

# THE ROYAL SOCIETY OF EDINBURGH



## PROCEEDINGS

Section **A** (Mathematics)

ISSN 0308-2105

PUBLISHED BY THE ROYAL SOCIETY OF EDINBURGH  
22 GEORGE STREET, EDINBURGH, EH22PQ

1976

# EDITORIAL BOARD

## Executive Editors

Professor W. D. COLLINS  
University of Sheffield

Professor W. N. EVERITT  
University of Dundee

Professor A. JEFFREY  
University of Newcastle upon Tyne

Professor J. DUNCAN  
University of Stirling

Professor D. C. PACK  
University of Strathclyde

Professor A. ERDÉLYI  
University of Edinburgh

Professor E. M. PATTERSON  
University of Aberdeen

Professor D. S. JONES  
University of Dundee

Professor R. A. RANKIN  
University of Glasgow

Dr J. B. McLEOD  
University of Oxford

Dr F. SMITHIES  
University of Cambridge

Professor I. N. SNEDDON  
University of Glasgow

Dr A. E. RITCHIE  
*General Secretary*  
Royal Society of Edinburgh

W. H. RUTHERFORD  
*Executive Secretary*  
Royal Society of Edinburgh

---

## Consulting Editors

Professor F. M. ARSCOTT  
University of Manitoba

Professor A. M. MACBEATH  
University of Birmingham

Professor F. V. ATKINSON  
University of Toronto

Professor Dr E. MEISTER  
Technical University of Darmstadt,  
Germany (FDR)

Professor R. CONTI  
Istituto Matematico, Firenze

Professor ÅKE PLEJEL  
University of Uppsala, Sweden

Dr W. A. COPPEL  
Australian National University

Professor A. P. ROBERTSON  
University of Western Australia,  
Nedlands, Australia

Dr M. S. P. EASTHAM  
Chelsea College, London

Professor G.-C. ROTA  
Massachusetts Institute of Technology,  
USA

Professor D. E. EDMUNDS  
University of Sussex

Professor S. M. SHAH  
University of Kentucky, Lexington,  
Kentucky, USA

Professor AVNER FRIEDMAN  
Northwestern University, Evanston,  
Illinois, USA

Professor J. K. HALE  
Brown University, Providence, RI, USA

Professor Dr F. STUMMEL  
Johann Wolfgang-Goethe University,  
Frankfurt am Main, Germany (FDR)

Professor P. R. HALMOS  
University of Indiana, Bloomington,  
USA

Professor Dr E. M. DE JAGER  
University of Amsterdam

Professor F. URSELL  
University of Manchester

Professor TOSIO KATO  
University of California, Berkeley, USA

Professor J. WERMER  
Brown University, Providence, RI, USA

PROCEEDINGS  
OF THE  
ROYAL SOCIETY OF EDINBURGH

PROCEEDINGS  
OF  
THE ROYAL SOCIETY  
OF EDINBURGH

Section A (Mathematics)

VOL. 75

1975–1976

PUBLISHED BY  
THE ROYAL SOCIETY OF EDINBURGH  
22 GEORGE STREET  
EDINBURGH EH2 2PQ

1976

# CONTENTS

NO.		PAGE
1	An algorithm for the construction of limit circle expressions. By A. ZETTL . . . . .	1
2*	The matrix functional differential expression $y'(x) = Ay(\lambda x) + By(x)$ . By J. CARR and J. DYSON . . . . .	5
3*	A note on projective modules. By P. F. SMITH . . . . .	23
4*	An algorithm for the construction of all disconjugate operators. By A. ZETTL . . . . .	33
5	Semi-bounded Dirichlet integrals and the invariance of the essential spectra of self-adjoint operators. By W. D. EVANS . . . . .	41
6	Oscillation theory for semilinear Schrödinger equations and inequalities. By E. S. NOUSSAIR and C. A. SWANSON . . . . .	67
7*	Acoustic diffraction by an absorbing semi-infinite plane in a moving fluid. By A. D. RAWLINS . . . . .	83
8*	Constructive methods for solving the exterior Neumann problem for the reduced wave equation in a spherically symmetric medium. By D. COLTON and W. WENDLAND . . . . .	97
9	Bivariational bounds associated with non-self-adjoint linear operators. By M. F. BARNESLEY and P. D. ROBINSON . . . . .	109
10*	Norm inequalities for $C^*$ -algebras. By J. DUNCAN and P. J. TAYLOR . . . . .	119
11	Equations d'évolution du second ordre associées à des operateurs maximaux monotones. By L. VÉRON . . . . .	131
12	Rotation properties of adjoint pairs of differential systems. By K. KREITH . . . . .	149
13*	Some integral inequalities. By E. T. COPSON . . . . .	157
14*	Global non-existence of solutions to Ladyzhenskaya's variants of the Navier-Stoke equations backwards in time. By B. STRAUGHAN . . . . .	165
15*	The inversion of an augmented information matrix occurring in factor analysis. By D. N. LAWLEY . . . . .	171
16	A remark on a paper by J. F. Toland and some applications to unilateral problems. By JOÃO-PAULO DIAS and JESÚS HERNÁNDEZ . . . . .	179
17	An upper bound for the largest zero of Hermite's function with applications to subharmonic functions. By W. K. HAYMAN and E. L. ORTIZ . . . . .	183
18	An inequality of C. R. Putnam involving a Dirichlet functional. By D. B. SEARS and S. D. WRAY . . . . .	199
19	Propagation of weak discontinuities in a layered hyperelastic half space. By ERDOGAN S. SUHUBI and ALAN JEFFREY . . . . .	209
20	Functional differential equations and non-linear evolution operators. By JANET DYSON and ROSANNA VILLELLA BRESSAN . . . . .	223

NO.		PAGE
21*	The structure of certain ordered regular semigroups. By T. S. BLYTH . . . . .	235
22	The linear transport equation. The degenerate case $c = 1$ . I. Full-range theory. By C. G. LEKKERKERKER . . . . .	259
23	The linear transport equation. The degenerate case $c = 1$ . II. Half-range theory. By C. G. LEKKERKERKER . . . . .	283
24*	Mean-square convergence of non-harmonic trigonometrical series. By J. COSSAR . . . . .	297
25*	On the eigenfunction expansion associated with a singular complex-valued fourth-order differential equation. By JYOTI CHAUDHURI and V. KRISHNA KUMAR . . . . .	325
26	On Shapiro's cyclic inequality. By P. J. BUSHELL and A. H. CRAVEN . . . . .	333

\* The thanks of the Society are due to the Carnegie Trust for the Universities of Scotland for a grant towards the cost of these papers.