Reading seminar C2 : PDEs and applications

Abstract:
This reading seminar will be divided into three independent parts. Each of them will deal with a particular topic aiming at illustrating/developping the basic courses or at preparing the advanced courses of the second semester.

- **Part 1 : Ordinary differential equations and numerical schemes**
  Coordinator : Jean-François Coulombel - `jean-francois.coulombel@math.univ-toulouse.fr`

  Ordinary, and partial, differential equations play a crucial role in the modeling of many physical phenomena. In this field, numerical simulations are important either to illustrate known theoretical results or to predict phenomena that are beyond the reach of analytical techniques. In this seminar, we shall review the stability and convergence theory for some numerical approximations of ordinary differential equations, focusing specifically on Runge-Kutta and multistep methods. Specific attention will be paid to large time stability issues through the notion of A-stability.

  The results seen within the reading seminar will be useful when dealing with the numerical approximation of dispersive equations (second semester).

  References.

  J. C. Butcher, *Numerical methods for ordinary differential equations*, 3ème édition, Wiley and sons, 2016.

  E. Hairer, S. P. Nørsett et G. Wanner, *Solving Ordinary Differential Equations I. Nonstiff Problems*, 2ème édition, Springer, 1993.

  E. Hairer et G. Wanner, *Solving Ordinary Differential Equations II. Stiff and Differential-Algebraic Problems*, 2ème édition, Springer, 2010.

- **Part 2 : Parabolic Equations in Biology: Growth, reaction, movement and diffusion**
  Coordinator : Francis Filbet - `francis.filbet@math.univ-toulouse.fr`

  In this reading seminar, we will present a variety of phenomena arising in the analysis of partial differential equations modelling of biological, physical and chemical processes. Several fundamental questions in mathematical biology such as Turing instability, pattern formation, reaction-diffusion systems, invasion waves and Fokker-Planck equations will be addressed.

  References.

  B. Perthame, *Parabolic equations in biology: Groxth, reaction, movement and diffusion*, Lecture Notes on Mathematical Modelling in the Life Sciences, Springer, 2015.

- **Part 3 : Optimisation of PDEs coefficients**
  Coordinator : Frédéric de Gournay - `frederic.de-gournay@insa-toulouse.fr`

  The goal of this reading seminar will be to introduce the students to some important optimisation problems coupled with elliptic PDEs. In that respect, the seminar will use and illustrate the basic courses A4 and A5.

  References.

  G. Allaire, *Conception optimale de structures*, Mathématiques & Applications, Vol. 58, Springer, 2007.

  N. Banichuk, *Introduction to optimization of structures*, Springer Verlag, New York, 1990.

  J. Haslinger, R. Makinen, *Introduction to shape optimization. Theory, approximation, and computation*, SIAM, Philadelphie, 2003.

  O. Pironneau, *Optimal shape design for elliptic systems*, Springer-Verlag, New York,