MATH 7/8047 -NONLINEAR PDEs-Fall 2020.

Instructor: Irena Lasiecka, Lasiecka@memphis.edu.

Time: MW, 4:00 PM -5:25 PM. DH 249.

Course Description and Objectives.

The main aim of the course is to provide a background in Nonlinear Functional Analysis suitable for studying topics in nonlinear PDE's, Mathematical Physics and Calculus of Variations. The course will start with variational analysis and theory of extremal problems in Banach spaces. This background material will allow us to built the foundations for several methods of nonlinear analysis suitable to address, on a qualitative level, solvability of some classes of nonlinear PDE's. Both static and dynamic models will be discussed. For the latter- some elements of semigroup theory combined with variational principles will be employed.

1.Variational problems for elliptic equations [ref:A]

- Projection Operators
- Variational Inequalities in Banach spaces.

2. Methods of Nonlinear Analysis [ref:A]

- Fixed Point Theorems.
- Nonlinear Galerkin Method
- Variational-Mountain Pass
- Compensated Compactness
- Blow-up Methods

3. Applications to [ref:B]

- **Static problems** : Elliptic equations: scalar and systems- elasticity; Stokes equations –fluids.; Maxwell equations**.** –electromagnetism**.**
- **Dynamic problems:** nonlinear heat equation, wave equation, Navier Stokes equation.

Texts:

A. S. Kesavan, Topics in Functional Analysis with Applications. Chapters 3, 5. New Age International Publishers,Third Edition 2019.

B. T.Cazenave and A. Haraux An Introduction to Semilinear Evolution Equations. Chapters 4-6,. Oxford Science Publications, 1998.

Additional background reading may be found in:
H. Brezis, Functional Analysis, Sobolev Spaces and PDE's. Springer,2011

Prerequisite: Real Analysis 7351- 7352. Functional Analysis desired but not required. The needed background will be provided during the lectures.

Grading Policy: Presentation in class and 3 graded homework. Work in groups is encouraged. However solutions need to be written down individually.

Grading Scale: A-B-C-F with (+)and (-)

Disability Statement: "The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in Wilder Tower."

Academic Misconduct statement. For information about academic misconduct policies and procedures;see: http://www.memphis.edu/studentconduct/academic-misconduct/process.php

Student Accommodations

Students with accessibility issues or learning accommodation issues due to a disability should contact Disability Resources for Students (DRS) to submit an official request for course accommodations. Contact DRS at 901.678.2880 or at drs@memphis.edu. (https://www.memphis.edu/drs/index.php)

Academic Integrity

Plagiarism, cheating and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly, through participation or assistance, are immediately responsible to the instructor of the class in addition to other possible disciplinary sanctions which may be imposed through the regular institutional disciplinary procedures. (https://www.memphis.edu/osa/students/academic-misconduct.php)

Student Health

Students who have a positive COVID-19 test should contact the Dean of Students at deanofstudents@memphis.edu.

Student Resources

Students who need additional resources can visit the Dean of Students Office website at https://www.memphis.edu/deanofstudents/crisis/index.php.

If we return to face-to-face instruction [fully on ground or hybrid] the following applies:

COVID-19 Health and Safety Policy - Masks and Social Distancing

All students, faculty and staff will wear masks in all public spaces, including our classroom (lab) per the COVID-19 policy. The first time a student enters

a classroom without wearing a face covering, the student will be asked to leave the class until they return a covering. Further violations will be referred to the Office of Student Accountability. Students who repeatedly or flagrantly violate these community expectations may be referred for discipline under the Student Code and, if appropriate, immediately removed from campus by the Dean of Students.

Student Health

Students who are experiencing symptoms such as sneezing, coughing or a higher than normal temperature should inform me by email so they can be excused from class and should stay home. Students should contact their health care provider or the Student Health Center at https://www.memphis.edu/health/.

Students who have a positive COVID-19 test should contact the Dean of Students at deanofstudents@memphis.edu.

Student Accommodations

If and when we return to class, students seeking to remain remote for health or other serious reasons should discuss their options with me. Students with accessibility issues or with other learning