Bahçeşehir University, Istanbul, Türkiye
Analysis & PDE Center, Ghent University, Ghent, Belgium
Institute Mathematics & Math. Modeling, Almaty, Kazakhstan

"Analysis and Applied Mathematics"

Weekly Online Seminar

Seminar leaders:
Prof. Allaberen Ashyralyev (BAU, Istanbul),
Prof. Michael Ruzhansky (UGent, Ghent),
Prof. Makhmud Sadybekov (IMMM, Almaty)

Date: **Tuesday, June 25, 2024**
Time: 14.00-15.00 (Istanbul) = 13.00-14.00 (Ghent) = 16.00-17.00 (Almaty)

Place: Meeting room of Faculty of Engineering & Natural Sciences, BAU, D-415
Zoom link: https://us02web.zoom.us/j/6678270445?pwd=SFNmQUlvT0tRaHlDa-VYrN3l5bzJVQT09, **Conference ID:** 667 827 0445, **Access code:** 1

Speaker:
Dr. Gülsemay Yiğit
Bahçeşehir University, Istanbul, Türkiye

Title: **Rigorous mathematical analysis and simulations of reaction-diffusion systems with linear cross-diffusion on convex and non-convex domains**

Abstract: In this talk, a domain-dependent mathematical analysis of reaction-diffusion systems is presented to understand the role of geometry and cross-diffusion in pattern formation. Linear stability analysis is employed to derive the constraints which are necessary in understanding the dual roles of linear cross-diffusion and domain-size for studying the instability of a reaction-diffusion system. Theorems are stated for the conditions for Turing, Hopf and transcritical instabilities and are proven in terms of lower and upper bounds of the domain-size together with the reaction, self- and cross-diffusion coefficients. These bounds allow for the full parameter classification of the model system, which is presented in terms of the relationship between the domain size, self and cross-diffusion parameters. Regions showing Turing instability, Hopf and transcritical types of bifurcations are demonstrated using the parameter values of the system. To support theoretical findings, a state-of-the-art finite element method is employed. The finite element method is a numerical method that solves highly nonlinear systems of partial differential equations on complex geometries. The finite element numerical solutions reveal spatial and spatiotemporal patterns on rectangular, circular, and annular geometries, with no flux boundary conditions. Observed patterns on non-convex geometries, for example, resemble ring-shaped cross-sectional scans of hypoxic tumours. Specifically, the cross-section of an actively invasive region in a hypoxic tumour can be effectively approximated by an annulus.

Biography:

Gülsemay Yiğit received a Bachelor's degree in Mathematics from Eskişehir Osmangazi University, Türkiye, in 2010. In 2012, she obtained a Master's degree in Mathematical Engineering from Yıldız Technical University, Türkiye, followed by a PhD in Mathematical Engineering from Yıldız Technical University, Türkiye in 2019. She is currently working as an Assistant Professor in Mathematics in Bahçeşehir University. Her research lies at the intersectional interfaces between computational biology, numerical analysis and analysis of partial differential equations (PDEs). One of the fields of her research interest is to explore efficient algorithms for solving PDEs in the areas of applied mathematics. Her goal is to use these numerical methods to simulate and study complex natural systems, focusing on understanding the underlying physical principles that govern these systems. She conducts research on exploring the spatiotemporal analysis to study pattern formation in cross-diffusive reaction-diffusion systems on two dimensional geometries explaining the ability of mathematical models to describe and predict the behaviour of pattern formation as observed in nature. More recently, her research interests include mathematical modelling of single and collective cell migration. This research seeks to unravel how single cells, as fully three-dimensional geometric entities navigate through their complex and generally non-isotropic native environments. What are the mechanisms associated with single cell migration and what is their decision process as they navigate through complex and stiff environments? She seeks to answer some of these questions as part of her postdoctoral research funded by the International Postdoctoral Research Fellowship Program, awarded by The Scientific and Technological Research Council of Türkiye (TÜBİTAK).