Differential Equations Preliminary Exam Syllabus
Department of Mathematical Sciences
University of Cincinnati

Ordinary Differential Equation

Linear systems: linear systems with constant coefficients, phase portraits and dynamical classification, linear systems and exponentials of operators, linear systems and canonical forms of operators.

Fundamental theory: existence and uniqueness, continuity and differentiability of solutions in initial conditions, extending solutions, global solutions.

Nonlinear systems: nonlinear sinks and sources, hyperbolicity, stability, limit sets, gradient and Hamiltonian systems, other topics at instructor's discretion.

This material is covered in MATH7005

Suggested Texts:

Differential Equations and Dynamical Systems by Lawrence Perko

Partial Differential Equations

Four important linear partial differential equations: 1)Transport equations, initial value problem; 2) Laplace equation: fundamental solution, mean value formulas, Green's function; 3) Heat equation, fundamental solution, maximum principle; 4) Wave equations, solution by spherical means energy methods.

Nonlinear first-order PDEs: complete integrals, characteristics, introduction to Hamilton-Jacobi equations, and introduction to conservation laws.

Other ways to represent solutions: separation of variables, Fourier transform, Laplace transform, non-characteristic surfaces, real analytic functions, Cauchy-Kovalevskaya theorem.

This material is covered in MATH7006

Suggested Texts:

Partial Differential Equations (2nd edition) by Lawrence C. Evans