KINGDOOM OF SAUDI ARABIA
Ministry of Education
Al-Imam Mohammad Ibn Saud Islamic University
College of Sciences
Department of Mathematics & Statistics

المملكة العربية السعودية
وزارة التعلـيـم
جامعة الإمام محمد بن سعود الإسلامية
كلية العلوم
قسم الرياضيات والإحصاء

SYLLABUS

Course Code	Course Num.	Course Name	Credit Hours	Lec.	Lab.	Tut.	Private study	Pre-requisites	Course Level	Teaching Language
MAT	**615**	**Applied Functional Analysis**	**4**	**3**	**0**	**1**	**8**		**3-4**	**English**

A. Course Description

This course describes the most important ideas, theoretical results of Functional Analysis in order to introduce the Sobolev space $H^1(I)$ with application to some linear PDEs. The main topics of this course are the measure, integration, the Hilbert space $L^2(I)$, and the distribution theory. Of particular importance is also the notion of weak derivative so as to define the Hilbert space $H^1(I)$ and employ it as adequate setting to formulate some Dirichlet and Neumann BVPs for simple linear PDEs.

B. Course Outcomes

At the end of this course the student will be able to:

1. Introduce the Hilbert space $L^2(I)$ together with its main properties and weak convergence.
2. Introduce the Sobolev space $H^1(I)$ where I is an open subset of the real line.
3. Review the fundamentals on test functions and distribution theory as well as the calculus on distributions including convergence of distributions.
4. Show how the functional setting of the Sobolev space $H^1(I)$ can be used to derive variational formulation for some one-dimensional linear partial differential equations.

C. References

Required Textbook

Functional Analysis, Sobolev Spaces, and Partial Differential Equations, H. Brezis, Springer, 2010.

Other references

1. *Partial Differential Equations*, L.C. Evans, 2nd Edition, American Mathematical Society, 2010.
2. *Distributions*: Theory and Applications, J.J. Duistermaat, J.A.C. Kolk, Springer, 2006.
3. *Elements of Functional Analysis*, F. Hirsch, G. Lacombes, Springer, 1999.

Course Website: Google Classroom Webpage: http://www.imamm.org/

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D. Topics Outline

1. **The Hilbert Space $L^2(I)$, $I \sqsubseteq R$**: Basic Properties, Cauchy-Schwarz Inequality, Convergence in Norm. Riesz-Fisher Theorem and the Complete Space L^2, Riesz-Frechet Representation Theorem and Reflexivity, Convolution and Regularization. Separability.

2. **Review Of Distribution Theory:** The Space $\mathbf{D}(I)$ of Test Functions, $I \sqsubseteq R$, Support of a Distribution, Regularization and Approximation, Derivative of a Distribution, The Space $\mathbf{D'}(I)$: Calculus on Distributions, Antiderivative of a Distribution, Convergence of Distributions, Applications: Fundamental Solutions of Some ODEs.

3. **The Sobolev Space $H^1(I)$, $I \sqsubseteq R$**: Definitions and Properties, Mollifiers and Density Theorems, Sobolev Imbedding Theorems, Product, Composition, and Differentiation in $H^1(I)$. Trace Operator and $H_0^1(I)$, The Dual Space $H^{-1}(I)$: Definitions and Properties, Poincare-Wirtinger Inequality.

4. **Variational Formulation of Linear Bvps:** Linear PDEs for Laplacian Operator, Lax-Milgram Theorem, Weak Solution, Classical Solution, Maximum Principle.

E. Office Hours

Office hours give students the opportunity to ask in-depth questions and to explore points of confusion or interest that cannot be fully addressed in class.

F. Exams & Grading System

The semi-official dates of the exams for this course are:

- **Midterm:** 8th or 9th week.
- **Quizzes & Homework:** During the semester.
- **Final Exam:** 16th week.

Your course grade will be based on your semester work as follows:

Midterm : 30 %	Final Exam: 40 %
4 Quizzes + 4 Homeworks, Attendance & Participation: 30 %	

The grading distribution:

A^+	A	B^+	B	C^+	C	F
[95, 100]	[90, 95)	[85, 90)	[80, 85)	[75, 80)	[70, 75)	[0, 70)

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G. Student Workload:

#	Teaching/learning activities	Contact Hours	Frequency	Total Contact hours	Self-study hours	Total self-study hours	Student Learning Time
1	Lecture	3	15	45	1.5	22.5	67.5
2	Tutorial	1	15	15	3	45	60
3	Lab\Practical	0	0	0	0	0	0
4	Homework	0	4	0	1.5	22.5	22.5
5	Quiz	0.25	4	1	1	4	5
6	Test (Midterm)	2	1	2	12	12	14
7	Final Exam	2	1	2	12	12	14
Total				65		118	183

Independent self-study = 118/15 $\cong$ 8 hrs per week

H. Student Attendance/Absence

Only three situations will be considered as possible excused absences:

- Occurrence of a birth or death in the immediate family will be excused. ("Immediate family" is defined by the University as spouse, grandparents, parents, brother, or sister).
- Severe illness in which a student is under the care of a doctor and physically unable to attend class will be excused. Students are not excused for a doctor's appointment. Do not make appointments that conflict with rehearsals. Notes from the University Health Center will be accepted.

Executive Rules for Study Regulations and Examsgoo.gl/ykm7t3