BULLETIN

INTERNACIONAL CENTER FOR MATHEMATICS

June 1998

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In this issue we start the publication of small cartoons with some mathematical content. Collaboration from our readers to this section will be most welcome.

Activities in 1998

Linear Algebra and Control Theory: Thematic Term

As announced in the last Bulletin, the Thematic Term on Linear Algebra and Control Theory began on May 11th, and the first participants have already arrived. Amongst them are guest researchers Prof. Paul Fuhrmann (Ben Gurion University of Negev), Prof. Jean Jacques Loiseau (CNRS, Nantes), Prof. Itziar Baragaña (Universidad del País Vasco), Prof. Vladimir Kučera (Academy of Sciences, Czech Republic) and the postdoctoral fellows for the Term, Dr. Adam Czornik (Silesian Technical University, Poland) and Dr. Marko Huhtanen (Helsinki University of Technology, Finland).

The Thematic Term opened with a research seminar given by Prof. Vladimir Kučera on "A Bridge between State-space and Transfer-function Methods". There are also many activities planned for the following two weeks, including, from May 21st to 29th, the two courses of the first School, on Structure and Design of Linear Systems, given by Prof. Jean Jacques Loiseau and Prof. Petr Zagalak (Academy of Sciences, Czech Republic). The course programmes are as follows:

Structural Properties of Linear Systems (J. J. Loiseau)

1. Examples of linear systems.
2. Realization of linear systems.
3. Basic control I: Stabilization.
4. Structure of linear systems. Geometric tools.
5. Multivariable Control II: Exact problems.
6. Pole placement and related topics.
7. Time-delay systems.

Linear Systems and Control (P. Zagalak)

1. Representations of linear systems.
2. Structure of linear systems: basics.
3. Basic control II: Regulation.
4. Structure of linear systems: Polynomial tools.
5. Multivariable Control I: LQ control and Kalman filtering.
6. Robust Control I.
7. Robust Control II.

The courses will take place from 9.30 am to 1 pm (except for the first day, when they will be after lunch). This will leave the afternoon free for other activities such as seminars or lectures. So far, three seminars have been programmed: Linear Systems with Prescribed Similarity Invariants (I. Baragaña), Observers and Conditioned Subspaces (P. Fuhrmann) and Nearest Pair with more non-constant Invariant Factors: Pseudospectrum (Juan M. Gracia, Universidad del País Vasco).

The second School, which takes its title from the name of the Term (Linear Algebra and Control Theory), will be held from 15th to 23rd June. It will consist

of two courses given by Prof. Paul Fuhrmann and Prof. Peter Lancaster (University of Calgary, Canada). The programmes of these courses are as follows:

Algebraic System Theory (P. Fuhrmann)

1. Polynomial and rational models. Factorizations and invariant subspaces. Intertwining maps. Canonical forms. Polynomial matrix interpolation.
2. Linear systems. Shift realization theory. Reachability observability and coprimeness. Polynomial system matrices and system equivalence. Doubly coprime factorizations.
3. Feedback, output injection and duality in the model context.
4. Factorization theory and geometric control.
5. Hankel norm approximation, scalar case.
6. Spectral factorization. The regular case. DSS factorizations. Parametrization of the set of minimal spectral factors.
7. Spectral factorization. The rectangular case.

Linear Algebra Stability and Control (P. Lancaster)

1. Basic material: Ideas from linear algebra. The continuous and discrete LQR problems.
2. Stability and canonical forms: Stability of continuous and discrete systems. Stabilizing a controllable dissipative system. BIBO stability. Canonical forms for matrices and pencils.
3. Realization of rational functions: Transfer functions for filters and systems. Existence, minimality. Pencil realizations. Realizations for functions with symmetries.
4. Balanced realization: Hankel singular values. Balanced realization. All-pass transfer functions.
5. Continuous algebraic Riccati equations: Examples and motivation. The role of the Hamiltonian. Direct solution methods. Concerns of numerical analysis.
6. Discrete algebraic Riccati equations: The role of symplectic pencils. Direct solution methods. Numerical solution of CARE and DARE in the singular cases.
7. Stability under perturbations: Strong stability. Higher order systems. Parametric perturbations. Analytic perturbation theory. Application to gyroscopic systems.

These courses will also be given in the morning, and the afternoons will be occupied by seminars and lectures. These will include a series of 3 or 4 seminars on Linear Systems over Finite Fields and Coding Theory given by Prof. Joachim Rosenthal (University of Notre Dame, Indiana) between June 16th and 19th, plus other seminars which have been programmed but which as yet have not been scheduled.

The International Center for Mathematics (CIM) will be visited in the second half of June by many researchers, come to attend the workshop that will take place from 24th to 26th of that month. During the first ten days of July, however, most of these will leave in order to attend meetings elsewhere (MTNS in Padua, IFAC on Linear System Structure and Control, etc.). Therefore, the regular activities of the Term will resume on July 11th to continue until the end of the month.

Up-to-date information about the Thematic Term can be obtained at our web site:

http://hermite.cii.fc.ul.pt/lin98/

or by sending an e-mail to:
lin98@hermite.cii.fc.ul.pt.

Optimal Shape Design School

In cooperation with CIME (Centro Internazionale Matematico Estivo, Florence, Italy) – maybe the oldest european organization dedicated to summer schools in Mathematics – CIM will organize in Tróia, Portugal, from 1 to 6 June 1998, a summer school on "Optimal Shape Design", i.e., determination of optimal forms for the construction of structures. By optimal we mean the best possible according to criteria seemingly appropriate, in general associated to a cost – be it of manufacturing, of utilization, of maintenance, or mixed. By structures, in particular we intend applications to naval and aerospatial engineering. For example, to determine the best form that the hull of a ship should have in order to fulfill its duty. Or to compute the optimal form for an airplane or a spaceship so that its fuel consumption is minimal.

This summer school is supported by the european union through the TMR programme. Its lecturers are five of the most famous world researchers in this area:

Bernd Kawohl (Köln, Germany),
Some nonconvex shape optimization problems
Olivier Pironneau (Paris, France),
Mesh adaptation for optimal shape design
Luc Tartar (Pittsburgh, USA),
Homogenization methods in optimal shape design
Piero Villaggio (Pisa, Italy),
Explicit solutions in elastic optimization
Jean Paul Zolesio (Nice, France),
Optimal shape design: theory, models, numerical algorithms.