King Fahd University of Petroleum and Minerals
Department of Mathematics and Statistics
**SYLLABUS**
Semester I: 2021-2022**(211)**

**Instructor:** Dr. A. Bonfoh
**Course #:** MATH 695 Reading and Research I
**Title:** Infinite-dimensional Dynamical Systems

**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:** The course will cover existence and uniqueness of solutions, Semigroups, limits sets, existence of the global attractor. As typical examples, attractors for reaction-diffusion equations, Navier-Stokes equations, the Cahn-Hilliard equation and the phase-field system will be studied.

**Credit:** 3 credit hours

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

**Papers to read :**
1.Large time behavior of a conserved phase-field system, by A. Bonfoh and C. Enyi (2016).
2.On Cahn-Hilliard-Gurtin equations, by A. Bonfoh and A.Miranville (2001).
3.Global Attractors of Sixth Order PDEs Describing the Faceting of Growing Surfaces, by M. Korzec et al. (2016).

| Week | Date | Sec. | Topics | Suggested Homework Problems |
|---|---|---|---|---|
| 1 | | | Some nonlinear analysis tools | |
| 2 | | 8.1<br>8.2<br>8.3<br>8.4 | Nonlinear Reaction-Diffusion Equation (NRDE)<br>The Basis for the Galerkin Expansion<br>Weak solutions of the NRDE<br>Strong solutions of the NRDE | |
| 3-4 | | 9.1<br>9.2<br>9.3<br>9.4<br>9.5<br>9.6 | The Stokes operator<br>The weak form of the Navier Stokes equation<br>Properties of the Trilinear form<br>Existence of weak solutions<br>Unique solution in 2d<br>Existence of strong solutions in 2d | |
| 5-6 | | 10.1<br>10.2<br>10.3<br>10.4<br>10.5<br>10.6 | Semigroups<br>Dissipation<br>Limits sets and attractors<br>A theorem for the existence of global attractors<br>An example- The Lorenz attractor<br>Structure of the attractor | |
| 7-8 | | 11.1 | Reaction-Diffusion Equation- Absorbing sets and the attractor | |

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| | | 11.2<br>11.4<br>11.5 | Regularity results<br>A Lyapunov functional<br>The Chaffee-Infante equation | |
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| 9-10 | | 12.1 | Attractors for 2d Navier-Stokes equation | |
| 11-15 | | | Reading of the above-mentioned papers (with a focus on the Cahn-Hilliard equation and phase-field systems) | |

**Overlap with regular courses**: less than 5%

**Grading:**

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| Midterm | 30% |
| Homework assignments | 30% |
| Presentation | 10% |
| Final Exam | 30% |