Matrix Classes in Solving the Linear Complementarity Problem (ONLINE)

Overview:

Optimization is an important scientific tool, being widely used in engineering, automatic control systems, electronic designs, network designs and mathematical finance. In particular, optimal design problems arise frequently in civil, mechanical and aerospace engineering. The Linear Complementarity Problem (LCP) represents an important model for such problems in mathematical optimization and finds additional use in game theory and models of the economy, among many other scientific fields.

Given a real matrix M and a real vector q, the Linear Complementarity Problem LCP(q,M) seeks to find a nonnegative vector z such that w = M z + q is nonnegative and is perpendicular to z. Much of the theory of the LCP and its solutions is intimately linked, in various ways, to specific matrix classes. The course aims to introduce various classes of matrices M for which LCP(q,M) admits a solution with various properties for certain real vector q. Semipositive, semimonotone and M- matrices are among such classes of matrices.

The proposed compact course emphasizes the various properties of semipositive matrices and their semipositive cones, semimonotone and central matrices, as well as their applications. The lectures comprise an overview of relevant theory, a study of the relations among matrix classes associated with LCP, and an examination of computational challenges that arise for these classes of matrices. Moreover, the course will include an exposition of challenges and open problems in LCP, promoting the pursuit of future research collaborations by the participants.

Objectives of the Program	1. Introduce semipositive matrices, semimonotone matrices and related classes, as well as their various geometric and algebraic properties. 2. Develop, explore and exploit the relations among these matrix classes in optimization. 3. Exhibit recent trends and propose future work in the field.
Module	15 hours Lectures and 4 hours Tutorials: December 12 to December 16, 2022 (Online mode) Number of Participant limited to seventy
Who can attend	• Students at all levels (BTech/MSc/MTech/PhD). • Engineers, researchers and faculty from academic and technical institutions
Course Fees	***The participation fees for taking the course are as follows:*** ***Participants from abroad****:* US $100 ***Industry/ Research Organizations:*** INR 5000 ***Academic Institutions****:* INR 2000 (Faculty/Post doc), INR 1000 (Ph.D/MTech students) INR 500 (M.Sc/BTech). The above fee includes all instructional materials, tutorials and assignments.
Mode of Registration	**Step-1: One time Web (Portal) Registration:** All prospective participants need to do web registration on GIAN (https://gian.iitkgp.ac.in/GREGN/index) portal by making onetime non-refundable payment of Rs. 500/-, in case not registered before. **Step-2: Course Registration (Through GIAN Portal)** **Step-3:** After GIAN Registration the Course fee is to be deposited online in the institute account. The program fee covers the course materials and access to all the sessions. Participants should pay course fee through online mode (NEFT/IMPS) and fill up transaction ID/details in the google form with the link and the account details given below. **Step-4:** After online payment of course fee, fill the google form Registration link given below: https://forms.gle/AUfWTsemkKEVnP9s5 **The last date for registration:30-11- 2022, Intimation of selection: 05-12-2022, Confirmation of participation: 07-12-2022, Online link will shared: 10-12-2022**
Account Detail for Payment of Course Fee	**Bank Name** : UCO Bank **Account Name** : NIT MEGHALAYA R AND D ACCOUNT **Account Number** : 23730110010280 **IFSC Code** : UCBA0002373 **MICR No** : 793028003

Tentative Schedule (Online)

Time / Dates	IST: 8:00 AM to 8:45 AM PT: 8:30 PM to 9:15 PM (-1 Day)	IST: 9:00 AM to 9:45 AM PT: 9:30 PM to 10:15 PM (-1 Day)	IST: 10:00 AM to 10:45 AM PT: 10:30 PM to 10:45 PM (-1 Day)	IST: 11:00 PM to 11:45 PM PT: 11 PM to 11:45 PM (-1 Day)
12.12.2022 (Monday)	***Session 1*** **Topic**: Introduction to Quadratic Programming, Game Theory and their relation to LCP (MT)	***Session 2*** **Topic**: Matrix tools and transformations (MT)	***Session 3*** **Topic**: Existence and Uniqueness of Solutions of LCP (MS)	***Session 4*** **Topic**: Tutorial/Discussion/ Homework (MS)
13.12.2022 (Tuesday)	***Session 5*** **Topic**: The hierarchy of matrix positivity classes (MT)	***Session 6*** **Topic**: Matrix semipositivity: algebraic and geometric properties (MT)	***Session 7*** **Topic**: LCP and matrix classes (MS)	***Session 8*** **Topic**: Tutorial/Discussion/ Homework (MS)
14.12.2022 (Wednesday)	***Session 9*** **Topic**: Overview of methods to solve the LCP (MT)	***Session 10*** **Topic**: Focus on P-matrices and their subclasses (MT)	***Session 11*** **Topic**: Cones and their spectral properties (MS)	***Session 12*** **Topic**: Sign Pattern of semipositive matrices (MS)
15.12.2022 (Thursday)	***Session 13*** **Topic**: Semimonotone and central matrices (MT)	***Session 14*** **Topic**: Recent advances in theory and computations (MT)	***Session 15*** **Topic**: M-matrices and LCP-I (KCS)	***Session 16*** **Topic**: Tutorial/Discussion/ Homework (KCS)
16.12.2022 (Friday)	***Session 17*** **Topic**: Challenges, ideas and open problems on LCP (MT)	***Session 18*** **Topic**: M-matrices and LCP-II (KCS)	***Session 19*** **Topic**: Tutorial/Discussion/ Homework (KCS)	Examination

MT : Prof. Michael J. Tsatsomeros
KCS : Prof. K.C. Sivakumar
MS : Dr. Manideepa Saha

Please send an email to course coordinator in case of any question: manideepa.saha@nitm.ac.in

Foreign Faculty

Prof. Michael Tsatsomeros is a professor in the department of Mathematics & Statistics, Washington State University, Pullman, USA. He received his Ph.D degree in Mathematics, from University of Connecticut, USA in 1990. His research interests lie in Linear Algebra and Matrix Theory, especially the theory of nonnegative matrices and their generalizations. Particular interests include the numerical range, graphs and patterns associated with matrices, numerical linear algebra, applications to dynamical systems and control theory. Prof. Tsatsomeros has published over 65 research papers in these and related areas in reputed international journals. He is also recipient of more than 10 research/equipment grant from various agencies over the world, which include *SPARC* project, Govt. of India. Currently he is Co-Editor-In-Chief of *Electronic Journal of Linear Algebra* and an Associate Editor of *Linear Algebra and its Application.* Additionally, he was special editor of special issues of Electronic *Journal of Linear Algebra* and *Linear Algebra and its Application.*

Guest Faculty

Prof. K. C. Sivakumar is a professor in the department of Mathematics, Indian Institute of Technology Madras, India. His area of research lie on infinite Linear Programming, Generalized Inverses of Operators over Hilbert Spaces, Nonnegative Generalized Inverses, Generalizations of Matrix Monotonicity, Linear Complementarity Problems, Generalized Inverses of Matrices over Indefinite Inner Product Spaces. He published many research articles in reputed journals and many research grants from various agencies including a joint SPARC proposal with Prof. Michael Tsatsomeros . He also refereed in many reputed journals including *Electronic Journal of Linear Algebra, Linear Algebra and its Application, Linear and Multilinear Algebra , Journal of Computational and Applied Mathematics etc.*

Host Faculty

Dr. Manideepa Saha is an assistant professor in the department of Mathematics, National Institute of Technology Meghalaya, India. Her primary research interests are related to Linear Algebra and matrix theory

Course- Coordinator

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