AYDIN ADNAN MENDERES UNIVERSITY
COURSE INFORMATION FORM

Course Title	Inverse Problems and Applications								
Course Code	MTK647		Couse Level		Third Cycle (Doctorate Degree)				
ECTS Credit	7.5	Workload	188 *(Hours)*	Theory	3	Practice	0	Laboratory	0
Objectives of the Course	The purpose of this course is to introduce and to understand theory and solution for linear and nonlinear inverse problems with emphasis on regularization techniques and parameter estimation, and the course also aims to gain the ability of researching using modern approaches in this field in both theoretically and practically.								
Course Content	Overview of inverse problems, and some examples of direct problems, the definition of ill-posed and ill-conditioned problems, the deconvolution problem, Tikhonov regularization, Truncated Fourier decomposition, Regularization parameter selection, generalized Tikhonov regularization with Bayesian perspective, ill-posedness and regularization of linear operators in function spaces, compact operators, Singular value decomposition (SVD), Least squares solution, Minimization of quadractic functionals, Truncated SVD, Generalized Tikhonov /Bayesian regularization, some inverse problems and their applications.								
Work Placement	N/A								
Planned Learning Activities and Teaching Methods	Explanation (Presentation), Discussion, Individual Study, Problem Solving								
Name of Lecturer(s)									

Assessment Methods and Criteria		
Method	Quantity	Percentage (%)
Midterm Examination	1	30
Final Examination	1	50
Assignment	1	20

Recommended or Required Reading	
1	Curtis R. Vogel, H. T. Banks, Computational Methods for Inverse problems (Frontiers in Applied Mathematics), Society for Industrial and Applied Mathematics (SIAM), ISBN-13: 978-0898715071, 2002.
2	Andreas Kirsch, An Introduction to the Mathematical Theory of Inverse Problems (Applied Mathematical Sciences, Vol. 120), 2nd Edition, Springer, ISBN-13: 978-1441984739, 2011.
3	Jennifer L. Müller, Samuli Siltanen, Linear and Nonlinear Inverse Problems with Practical Applications (Computational Science and Engineering), ISBN-13: 978-1611972337, Society for Industrial and Applied Mathematics (SIAM), 2012
4	Richard C. Aster, Brian Borchers, Clifford H. Thurber, Parameter Estimation and Inverse Problems, Second Edition, Academic Press, ISBN-13: 978-0123850485, 2012.

Week	Weekly Detailed Course Contents	
1	Theoretical	Overview of inverse problems, and some examples of direct and inverse problems
2	Theoretical	Ill-posed and ill-conditioned problems
3	Theoretical	The deconvolution problem
4	Theoretical	Tikhonov regularization
5	Theoretical	Truncated Fourier decomposition
6	Theoretical	Regularization parameter selection
7	Theoretical	Generalized Tikhonov regularization with Bayesian perspective
8	Theoretical	Ill-posedness and regularization of linear operators in function spaces, compact operators
9	Preparation Work	All subjects covered
	Intermediate Exam	Midterm Exam
10	Theoretical	Singular value decomposition (SVD)
11	Theoretical	Least squares solution and minimization of quadractic functionals
12	Theoretical	Truncated SVD and Generalized Tikhonov /Bayesian regularization
13	Theoretical	Some applications of inverse problems (Inverse heat transfer and heat conduction problems)
14	Theoretical	Some applications of inverse problems (Image Deblurring Problems)
16	Final Exam	Final Exam

Workload Calculation				
Activity	Quantity	Preparation	Duration	Total Workload
Lecture - Theory	14	2	3	70
Assignment	1	24	2	26
Midterm Examination	1	40	2	42
Final Examination	1	48	2	50
			Total Workload (Hours)	188
			[Total Workload (Hours) / 25*] = **ECTS**	7.5
**25 hour workload is accepted as 1 ECTS*				

Learning Outcomes	
1	Ability to understand the concept of ill-posed problems
2	Ability to understand parameter estimation problem
3	Ability to use regularization methods for selecting parameters
4	Ability to develop and implement some methods for inverse problems
5	To be able to use mathematical concepts in solving certain types of problems

Programme Outcomes *(Mathematics Doctorate)*	
1	To be able to develop the current and advanced knowledge of mathematics domain to expertise level by an original idea or research, based on the level of its knowledge at the graduate level, and to be able to reach original definitions that will bring innovation to Mathematics.
2	To be able to comprehend the interdisciplinary interaction associated with Mathematics.
3	To be able to use and evaluate the new knowledge in the field of Mathematics with a systematic approach.
4	To be able to develop an idea, a method, a design or an application that will bring innovation to Mathematics, to use well known ideas, methods, designs or applications on a different research area, or to search, comprehend, design, adapt and apply an original subject matter.
5	To be able to criticize, analyze, synthesize and evaluate new and complex ideas.
6	To be able have high-level skills in research methods related to studies on Mathematics.
7	To be able to expand the frontiers knowledge in the field of Mathematics via generating or interpreting an original study, or publishing at least a scientific paper in national/international refereed journals.
8	To be capable of leadership in the positions that require the analyses of problems related to the field of Mathematics.
9	To be able to defend his/her original ideas among the experts in the discussion of math related issues, and to be able to communicate effectively to show his/her competence in the field of Mathematics.
10	To be able to contribute to the solution of the social, scientific, cultural and ethical problems related to the Mathematics, and to be able to support the development of social, scientific, cultural and ethical values.
11	To be able to have both oral and written communication using a foreign language.

Contribution of Learning Outcomes to Programme Outcomes *1:Very Low, 2:Low, 3:Medium, 4:High, 5:Very High*

	L1	L2	L3	L4	L5
P1	4	4	4	5	4
P2	4	3	3	5	5
P3	4	3	3	5	5
P4	4	3	3	5	4
P5	4	3	3	5	5
P6	4	4	4	5	4
P7				3	3
P8				3	3
P9	3			3	
P10				3	3
P11	3	3	3	3	3