

King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics
MATH 595 Reading and Research I
Title: Global attractors
Semester II, 2018-2019 (182)
Dr. A. Bonfoh

Objectives: This course is designed to prepare students to take up research in the area of infinite-dimensional dynamical systems with applications to nonlinear PDEs.

Course Description:

This course will introduce students to the theory of global attractors for dissipative partial differential equations in infinite dimension. The course will cover Sobolev embedding theorems, existence and uniqueness of solutions, Semigroups, limits sets, the global attractor. As typical examples, attractors for reaction-diffusion equations and Navier-Stokes equations will be studied.

Credit: 3 credit hours

Text Book: J.C. Robinson, *Infinite-dimensional Dynamical systems*, Cambridge University Press, Cambridge, 2001

Additional Reading:

1. R. Temam, *Infinite-dimensional dynamical systems in Mechanics and Physics*, Second Edition, Springer-Verlag, New York, 1997.
2. Large time behavior of a conserved phase-field system, *Commun. Pure Appl. Anal.* 15 (2016), 1077-1105, by A. Bonfoh and C. D. Enyi.
3. A well posedness result for nonlinear viscoelastic equations with memory, *Nonlinear Analysis* 94 (2014), 206-216, by M. Conti, E.M. Marchini and V. Pata
4. Global attractors for a semilinear hyperbolic equation in viscoelasticity. *Journal of Mathematical Analysis and Applications* 260 (2001), 83-99, by C. Giorgi, J.E. Muñoz Rivera and V. Pata.

Week	Sections	Material
1	5.2 5.7 6.1 6.2 6.3	General Sobolev spaces The Sobolev embedding theorem Classical, strong and weak solutions Weak solution of Poisson's equation Higher regularity for the Laplacian
2	7.1 8.1 8.2 8.3 8.4	Banach spaces valued function spaces Nonlinear Reaction-Diffusion Equation The Basis for the Galerkin Expansion Weak solutions Strong solutions

3, 4	9.1 9.2 9.3 9.4 9.5 9.6	The Stokes operator The weak form of the Navier Stokes equation Properties of the trilinear form Existence of weak solutions Unique solution in 2d Existence of strong solutions in 2d
5, 6	10.1 10.2 10.3 10.4 10.5 10.6	Semigroups Dissipation Limits sets and attractors A theorem for the existence of global attractors An example- The Lorenz attractor Structure of the attractor
7, 8	11.1 11.2 11.4 11.5	Reaction-Diffusion Equation- Absorbing sets and the attractor Regularity results A Lyapunov functional The Chaffee-Infante equation
9, 10	12.1	Attractors for 2d Navier-Stokes equation
11	12.2	Attractors for the 3d Navier-Stokes equation
12-15	Case study	Well posedness and existence of the global attractor for the equations considered in the papers 2, 3 and 4 mentioned in "Additional reading"

Grading:

Class test I, II	20% each
Homework assignments/Presentations	30%
Final Exam	30%