Weizman Institute of Science, Rehovot, Israel)
 J.E. Radue (University of Natal, Durban)
 H.A. Riphagen (CSIR, Pretoria)
 R. Rösel (CSIR, Pretoria)
 C.H. Rohwer (University of Zululand, Kwa-Dlangezwa)
 S.W. Schoombie (University of the Orange Free State, Bloemfontein)
 J.A. Snyman (University of Pretoria, Pretoria)
 I.M. Snyman (UNISA, Pretoria)
 D.J. van Wyk (Potchefstroom University for C.H.E., Potchefstroom)
 F. Verardi (CSIR, Pretoria)
 H.R. Weistroffer (University of Natal, Durban)
 W. Wetterling (Technische Hogeschool Twente, Enschede, Netherlands)
 C.J. Wright (University of the Witwatersrand, Johannesburg)

CONTENTS

	<u>Page</u>
Preface	iii
Participants	iv
First and second order conditions for local extrema in optimization and approximation by W. Wetterling	1
Numerical solution to a non-linear eigenvalue problem by J.A. Snyman and P.J. Vermeulen	5
A note on the θ -method for solving parabolic partial differential equations by J.F. Botha and G.N. Bakkes	7
A penalty-function method for solving constrained non-linear optimization problems by H.R. Weistroffer	9
The finite element method in partial differential equations by A.R. Mitchell	17
Avoiding the singularity in numerical integration by F. Rabinowitz	23
The iterative solution of the Poisson equation for the Thomas-Fermi atom by J.D. Neethling	39
Possibility of extrapolation applied to elliptic systems by J. MacKinnon and J.D. Neethling	41
Steepest descent method applied to optimal shape problems by S. Adali and T. Speer	51
The numerical evaluation of Cauchy principal value integrals by P. Rabinowitz	53
Connections between certain solution methods for Fredholm integral equations of the first kind by M.L. Baart	83
Special functions and convergence acceleration by D.P. Laurie	89
Routines for solving very large least-squares problems by K.N. Greggor	95
The strict Chebyshev solution of overdetermined systems of linear equations with rank deficient matrix by M. Brannigan	121
Difference methods for the numerical solution of the two dimensional diffusion equation by T. Hopton and G.R. Joubert	123
A survey on the use of reachable sets in the computation of optimal controls by F. Verardi	137
Overdetermined eigenvalue problems by W. Wetterling	151
Galerkin methods in conduction - convection problems by A.R. Mitchell	155
An introduction to the collocation method applied to a parabolic equation in two space dimensions by B.M. Herbst and J.F. Botha	161
Fourth-order compact ADI methods for the shallow-water equations by I.M. Navon	163
Error estimates for the solution of the radial Schrödinger equation by the finite element method by S.W. Schoombie and J.F. Botha	165
Recurrent relations in parallel numerical mathematics by U. Schendel	175
Padé approximants for the solvent of self-adjoint operators by W.D. Heiss	183
Nonlinear constrained function minimisation using Powell's Algorithm (NS01A) by S.E. Piper and W.J.T. Greening	193
Smoothing and filtering in numerical weather prediction by H.A. Riphagen	211