Detailed Course Description - Course Plan Development and Updating Procedures/ Mathematics Department	QF01/0408-3.0E

Faculty	Faculty of Science and Information Technology	**Department**	Mathematics
Course number	0101452	**Course title**	Functional Analysis
Number of credit hours	3	**Pre-requisite/co-requisite**	Real Analysis (2) 0101353

Brief course description
A first course in functional analysis. Topics include metric spaces, normed linear spaces, inner product spaces, Hilbert spaces, Banach spaces, bounded linear operators on these spaces, and fixed point theorems.

Course goals and learning outcomes	
Goal 1	**Understand the basic facts about metric space, normed linear spaces and inner product spaces.**
Learning outcomes	1.1 Students will be able to list the basic definition and properties of metric space, normed space, and inner product spaces. 1.2. Recognize the classical examples of metric space, normed space and inner product spaces. 1.3. 2.2. Students will be able to know the relation between metric space, normed space, and inner product spaces.
Goal 2	**Know the basic concepts of Banach spaces and Hilbert spaces**
Learning outcomes	2.1. Students will be able to list the basic definition and properties of Banach space and Hilbert space. 2.2. Students will be able to differentiate between Banach space and Hilbert space. 2.3. Describe some applications of Banach space and Hilbert space and some examples of such spaces.
Goal 3	**Know the basic facts about bounded linear functionals and bounded linear operators.**
Learning outcomes	3.1. State the definition and properties of continuous linear operator as well as functionals and duality. 3.2. Describe some applications of linear operator and linear functional.
Goal 4	**State and prove basic results about Projection, Orthogonality and Riesz representation theorem.**
Learning outcomes	4.1. Students will be able to list the basic definition and properties of Projection, Orthogonality and Riesz representation theorem. 4.2.Describe concrete examples for projection and orthogonality as well as Reisz representation theorem.

Textbook	1. E. Kreyszig, Introductory Functional Analysis with Applications, Wiley, New York, 1980**.**
Supplementary references	1. J.B. Conway , A Course in Functional Analysis, 2nd ed., Springer-Verlag, New York, 1990. 2. I. Gohberg and S. Goldberg, Basic Operator Theory, Birkhauser, Boston, 1981. 3. C.W. Groetsch, Elements of Applicable Functional Analysis, Dekker, New York, 1980. 4. A.E. Taylor and D.C. Lay, Introduction to Functional Analysis, 2nd ed., Wiley, New York, 1980.

Course timeline			
Week	**Number of hours**	**Course topics**	**Pages (textbook)**
01	1 1 1	Metric spaces Further example of metric spaces	1-16
02	1 1 1	Open set, closed set and neighborhood in metric space Convergence sequence in metric space	17-27
03	1 1 1	Cauchy sequence in metric space Complete metric space	28-40
04	1 1 1	Examples of completeness in metric space Normed space	41-50
05	1 1 1	Banach space Further properties of normed spaces	51-71
06	1 1 1	First Exam 20% Finite dimensional normed spaces and subspaces	73-81
07	1 1 1	Linear operators Bounded linear operators	82-85
08	1 1 1	Continuous linear operators Linear functionals	86-110
09	1 1 1	Linear operators and Linear functionals on finite dimensional spaces	111-116
10	1 1 1	Normed space of operators Dual space	117-126
11	1 1 1	Inner product space Further example of Inner product space	127-136
12	1 1 1	Hilbert space Further properties of inner products spaces	137-141
13	1 1 1	Second Exam 20% Orthonormal Orthonormal systems	142-150
14	1 1	Zorn's Lemma Hahn-Banach Theorem	209-217

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15	1 1 1	Fixed point theorems	299-306
16	1 1 1	Final Exam 50%	

Theoretical course evaluation methods and weight	Participation = 10% First exam 20% Second exam 20% Final exam 50%	**Practical (clinical) course evaluation methods**	Semester students' work = 50% (Reports, research, quizzes, etc.) Final exam = 50%

Approved by head of department		**Date of approval**	

Extra information (to be updated every semester by corresponding faculty member)

Name of teacher	Prof. Iqbal Jebril	Office Number	127
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Office hours			