



Seminario de Matemática Aplicada Conferencia

por

Ram Shiromani

"Two-Dimensional Singularly Perturbed Problems: Boundary Layers, Interior Layers and Uniform Convergence of Numerical Methods"

Abstract: This talk illustrates, in an accessible and rigorous way, the compelling need for efficient numerical resolution of singularly perturbed differential equations problems in which a small positive diffusion parameter in $(0,1]$ multiplies the highest-order derivative, fundamentally altering the qualitative and quantitative structure of the solution. These equations arise across a broad spectrum of physical and engineering phenomena: the **transport and dispersion of contaminants** in fluids or porous media, **heat and mass transfer** in catalytic converters and near oceanic boundaries, **chemical reaction--diffusion--convection** processes, **oil and gas reservoir simulations**, **blood flow and drug delivery** modelling in the human body, as well as **ecological and population-dynamics** models.

The defining mathematical feature is a **multiscale solution structure**: regions of extremely rapid variation (large gradients) of width $O(\varepsilon)$ or $O(\varepsilon^{1/2})$, termed *boundary layers* or *interior layers*, coexist with regions of smooth, $O(1)$ -varying behavior. Classical methods on **uniform meshes** fail to resolve these layers efficiently, producing spurious oscillations unless the mesh spacing is taken of order ε everywhere. This motivates the construction and analysis of **ε -uniform numerical methods**, which achieve convergence independent of the perturbation parameter, typically through the use of *layer-adapted meshes* (Shishkin, Bakhvalov) or appropriate stabilization.

We present the mathematical framework, illustrate layer phenomena through representative two-dimensional examples, survey engineering applications, and discuss the analytical tools required to prove uniform convergence.

Día: Viernes 15 de mayo de 2026

Hora: 12:00

Lugar: Aula 22, Edificio Torres Quevedo de la Escuela de Ingeniería y Arquitectura