Nonlinear systems

Research in the broad area of nonlinear systems encompasses a wide range of applications in engineering, industry, finance, environmental sciences and chemical and biological sciences, together with the development of fundamental mathematical theory and methodology.

In particular, application areas include nonlinear waves in alluvial river flows, oil pipe line flows, classical free surface flows and jets, while nonlinear oscillations are studied in feedback chemical reactions and hydrogen fuel cell models.

Reaction-diffusion theory is developed with emphasis of the evolution of travelling waves, extinction and blow-up in chemical, biological, medical and diffusive solvent systems. Mathematical theory is developed for singular non-Lipschitz reaction-diffusion systems, alongside the development of asymptotic methods for determining the large time structure for a generic class of nonlinear evolution PDE, such as the generalised Fisher, KdV, Burgers and KdV-Burgers equations.

Research on the theory of inverse problems in nonlinear PDE is focused around the development of stable numerical methodology, with particular applications in medical imaging and non-destructive testing.

The theory of autonomous holomorphic dynamical systems is also an active area of research, with attention being focused on generalised centre theorems for such systems. Methods are used to solve problems with multiple scales and with multiple physics.

Asymptotic methods used in quantitative finance are also studied.The research interests of the members of the group are given below.

Open all sections

Professor David Needham

Professor of Applied Mathematics,

Reaction-diffusion theory, evolution PDE, asymptotic methods, Holomorphic dynamical systems, nonlinear waves in fluids, porous media flows, two phase flows, morphological river hydraulics.

Profile (/staff/profiles/maths/needham-david.aspx)

Professor John Leach

Professor of Applied Mathematics, Head of Group

Non-linear waves with areas of expertise encompassing reaction-diffusion theory (both classical and singular), hyperbolic reaction-diffusion theory, non-linear evolution equations, dynamical systems and asymptotic methods.

Profile (/staff/profiles/maths/leach-john.aspx)

Dr Warren Smith

Lecturer

Applications of mathematics in engineering, material science and industry. Especially singular perturbation theory and moving boundary problems. Examples include: oscillations of a viscous drop; strongly nonlinear waves; planar-flow spin casting; semiconductor lasers and laser percussion drilling.

Profile (/staff/profiles/maths/smith-warren.aspx)

Dr Jamal Uddin

Lecturer

The application of fluid dynamics to industrial and engineering problems, including liquid jet breakup, nonlinear waves, asymptotics, hydrogen fuel cell modelling, electro- and magnetohydrodynamics, biological and pharmaceutical applications.

Profile (/staff/profiles/maths/uddin-jamal.aspx)

Dr Chris Gurney

KTN Research Fellow

Applications of fluid dynamics in chemical engineering and industrial applications, focussed on flows within fuel cell systems and liquid jet break-up. Work in conjunction with Intelligent Energy on PEM fuel cell design.