

# Lecture Notes in Mathematics

Edited by A. Dold and B. Eckmann

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Equadiff 6

Proceedings, Brno 1985

Edited by J. Vosmanský and M. Zlámal



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Proceedings of the International Conference  
on Differential Equations and their Applications  
held in Brno, Czechoslovakia, Aug. 26–30, 1985

Edited by J. Vosmanský and M. Zlámal



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## Editors

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## PREFACE

Following the tradition of the previous Conference EQUADIFF 1-5, held periodically in Prague (1962, 1977), Bratislava (1966, 1981) and Brno (1972), The 6th Czechoslovak Conference on Differential Equations and Their Applications EQUADIFF 6 was held in Brno from August 26 to August 30, 1985. The Conference was organized by the University of J. E. Purkyně in Brno with support of the International Mathematical Union in cooperation with the Technical University in Brno, the Mathematical Institut of the Czechoslovak Academy of Sciences, Society of Czechoslovak Mathematicians and Physicists, sponsored by the Faculty of Mathematics and Physics of the Charles University in Prague, the Faculty of Mathematics and Physics of the Comenius University in Bratislava, the Czech Technical University in Prague, the Faculty of Science of the Palacký University in Olomouc, the Faculty of Science of the University of P. J. Šafárik in Košice, the School of Mechanical and Electrotechnical Engineering in Plzeň and the School of Transport and Communications in Žilina.

EQUADIFF 6 was prepared by the Organizing Committee president by M. Zlámal, chairman, and J. Vosmanský, executive secretary, with the help of the local organizing staff.

The topic of this meeting were differential equations in the broad sense including numerical methods of their solutions and applications. The main goal was to stimulate cooperation among various branches in differential equations.

The Conference was attended by 473 participants (207 from Czechoslovakia, 266 from abroad) and 62 accompanying persons from 31 countries. 36 participants from abroad were granted the financial support.

92 invited mathematicians from abroad took part in the Conference and together with Czechoslovak scientists delivered plenary lectures and other invited lectures and communications in sections. The participants had the opportunity to deliver their papers as communications, at the poster session or in the form of the enlarged abstracts (without oral presentation).

The scientific program comprised 10 plenary lectures and 64 main lectures in the following sections:

- |                                    |      |
|------------------------------------|------|
| 1. Ordinary Differential Equations | (20) |
| 2. Partial Differential Equations  | (16) |
| 3. Numerical Methods               | (14) |
| 4. Applications                    | (14) |

In addition 251 papers were presented

- a) as communications in 9 simultaneous subsections (136)
- b) at the poster session (46)
- c) in the form of enlarged abstracts (70)

Besides the scientific program the participants and the accompanying persons could enjoy a rich social program.

Two slightly different parallel editions of this volume are published. The Springer-Verlag edition contains 9 plenary lectures and 48 main lectures in sections representing the substantial part of lectures presented at the Conference. The EQUADIFF 6 edition for the participants of the Conference and for the socialist countries contains also Supplement consisting of 7 additional contributions. These contributions are not fully compatible with the conditions for the Lecture Notes publication and their revised version could not be arranged.

#### Editors

## LIST OF FURTHER MAIN LECTURES PRESENTED AT THE CONFERENCE

- PLISS V.: Stable and unstable manifolds of hyperbolic systems (plenary lecture)  
 ATKINSON F. V.: Critical cases of certain ground-state problems for nonlinear wave equations  
 BOBROWSKI D.: Boundary-value problems for random differential equations  
 EVERITT W. N.: On linear ordinary quasi-differential equations  
 HEDBERG L. I.: Sobolev spaces and nonlinear potential theory  
 LAZAROV R.: Superconvergence of the gradient for triangular finite elements  
 MARKOWICH P.: The semiconductor device equations  
 MASLENNIKOVA V. N.: Boundary value problems for second order elliptic equations in domains having non-compact and non-smooth boundaries  
 PŮŽA B.: Ob odnom metode analiza razreshivosti kraevykh zadach dlja obyknovennykh differentsialnykh uravnenii  
 SELL G.: Lyapunov exponents and oscillatory behavior equations with negative feedback  
 SUSSMANN H. J.: A theory of envelopes and high order optimality condition for bang-bang controls

# LIST OF PAPERS PRESENTED AT THE CONFERENCE

## I. PAPERS PRESENTED AS COMMUNICATIONS IN SECTIONS

### A. Ordinary differential equations

- ANGELOV V.: A coincidence theorem in uniform spaces and applications  
 ANGELOVA D.: Asymptotic and oscillation properties on functional - differential equations  
 ANDRES J.: Higher kind periodic orbits  
 AUGUSTYNOWICZ A.: On the existence of continuous solutions of operator equations in Banach spaces  
 BERKOVIČ L. M.: A constructive approach in the theory of differential equations: Factorization and transformations  
 BIHARI I.: A second order nonlinear differential inequality  
 BRESQUAR A. M.: Asymptotic solutions for the oscillatory differential equation  
 BIANCHINI R. M., CONTI R.: Local and global controllability  
 ČADEK M.: Pointwise transformations of linear differential equations  
 DŁOTKO T.: Initial functions as controls  
 DOŠLÁ Z.: Differential equations and higher monotonicity  
 DOŠLÝ O.: Transformations of linear differential systems  
 ELBERT A.: Eigenvalue estimations for the half-linear second order differential equations  
 FENYŐ I.: On the interrodifferential equation  

$$x(t) + \lambda \int_0^{\infty} J_n(2\sqrt{tz}) (t/z)^{n/2} x^{(k)}(z) dz = F(t)$$
 FISHER A.: Almost periodic solutions of systems of linear and quasilinear differential equations with almost periodic coefficients and with time lag  
 FOFANA M. S.: The stability of a special differential equation  
 FOLTÝŇSKÁ I.: An oscillation of solutions of nonlinear integro-differential equations system  
 GARAY B. M.: Parallelizability in Banach spaces: Examples and counterexamples  
 GRAEF J. R., SPIKES P. W., ZHANG B. G.: Sufficient conditions for the oscillatory solutions of a delay differential equation to converge to zero  
 GREGUŠ M.: Nontrivial solutions of a nonlinear boundary value problem  
 HABETS P.: On periodic solutions of nonlinear second order differential equations  
 HADDOCK J.: Phase spaces for functional differential equations  
 HALICKÁ M.: Existence of regular synthesis for two classes of optimal control problems  
 HATVANI L.: A generalization of the invariance principle to nonautonomous differential systems  
 JAROŠ J.: Oscillation criteria for forced functional differential inequalities  
 KARTÁK K.: Generalized absolutely continuous solutions of ODE  
 KHEKIMOVA M.: Periodicheskie i kraevye zadachy dlya singulyarno vozmushchennykh sistem s impulsnym vozdeystvom

- KISIELEWICZ M.: Compactness and upper semicontinuity of solutions set of neutral functional - differential inclusions
- KRISZTIN T.: On the rate of decay of solutions of functional differential equations with unbounded delay
- KRUPKOVÁ O.: The inverse problem of the calculus of variations
- KULEV G., BAJNOV D.: „Prakticheskaya ustoichivost“ sistem s impulsnym vozdeistviem pri postoyano deĭstvuyushchik vozmushcheniyakh
- KÜPPER T.: Identification through forced bifurcation
- LAFORGIA A.: Turan - type inequalities for the zeros of the ultraspherical and laguerre polynomials
- LAITCHOVÁ J.: Global transformations of linear second order differential equations of a general form
- LALLI B.: Oscillatory behavior of nonlinear differential equations with deviating arguments
- MARUSIAK P.: Oscillation theorems for nonlinear differential systems with general deviating arguments
- MAKSIMOV V. P.: O nekotorykh novykh napravleniyakh razvitiya teorii nelinejnykh uravnenii s posledestviem
- MEHRI B.: A note on existence of a periodic solution for certain non-linear second order differential equation
- MÖLLER M.: Boundary-eigenvalue problems depending nonlinearly on the parameter
- MIHÁLIKOVÁ B.: O koleblemosti reshenii sistem differentsialnykh uravnenii
- MIKOLAJSKI J.: On nonoscillatory solutions of some systems of differential equations
- MIRONENKO V.: Reflective function of a system
- MOSON P.: Quasi-periodic solutions of 4-dimensional systems
- MULDOWNEY J. S.: The converse of Polya's mean value theorem
- OMARI P.: Periodic solutions of lineard equations (a joint work with F. ZANOLIN)
- PUDEI V.: Zum Problematik der Extremallösungen von linearen Differentialgleichungen n-ter Ordnung
- RONKOV A.: Linear inequalities for functions defined in partially ordered spaces
- SHKIL N. I.: About periodical solutions of systems of second order differential equations
- SCHAAF R.: Time maps and global solution branches
- SCHNEIDER K. R.: Integralmanifolds of periodic solutions of autonomous differential equations
- ŠIMŠA J.: Asymptotic integration of linear differential equations of order N under mild integral smallness conditions
- TERJÉKI J.: On the stability of solutions of functional differential equations with infinite delay
- VANDERBAUWHEDE A.: Bifurcation of subharmonic solutions in time reversible systems
- VOLKMANN P.: Un theoreme d'existence pour les equations integrales de Volterra dans les espaces de Banach
- VRDOLJAK B.: On solutions of the lagerstrom equation
- WYRWINSKA A.: Integrability of certain nonlinear differential equation with deviating arguments
- ZANOLIN F.: On a dynamical system in the Lienard plane



## B. *Partial differential equations*

- BIROLI M.: Wiener obstacles for  $\Delta^2$   
 BOJARSKI B.: Microlocal analysis of linear transmission problems  
 DLOTKO T.: Geometric description of quasilinear parabolic equations  
 DRÁBEK P.: Destabilizing effect of certain unilateral conditions for the system of reaction-diffusion type  
 DZIUK G.: A simple climate model  
 FILO J.: On a nonlinear diffusion equation with nonlinear boundary conditions: Method of lines  
 FILA M.: Connecting orbits in certain reaction diffusion equations  
 HEGEDŰS J.: Zadachi sopryazheniya dlya nekotorykh ellipticheskikh i giperbolicheskikh uravnenii  
 HUEBER H.: Dirichlets problem for some hypoelliptic differential operators  
 KAMONT Z.: Weak solutions of first order partial differential equations with a retarded argument  
 KAWOHL B.: Starshaped rearrangement and applications  
 KOLOMÝ J.: On accretive operators  
 LEWIS R. T.: The eigenvalues of elliptic differential operators  
 LORENZI A.: An inverse problem for a quasilinear parabolic equation in divergence form  
 MUSTONEN V.: Topological degree of mappings of monotone type and applications  
 NARAZAKI T.: Global classical solutions of semilinear evolution equation  
 NAUMANN J.: Liouville property and regularity for parabolic systems  
 NETUKA I.: The best harmonic approximation  
 ÓTANI M.: Existence and non-existence of non-trivial solutions of some nonlinear degenerate elliptic equations  
 PULTAR M.: Numerical methods of solution of hyperbolic equations  
 ROTHER W.: Generalized Thomas-Fermi-von Weizsäcker equations  
 SALVI R.: The equations of viscous incompressible non-homogenous fluids: On the existence and regularity  
 SHOPOLOV N.: The first boundary problem of a parabolic equation with arguments reversing their roles  
 SOKOLOWSKI J.: Differential stability of solutions to constrained optimization problems for p.d.e.  
 SPECK F.-O.: Boundary value problems for elliptic convolution type equations  
 SZULKIN A.: Minimax principles for lower semicontinuous functions and applications to elliptic boundary value problems  
 ŠVEC A.: Spectrum of spheres  
 TERSIAN S.: Characterizations of the range of Neumann problem for semilinear elliptic equations  
 TIBA D.: Control of nonlinear hyperbolic equations  
 TURO J.: A boundary value problem for quasilinear hyperbolic systems of differential-functional equations  
 VERHULST F.: The Galerkin-averaging method for a nonlinear Klein-Gordon equation

## C. *Numerical methods*

- AMIRALIEV G.: Towards the numerical solution of the system of Boussinesq equation

- BALLA K.: On error estimation of the approximative solution for certain singular differential equations of Riccati type
- BURDA P.: Finite element solution of a problem of potential flow
- DECHEWSKI L. T.: A method for error estimation of numerical solutions of differential equations
- ELSCHNER J.: On suboptimal convergence of finite element methods
- FRIVALDSZKY S.: Lineare und nichtlineare Mehrschrittverfahren mit variablen Koeffizienten
- FRÖHNER M.: Galerkin techniques and the method of lines applied to Burger's equation
- GUDOVICH N. N.: Ustoichivye raznostnye metody proizvoljnogo porjadka approximatitsii dlja differentsialnykh uravnenij
- HAN H.: Nonconforming finite element approximation of Navier-Stokes equations
- HEINRICH B.: On finite difference methods with fem-character for elliptic problems
- HLAVÁČEK I.: Shape optimization by the dual finite element method
- CHOW Y.-M.: Initial-value methods for computing eigenvalues of two point boundary value problem
- JOVANOVIČ B.:
- KRETZSCHMAR H.: Stabile zweischichte Differenzenverfahren
- PIRČ V.: On the possibility of calculation of zero points of solution of second order differential equations
- PRÁGER M.: Numerical illustration of the dimension reduction method
- PROESSDORF S.: Spline approximation methods for singular integral equations
- REGIŇSKÁ T.: Superconvergence of external approximation for two-point boundary value problems
- ROOS H.-G.: Feedback grid generation via monotone discretization
- SÄNDIG A.-M.: Fem error estimates for elliptic boundary value problems in domains with conical points
- SEGETH K.: On the numerical evaluation of integrals involving Bessel functions
- STANKIEWICZ R.: Approximate methods for temporally inhomogeneous parabolic equation
- STREHMEL K.: Stability of linear implicit methods for retarded differential equations
- TAUFER J., VITÁSEK E.: Transfer of boundary conditions for two-dimensional problems
- VULCHANOV N. L.: Numerical integration of asymptotic two-point boundary value problems for ODE
- WEINER R.: Partitioned adaptive Runge-Kutta methods for the solution of stiff and nonstiff differential equations

#### D. Applications

- ANTES H.: Dual complementary variational principles in Reissner's plate theory
- BECKERT H.: The bending of plates and their stability region
- BOCK I.: Optimal control problems for von
- BRILLA I.: Bifurcation theory of the time dependent Karman equations
- FARKAS M.: Competitive exclusion by zip bifurcation
- JARUŠEK J.: Optimalheating of bodies with constrains on stresses
- JEDRYGA T. M.: An estimation of moment of the solution of a random operator integral equation of Volterra's type
- LAMZYUK V.: Ob odnom metode svedeniya granichnykh zadach k nachal'nym i ego ispol'zovaniu pri reshenii zadach matematicheskoi fiziki

- LOVÍŠEK J.: Optimal control of a variational inequality  
 MARKO L.: Buckled states of circular plates  
 MOSZNER Z.: On pseudo-processes and their extensions  
 NEDOMA J.: Contact problem in thermoelasticity. Coercive case.  
 POLCAR P., KOTOUL M.: On the numerical solution of two-dimensional stress wave propagation problem  
 PETROV K.: Automodel of motion partial gaseous mixture in electric field  
 RUMPEL H.: Mathematische Modelle der Fluidmechanik  
 RŮŽIČKOVÁ H.: On the transport-diffusion algorithm  
 SKIERCZYNSKI B.: Application of the methods of the sensitivity analysis in obtaining the solution of nonlinear differential equations  
 SOBOTKA Z.: Solutions of ordinary non-homogeneous linear differential equations following from rheological models  
 STĚPÁN G.: Delay of reflexes in balancing  
 VRKOČ I.: Integral equations attached to skin effect

## II. PAPERS PRESENTED AT THE POSTER SESSION

- BARTUZEL S.: Variational approach to certain diffusion problem  
 BARVÍNEK E.: The spectral theorem for normal diagonable operators on a real Hilbert space  
 BÉDA P.: On some global properties of a predator-prey model  
 ČURGUS B.: Eigenfunction expansions associated with ordinary differential operators with an indefinite weight function  
 CHERKAS L. A.: Periodicheskie resheniya avtonomnoï sistemy s fazovym prostranstvom  
 DESPERAT T.: Difference methods for the solutions of differential-algebraic systems  
 FARAGO I.: Dvykhshagovyĭ a-ustoichivyĭ metod dlya resheniya zadachi khemosorbtsii  
 FARZAN R.: Zadacha rasprostraneniya elektromagnitnykh voln v sredakh o neodnorodnostyami  
 GERGÓ L.: Adaptive finite element methods  
 GÖPFERT A.: Approximation by solutions of elliptic equations  
 GRYSA K.: On use of a certain ordinary differential equation to finding the sums of Dini series  
 HOROVÁ I.: On the variational principles for Dirichlet boundary-value problem  
 INVERNIZZI S.: Nonuniform nonresonance for jumping nonlinearities  
 JANKOWSKI J.: Green function application to numerical solving boundary problems  
 JANOVSKÁ D., MAREK I.: About the monotonicity of temple quotiens  
 KAFKA J.: One aspect of the discretization of Maxwell's equations  
 KÁROLYI K.: Parameter estimation in problems of chemical reaction kinetics  
 KHUSAINOV D.: Ispolzovanie vtorogo metoda Lyapunova optimizatsii kriteriev kachestva funktsionirovaniya dinamicheskikh sistem  
 KOSTOVA T.: Qualitative behavior of the solution of a class of equations generalizing Michaelis-Menten kinetics  
 KRBEČ M.: Maximal operators and imbedding theorems  
 KUNCHEV O. I.: Some extremal problems for high order elliptic equations  
 KUTEV N.: Fully nonlinear, nonuniformly elliptic equations  
 LAPINSKIĬ V. N.: Ob odnom metode konstruktivnogo analiza periodicheskikh reshenii differentsialnykh uravnenii

- LIPPOLD G.: Error estimation and adaptive refinement in finite element methods
- LITEWSKA K.: Some applications of the finite elements methods to the system of differential equations
- MEGAHED F., HAMAD G. D., SALEM Sh.: On some integral inequalities in  $n$ -independent variables
- MYJAK J.: On the set of solutions of a diff. inclusion
- NAZAROV V.: Gladkost' reshenii obyknovennogo differentsial'nogo uravneniya s otklonyayushchimsya argumentom v prostranstvakh  $Rum^n$
- NGUEN DONG A.: Issledovanie vliyaniya razlichnykh periodicheskikh i sluchainykh vzbuzhdenii na sistemu Van-Der-Polya
- PAVLÍKOVÁ E.: Higher monotonicity properties of zeros of a third order differential equation
- PAVLOV V. A., NEVIDOMSKÍĀ A. I.: Reshenie matrichnogo uravneniya Rikkati ob odnoi zadache teorii optimal'nogo upravleniya
- PÄIVÄRINTA L.: The uniqueness of the one dimensional inverse problem
- PEKÁR J.: An algorithm for solving the multi-point boundary value problems for ODE
- PEŘINOVÁ V.: Fokker-Planck equation for free-electron laser
- PETROV I.: An inverse problem for Maxwell equations
- POPENDA J.: On the discrete generalizations of Gronwall's inequality
- RETI P.: Geometrical methods in chemical kinetics
- SCHIMMING R.: Laplace-Lie differential operators with a logarithm-free elementary solution
- TABISZ K.: Asymptotic behavior on solutions free boundary problem
- TÁBOAS P.: Periodic solutions of a forced Lotka-Volterra equation
- WAKULICZ A.: Convergence of a class of differential inclusion approximations
- WERBOWSKI J.: Asymptotic and oscillatory behavior of solutions of differential inequalities generated by retarded and advanced arguments
- ŽITŇAN P.: Lower bounds for the eigenvalues of the equation  $Au = Bu$  by residual defect method
- The papers of the following authors were also presented at the Poster Session:
- BOGDANOV R., BOUZNASKI E., VASSILEVSKI P.

### III. PAPERS PRESENTED IN THE FORM OF ENLARGED ABSTRACTS

- ANIKULAESEI G.: Optimal synthesis for a class of nonlinear control problems
- ANTONCHIK V.: Odno obobshechenie priznaka ustoičivosti Kh. Massera dlya nepravil'nykh sistem
- ASTROVSKÍĀ A. I.: Differentsial'naya upravlyaemost' lineinykh nestatsionarnykh sistem v klasse funktsii Chebyshcheva
- BOEV T.: Uniqueness and singularities of solutions of linear operators and applications
- BORZYMOWSKI A.: A Goursat problem for a polyvibrating equation of Di Mangeron
- CHAUVEHEID P.: Green functions for some over-determined boundary value problems
- CHOCHOLATÝ P.: Finite element simulation of an axisymmetric acoustic transmission system
- KHUSAINOV D., YUNJKOVA E., IVOKHIN E., ZHUÍKOVA A.: Ispol'zovanie vtorigo metoda Lyapunova v optimizatsii kriteriev kachestva funktsirovaniya dinamicheskikh sistem
- TSEREMENSKÍĀ A.: Stabilizatsiya v chastotnoi oblasti

- DIBLIK J.: On conditional stability of solutions of linear systems
- DOKTOR P.: On uniqueness periodic solution of a certain parabolic equation
- DOLEŽAL J.: New aspects of computer-aided design of dynamical systems
- FEDORENKO L.: Ob ustoičivosti reshenii stokhasticheskikh differentsialnykh uravnenii parabolicheskogo tipa
- FREILING G.: Irregular boundary value problems
- GAISHUN I. V.: Spektralnye kriterii eksponentsialnoï dikhotomii dlya uravnenii v polnykh proizvodnykh
- GONCERZEWICZ J.: On a boundary value problem with radial symmetry for the porous medium equation
- GOROKHOVIK S. YA.: Dostatochnye usloviya lokalnoï upravlyaemosti nelineinykh sistem
- GÓROWSKI J.: On the oscillatory properties of solutions of certain elliptic equation
- GRÖGER K.: Equations modeling semiconductor devices with high carrier densities
- HACIA L.: Approximate solutions of integral equations of the mixed type
- HÁČIK M.: A note to a certain property of Bessel functions
- HAVARNEANU T.: On an operatorial equation of hereditary type
- HYB W.: On the spectrum of flow on the two dimensional torus
- IGNATYEV V. N., ZADORIN A. I.: A finite difference method on nonuniform mesh for a singular perturbation problem
- INVERNIZZI G. C.: Periodic solutions of forced oscillators at resonance
- IONESCU I. R., SOFONEA M.: Existence stability and large time behaviour of the solution for a nonlinear viscoelastic problem
- KAFKA J.: One aspect of the discretization of Maxwell's equations
- KALENYUK P. I., BARANETSKIĬ YA. E.: Predstavlenie reshenii nekotorykh klassov kraevykh i nachaljnokraevykh zadach dlya lineinykh uravnenii s chastnymi proizvodnymi
- KALININ A. I., ROMANYUK G. A.: Optimizatsiya lineinykh vozmushchennykh sistem na baze opornykh i asimptoticheskikh metodov
- KAPANADZE D.: O plotnosti elektricheskogo zaryada na poverkhnosti provodyashchego parallelepipeda
- KARLSSON T.: Wiener's criterion and obstacle problems for vector valued functions
- KLÍČ A.: Bifurcations in symmetric systems
- KOVRIGIN A. B.: Filjtr Kalmana s vyrozhdannymi shymami v nablyudenyakh
- KUBEN J.: Time-optimal control of two-dimensional systems
- KUBIACZYK I., RZEPECKI B.: Existence theorem for ordinary differential equations
- KVEDARAS B.: Application of Laplace transformation method to the solution of a strongly degenerate elliptic equation
- KWAPISZ M.: An extension of Bielecki's method of proving of global existence and uniqueness results for functional equations
- LASKIN M. B.: Obosnovanie skhodimosti metoda Brauna dlya vypuklo-vognutykh funktsii s pomoshchyu funktsii Lyapunova
- LIZANA M.: Bounded, almost-periodic and periodic solutions of certain singularly perturbed systems with delay
- LAITTOCH M.: On central dispersions of the first kind and the theory of linear difference equations
- LUNGU N., MURESAN M.: On the number of small-amplitude limit cycles of certain systems of differential equations

- MALEC M.: Estimations of the measure of noncompactness and an existence theorem
- MERENKOV YU. N.: Kriterii ustoichivosti ura dlya funktsionaljno-differentsialnykh uravnenii
- MIRICA S.: Marginal characteristics solutions for Hamilton-Jacobi equations
- MORAČIĆ J.: Global'naya ekvivalentnost' i lineinye differentsialnyye uravneniya tret'ego poryadka vse resheniya kotorykh stremyatsya k nulyu
- MORCHALO J.: Asymptotic behaviour of the solutions of differential-difference equations
- NADZIEJA T.: Shadowing lemma for family of  $\varepsilon$ -trajectories
- NAZMUTDINOV A. T., MUDARISOV I. KH.: Otsenka verkhnego chisla osovykh tochek vtoroi gruppy
- NKASHAMA M. N., IANNACCI R.: Periodic solutions of second order delay-differential systems
- OKRASINSKI W.: On asymptotic solutions of some nonlinear problems
- POTRA T.: Finite element of spline type for elliptic partial differential systems
- PTASHNIK B. I., BERNIK V. I.: Zadacha tipa Dirikhle dlya differentsialnykh uravnenii v chastnykh pro izvodnykh sostavnogo tipa
- RAGAB A. A., OWALDY H. EL, ZAGHROUT A. A. S.: On oscillations of nonlinear differential equations
- RASVAN V.: Stability of a integro-differential system occurring in nuclear reactor dynamics
- RIZUN V. I.: Metod vspomogatelnykh funktsii i ego primereniya
- RUDYKH G. A.: Svoistva integralnoi krivoi neavtonomnoi sistemy differentsialnykh uravnenii
- RZEPECKI B.: On bounded solutions of a linear differential equation with a nonlinear perturbation in the case of Banach spaces
- SAMOILENKO A. M., BORISENKO A. D., BORISENKO S. D.: Limit behaviour of the solution of the Cauchy problem for parabolic equations with coefficients depending on parameter
- SIMERSKÁ C.: Generalized L-splines as a solution of n-point boundary value problem
- SIUDUT S.: Some remarks on the singular integrals on the line group
- SKOROBOGAT'KO V. YA.: Svyaz' obratnoi zadachi elektrorazvedki s mnogotochechnoi zadachei dlya obyknovennogo differentsialnogo uravneniya
- SOSULSKI W.: Generic properties of generalized differential equations of hyperbolic type
- SPIGLER R.: Numerical treatment of certain parabolic partial differential equations
- SZMANDA B.: Oscillation of solutions of higher order difference equations
- TRYHUK V.: The contribution to a linear differential delay equation of the first order
- VASSILEVSKI P. S.: Numerical solution of Poisson's equation on regions partitioned into substructures
- VERNESCU B.: Homogenization of a transmission problem in porous media flow
- VORNICESCU N.: Existence of optimal control without convexity
- WIEGNER M.: On the asymptotic behaviour of solutions of nonlinear parabolic equations
- ZACHARIAS K., GAJEWSKI H.: On a mathematical model of polymerization by particle growth and coalescence

# CONTENTS

PREFACE .....	III
LIST OF PAPERS PRESENTED AT THE CONFERENCE .....	IX
LIST OF PARTICIPANTS .....	XVII

## PLENARY LECTURES:

FEISTAUER M.: Critical point theory and nonlinear differential equations .....	3
FRIEDMAN A.: Free boundary problems in fluid dynamics .....	17
KAČUR J.: Method of Rothe in evolution equations .....	23
KUFNER A.: Boundary value problems in weighted spaces .....	35
MAWHIN J.: Critical point theory and nonlinear differential equations .....	49
NEUMAN F.: Ordinary linear differential equations – a survey of the global theory .....	59
REKTORYS K.: Numerical and theoretical treating of evolution problems by the method of discretization in time .....	71
STETTER H. J.: Algorithms for the inclusion of solutions of ordinary initial value problems .....	85
TRIEBEL H.: Recent developments in the theory of function spaces .....	95

## LECTURES PRESENTED IN SECTIONS:

### A. Ordinary differential equations:

BARTUŠEK M.: On properties of oscillatory solutions of nonlinear differential equations .....	109
BURTON T. A., DWIGGINS D. P.: Uniqueness without continuous dependence .....	115
FIEDLER B., BRUNOVSKÝ P.: Connections in scalar reaction diffusion equations with Neumann boundary conditions .....	123
GREGUŠ M.: On a certain boundary value problem of the third order .....	129
KRBEC P.: On nonparasite solutions .....	133
KREITH K.: Uniform zeros for beaded strings .....	141
KURZWEIL J., JARNÍK J.: Perron integral, Perron product integral and ordinary linear differential equations .....	149
MULDOON M. E.: On the zeros of some special functions: differential equations and Nicholson-type formulas .....	155
ŠEDA V.: Surjectivity and boundary value problems .....	161

ŠVEC M.: Some problems concerning the equivalences of two systems of differential equations . . . . .	171
TRENCH W. F.: Linear perturbations of general disconjugate equations . . . . .	181
TVRDÝ M.: On optimal control of systems with interface side conditions . . . . .	187

### B. *Partial differential equations*

BEBERNES J. W.: A description of blow-up for the solid fuel ignition model . . . . .	193
BRILLA J.: Spectral analysis of non-self-adjoint elliptic operators . . . . .	197
CHANG K. Ch.: On the mountain pass lemma . . . . .	203
GAJEWSKI H.: On uniqueness and stability of steady-state carrier distributions in semiconductors . . . . .	209
GIAQUINTA M.: Partial regularity of minimizers . . . . .	215
KREJČÍ P.: Periodic solutions of partial differential equations with hysteresis . . . . .	221
KUČERA M.: Stability and bifurcation problems for reaction-diffusion systems with unilateral conditions . . . . .	227
MAZ'YA V. G.: Boundary integral equations of elasticity in domains with piecewise smooth boundaries . . . . .	235
SIMADER C. G.: Higher regularity of weak solutions of strongly nonlinear elliptic equations . . . . .	243
STARÁ J., JOHN O.: Some regularity results for quasilinear parabolic systems . . . . .	247
TRUDINGER N. S.: Classical boundary value problems for Monge-Ampere type equations . . . . .	251
VALLI A.: Qualitative properties of the solutions to the Navier-Stokes equations for compressible fluids . . . . .	259

### C. *Numerical methods*

AGARWAL R.: On Gel'fand's method of chasing for solving multipoint boundary value problems . . . . .	267
AXELSSON O.: Stability and error estimates valid for infinite time, for strongly monotone and infinitely stiff evolution equations . . . . .	275
BREZZI F.: Recent results in the approximation of free boundaries . . . . .	285
ČERMÁK L., ZLÁMAL M.: Finite element solution of a nonlinear diffusion problem with a moving boundary . . . . .	291
DESCLOUX J., FERRO R.: Analysis of Thacker's method for solving the linearized shallow water equations . . . . .	295
GOERISCH F., ALBRECHT J.: The convergence of a new method for calculating lower bounds to eigenvalues . . . . .	303
JANOVSKÝ V., MAREK I., NEUBERG J.: Bifurcation analysis of stimulated Brillouin scattering . . . . .	309
KŘÍŽEK M.: Superconvergence results for linear triangular elements . . . . .	315
NEDELEC J. C.: Mixed finite element in 3D in $H(\text{div})$ and $H(\text{curl})$ . . . . .	321
NITSCHKE J. A.: Free boundary problems for Stokes' flows . . . . .	327
SCHMIDT J. W.: Enclosing methods for perturbed boundary value problems in nonlinear difference equations . . . . .	333



THOMÉE V.: Error estimates for finite element methods for semilinear parabolic problems with nonsmooth data	339
WHITEMAN J. R.: Singularities in two- and three-dimensional elliptic problems and finite element methods for their treatment	345
ŽENÍŠEK A.: Some new convergence results in finite element theories for elliptic problems	353
<b>D. Applications</b>	
BOLEK P., FOŘT J., KOZEL K., POLÁŠEK J.: Mathematical solution of direct and inverse problem	361
COLLATZ L.: Einige Anwendungen der Mehrdimensionalen Apprixi- mationstheorie zur Lösungseinschließung bei Randwertaufgaben	367
KODNÁR R.: A posteriori estimations of approximate solutions for some types of boundary value problem	373
KUBÍČEK M., HOLODNIOK M.: Nonlinear dynamic systems — bifurcations, continuation methods, periodic solutions	379
MARTENSEN E.: The rothe method for nonlinear hyperbolic problems	387
MEISTER E.: Some solved and unsolved canonical problems of diffraction theory	393
NEČAS J.: Entropy compactification of the transonic flow	399
NEUSTUPA J.: The global existence of weak solutions of the mollified system of equations of motion of viscous compressible fluid	409
SADOVSKÝ Z.: Bifurcations near a double eigenvalue of the rectangular plate problem with a domain parameter	415
SMÍTALOVÁ K.: Dealy makes problems in population modelling	421

## SUPPLEMENT (in the EQUADIFF 6 edition only)

ARSCOTT F.: Analytical and computational problems in higher special functions	427
CHANTURIA T. A.: On oscillation of solutions of linear ordinary differential equations	431
FAZEKAS F.: Deterministic and stochastic vector differential equations applied in technical systems theory	435
HASLINGER J.: Shape optimization in contact problems	445
KLÖTZLER R.: Zur analytischen Lösung alter und neuer geometrischer Optimierungsprobleme	451
KOSHELEV A. I.: On the smoothness of the solutions to the elliptic systems	459
KUSANO T.: On the asymptotic behavior of solutions of nonlinear ordinary differential equations	465