Differential Equations

Math 7412
MWF 3-3:50 PM, Dulles Hall 0020

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Syllabus

- Review of properties of differential equations.
- Contractive mapping principle, existence and uniqueness of solutions.
- Overview of the theory of linear systems.
- Lower order systems, phase portraits.
- (Existence and uniqueness theorems; more general results)
- Singularities of linear systems.
  - Singularities of the first kind (or Fuchsian, or regular singularities).
  - Singularities of the second kind.
  - Normal forms.
- Eigenvalue problems; completeness of eigenvectors.
- Integrable and chaotic systems. Criteria of solvability.
- Equilibria.
- Stability (local, global, asymptotic). Lyapounov functions

- The Poincaré-Bendixson theorem.
- Global nonlinear techniques.
- Integrability versus chaos.
- Attractors, bifuractions, genericity.
- Stable and unstable manifolds.
- Bifurcations: the flip and Hopf bifurcation.
- Homoclinic and heteroclinic intersections.
- Anosov and circle diffeomorphisms.
- Flows on the torus.

Other subjects will be added, if they are of special interest to students.

References

[1] E.A. Coddington and N. Levinson, *Theory of Ordinary Differential Equations*, McGraw-Hill, New York, (1955).

[2] M.W. Hirsch, S. Smale and R.L. Devaney *Differential Equations, Dynamical Systems and an Introduction to Chaos*, 2nd Edition, Elsevier, New York, (2004).

[3] V.I. Arnold, *Geometrical Methods in the Theory of Ordinary Differential Equations*, 2nd edition, Springer, (1996).

[4] David Ruelle, Elements of differentiable dynamibs and bifurcation theory, Academic Press, 1989

[5] M. Brin, G. Struck, Introduction to dynamical systems, Cambridge University Press, 2002.