### Dottorato di Ricerca in Matematica UNIMORE-UNIPR-UNIFE

#### Esame finale Ciclo XXXIV

Giovedì 24 Febbraio 2022, ore 10:00

Aula L1.3, Edificio Fisica, via Campi 213/A, 41125 Modena

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ABSTRACTS

Sara Bagossi

Title: Second-order covariation: an analysis of students’ reasonings and teacher’s interventions when modelling real phenomena

Abstract: This study aims to investigate covariation understood, in a broader epistemological sense, as the ability to grasp relationships of invariance between two mathematical objects introducing a new theoretical construct called second-order covariation. The research is specifically focused on the students’ forms of second-order covariational reasoning when involved in mathematical modelling tasks and on the teacher’s adaptive teaching strategies supporting covariational reasoning.

Augusto Davide Bignamini

Title: Transition semigroups associated to nonlinear stochastic differential equations

Abstract: A nonlinear stochastic partial differential equation (SPDE) in a separable Hilbert space and its associated transition semigroup are the main objects of study in my thesis. The generalized mild solution of the SPDE and its associated transition semigroup are introduced in the first part of the presentation. Then I make a summary of the original results contained in my Ph.D. thesis. In the last part of the presentation, I explain more in detail two results about the infinitesimal generators in L^2 type spaces of the transition semigroup and the stopped semigroup associated to the SPDE.

Gianluca Brilli

Title: Memory Interference and Mitigations in Reconfigurable HeSoCs for Embedded AI

Abstract: AI is widely adopted in the embedded domain and especially in Cyber Physical Systems (CPS). To match the computational requirements of modern CPS, chip manufacturers are adopting a heterogeneous design. Commercial-off-the-shelf heterogeneous systems embed hardware IPs that share resources. Resource contention, especially on main memory (DRAM), complicates the adoption of COTS HeSoCs on real-time systems. The presentation will cover three main points: i) a study on the contention problem; ii) a clock-cycle accurate methodology, to mitigate DRAM interference, while maximizing bandwidth exploitation; iii) an evaluation considering real-world embedded applications.

Elsa Corniani

Title: Wonderful compactifications and Kontsevich moduli spaces of conics
**Abstract:** We will construct the wonderful compactifications of the space of symmetric and symplectic matrices and of the spaces of complete collineations and quadrics of rank at most \( h \). We will study their birational geometry from the point of view of Mori theory and in the cases of small Picard rank we will give a complete description of the decomposition of the effective cone. Then, we will relate these wonderful compactifications to other moduli spaces. In this way we will prove several results on the birational geometry of Kontsevich moduli spaces of conics in projective spaces, in Grassmannians, in Lagrangian Grassmannians and of stable maps of bi-degree \((1,1)\) in a product of two projective spaces.

Giulia Di Credico

**Title:** Energetic Boundary Element Method for 2D Elastodynamics Problems in Time Domain

**Abstract:** In my doctoral dissertation, theoretical and practical aspects of the Energetic Boundary Element Method (Energetic BEM) are considered for the resolution of 2D elastodynamic problems, with an overview on the integral formulations for the representation of the unknown in unbounded domains and on the quadrature formulas, fundamental for the implementation of the method. \( H_p\)-method and graded meshes will be studied with the aim of improving the approximation of the solution at the corners of the obstacle and, in the end, the Adaptive Cross Approximation (ACA) will be analysed to reduce the computational costs of the Energetic BEM.

Maria Chiara Molinari

**Title:** Even Cycle decompositions of index 3 in 4-regular line graphs

**Abstract:** The notion of an even cycle decomposition (ECD) of index \( m \) is connected to a chromatic parameter, the palette index of a graph. It is 3 if and only if the graph has an even 2-factor or an ECD of index 3. No example of 4-regular graph whose edge set can be partitioned into even cycles and every ECDs has index larger than 3 is known. We study ECDs in 4-regular line graphs of class 2 cubic graphs. For some of the infinite families of class 2 cubic with large oddness, we can find an ECD of index 3 in the corresponding line graph.

Vincenzo Pallozzi Lavorante

**Title:** Geometry over finite fields and its applications

**Abstract:** This PhD dissertation focuses on particular problems in classical finite geometry, blocking sets and combinatorics. More precisely, there are three parts that are intertwined by the theory they rely on. The first part is the investigation and construction of hemysistems of the Hermitian surface. These geometrical structures are very rare and just
a few examples are known. The techniques used to reach our contribution are based on the Natural Embedding Theorem (NET) of algebraic maximal curves on the Hermitian surface. The second part is the investigation of a certain blocking set of the finite plane. The third part is the investigation of polynomials which permute the finite field of q elements. Again, techniques to be used will be of algebraic nature, involving the theory of algebraic curves defined over a finite field and Hasse-Weil type theorems.

Estrella Lucena Sanchez

Title: Nuovi metodi matematici e informatici perla ottimizzazione dello sfruttamento dello studio delle risorse naturali.

Abstract: I problemi con dati di origine naturale richiedono tecniche di analisi dei dati specifiche. In questa tesi sviluppiamo nuovi modelli matematici e informatici per lavorare con dati di origine naturale, che applichiamo all'ottimizzazione delle risorse idriche, atmosferiche e della terra. Nello specifico, ci concentriamo sulla progettazione di tecniche di pre-elaborazione dinamiche viste come problemi di ottimizzazione multivariata, per migliorare le prestazioni degli algoritmi di apprendimento e l'interpretabilità dei loro risultati.

Romina Travaglini

Title: BGK Models and Reaction-Diffusion Equations for Reacting Mixtures of Monatomic and Polyatomic Gases

Abstract: Kinetic models are presented for mixtures of monoatomic and polyatomic gases, which can interact in an inelastic or chemical way. One model of type BGK is provided for an inert mixture, along with two models for mixtures of reagent gases. The consistency of the models is proved, and numerical simulations are performed. Next, a mixture of five gas species is considered. By integrating the Boltzmann equations, we obtain reaction-diffusion equations for the densities of species, and we study the possibility of the phenomenon of Turing instability