

# King Fahd University of Petroleum & Minerals

Department of Mathematics & Statistics

( Spring 2010 - 2011 )

**Course #:** MATH 590  
**Title:** Advanced Partial Differential Equations (Modern Approach)  
**Textbook:** Partial Differential Equations, L.C. Evans  
**References**  
1) *Functional Analysis, Sobolev spaces, and PDE's*, Haim Brezis, Springer, Universitex 2010  
2) *Elements of nonlinear analysis*, Chipot M., Birkhuser 2000.  
**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 #	MATERIAL
1	Sobolev Spaces: Weak derivatives, Definitions, properties
2	Approximation: smooth functions, Interior approximation, global approximation
3	Extension
4-5	Embedding & Sobolev Inequalities: Gagliardo-Nirenburg-Sobolev inequality, Morrey's inequality, General inequalities, Compact embedding,
6	The space $W^{1,p}_0$ : Definitions, Poincaré's inequality,
7	Dual spaces: Definition and Representation
8-9	Linear Elliptic inequalions: Definitions and weak solutions, Lax-Milgram Lemma, Dirichlet and Neumann Problems and solutions
10	Regularity: Interior and boundary regularity
11	Maximum Principle: Weak and strong maximum principle
12-14	Nonlinear Elliptic Problems: : Maximal Monotone operators in Hilbert spaces, A motonocity method, A compactness method
15	Catch up