The course is an introduction to the modern theory of partial differential equations. The linear equations will include the classical heat, wave and Laplace equations. Amongst the nonlinear equations we shall consider Burger’s equation, the Kadomtsev-Petviashvili (KP) and Sine-Gordon (SG) equations, and the Navier-Stokes equations for incompressible, viscous flow. Some of these equations will be derived in class.

We shall examine classical solutions of the linear equations and a variety of techniques for obtaining them. This will include: separation of variables, Fourier transforms, Laplace transforms, and symmetry group reductions. The study of nonlinear equations will begin with the method of characteristics for first order pdes and we shall use this to introduce shocks and weak solutions of hyperbolic equations. Special solution techniques exist for several of the listed nonlinear equations and we shall investigate the simplest of these, the Hirota transformation.

The first figure is a solution of the SG which is defined in terms of elliptic functions. The second figure is a small amplitude solution of the KP equation.