Syllabus for the Preliminary Exam in Differential Equations

The preliminary exam in differential equations for the Mathematics Department of the New Mexico Institute of Mining and Technology is designed to determine whether you have an adequate background in the theory of ordinary and partial differential equations to continue study at the Ph.D. level. The following areas are considered essential, and it is suggested that you work many problems in the areas listed below, taking examples from as many different sources as possible. The practice exams have examples of problems from all of these areas at approximately the level of those on the actual exam.

ODES

1. Liapunov functions

2. Poincarè-Bendixson theorem

3. Analysis of nonlinear systems

4. Nonlinear systems with a parameter dependent solution

5. Systems with generalized eigenvectors (and parameter dependence)

6. Homoclinic and heteroclinic connections

7. Stability of difference equations

PDES

1. First order equations / method of characteristics

2. Quasilinear equations / shocks

3. Classification of PDEs

4. Duhamel's principle

5. Transforms; Fourier, Laplace

6. Divergence theorem in three dimensions

7. Sturm-Liouville problems

BIBLIOGRAPHY

Elementary

1. William D. Stone, *Systems of Ordinary Differential Equations*

2. Stanley J. Farlow, *Partial Differential Equations for Scientists and Engineers*, Dover, 1993, ISBN 0-486-67620-X

3. Richard Haberman, *Elementary Applied Partial Differential Equations*, Second Edition, Prentice-Hall, 1983, ISBN 0-13-252875-4

Intermediate

1. Morris W. Hirsch and Stephen Smale, *Differential Equations, Dynamical Systems, and Linear Algebra*, Academic Press, 1974, ISBN 0-12-349550-4

2. Ronald B. Guenther, John W. Lee, *Partial Differential Equations of Mathematical Physics and Integral Equations*, Dover, 1988, ISBN 0-486-68889-6

3. James Ward Brown, Ruel V. Churchill, *Fourier Series and Boundary Value Problems*, Sixth Edition, McGraw-Hill Higher Education, ISBN 0-70-232570-4

4. Erich Zauderer, *Partial Differential Equations of Applied Mathematics*, John Wiley & Sons, 1989, ISSN 0079-8185

Advanced

1. E. C. Zachmanoglou, Dale W. Thoe, *Introduction to Partial Differential Equations with Applications*, Dover, 1986, ISBN 0-486-65251-3

2. A. N. Tychonov and A. A. Samarski, *Partial Differential Equations of Mathematical Physics*, vols. $1, 2$, Holden-Day, 1964,