King Fahd University of Petroleum & Minerals
Department of Mathematics & Statistics

(Fall 2013 - 2014)

Math 690

Linear Elliptic Partial Differential Equations

Objective: This course is intended to introduce students to the functional analysis approach and modern theory of solving PDE's arising in mathematical physics and prepare them for further studies and research in the domain of PDE's.

Outcomes: By the end of the course, the students should be able to use the modern ideas of Functional Analysis to

1) Deal comfortably with Sobolev spaces
2) Solve some linear elliptic (stationary) problems
3) Have a vision to future research

Prerequisite: Math 531 (Math 535 or Math. 538 are recommended).

Syllabus

Course #:	MATH 690
Title:	Linear Elliptic Partial Differential Equations
Textbook:	*Functional Analysis, Sobolev spaces, and PDE's, Haim Brezis, Springer, Universitex 2011*
References	Partial Differential Equations, L.C. Evans (AMS), Second Edition.
Course Description	Sobolev spaces, Lax Milgram Lemma, linear and nonlinear elliptic problems, Existence and regularity, maximum principle.
Objectives:	This course is intended to introduce students to the functional analysis approach and modern theory of solving PDE's and prepare them for further studies in the subject.

Week #	Chapter	Section	HW
1	**Chapter 4:** L^p **Spaces: Review**	4.1 Some Results about Integration That Everyone Must Know 4.2. Definition and Elementary Properties of L^p Spaces	4.3, 4.6, 4.15, 4.19, 4.28
2		4.3 Reflexivity. Separability. Dual of L^p 4.4. Convolution and regularization	
3	**Chapter 8:** **Sobolev Spaces and the Varia-tional Formulation of Boundary Value Problems in One Dimension**	8.1 Motivation	
4-5		8.2. The Sobolev Space: Weak derivatives, Definitions, properties, Extension, Embeddings	8.1, 8.4, 8.8, 8.13, 8.18, 823 (1,2,3), 8.25 (1-5)
6		8.3 $\mathbf{W}^{1,p}$**_0**: Definitions, Poincaré's inequality.	8.34 (1,2,3)
7		Higher order Sobolev spaces	
8		8.4 Some Examples of Boundary Value Problems	8.36: A (1,2,3), B
9	**Chapter 9: Sobolev Spaces and the Variational Formulation of Elliptic Boundary Value Problems in *N* Dimensions**	9.1. Definition and Elementary Properties of the Sobolev Spaces $\mathbf{W}^{1,p}$ (Ω)	
10		9.2. Extension Operators 9.2. Sobolev Inequalities	
11		9.4. The Space $\mathbf{W}^{1,p}$**_0** (Ω):Definitions, Poincaré' s inequality	
12		9.5 Variational Formulation of Some Boundary Value Problems	
13		9.6. Regularity of Weak Solutions	
14		9.7. The Maximum Principle	
15	**Cutch up**		

Grading policy: HW + Presentations: 40%, Midterm I: 30%, Midterm II: 30 %