

## Actividades Formativas IMEIO/ Educational Activities IMEIO

**Título/Title:** PhD Course on diffusion processes modelled by fractional derivatives  
**Organizador/Organizer:** Salvador Jiménez Burillo (UPM)  
**Profesores/Lecturers:** Luis Vázquez Martínez (UCM), M<sup>a</sup> Pilar Velasco Cebrián (UPM)  
**Horas totales/Number of hours:** 10 (5 sessions of 2 hours each)  
**Lugar/Location:** ETSI Telecomunicación, UPM  
**Fechas/Dates:** February-March 2023 (to be precised)

**Resumen/Summary:** Fractional calculus is a generalization of the classical integral and differential operators to non integer orders. There are many definitions of the fractional derivatives. The more widely used are defined through non local, linear operators with specific convolution kernels that may include singularities. These operators can model processes where multiple time or space scales are at play. Some practical applications can be found to diffusion processes where the behaviour of the solutions does not follow the “classical” diffusion, and in models of materials with memory. The use of fractional operators allow a better fidelity of the mathematical model to the underlying process without resorting to nonlinear terms. This course is an introduction to these models, their properties and their numerical simulation.

- 1. Introduction: basic elements of fractional calculus
- 2. Usual derivatives and their properties. Caputo derivative and “first principles”
- 3. diffusion equation with fractional time derivative: solution by separation of variables
- 4. Numerical methods and simulations
- 5. Some applications

**¿Aceptarías que el curso se pudiera emitir por videoconferencia restringido a algunos alumnos del doctorado que no pudieran asistir presencialmente?**  
**Would you accept that the course could be given by videoconference restricted to some doctoral students who could not attend in person? YES**