ABDULLAH GÜL UNIVERSITY
GRADUATE SCHOOL OF ENGINNERING & SCIENCE
INDUSTRIAL ENGINEERING DEPARTMENT
COURSE DESCRIPTION AND APPLICATION INFORMATION

Course Name	Code	Semester	T+P (Hour)	Credit	ECTS
Mathematics for Optimization	IE 501	Fall - Spring	3 + 0	3	10

Prerequisites	No prerequisite Undergraduate level Calculus and Linear Algebra courses are recommended / expected.

Course Type	Elective
Course Language	English
Course Coordinator	Assoc. Prof. Zübeyir Çınkır
Course Instructor	Assoc. Prof. Zübeyir Çınkır
Course Assistant	…
Course Objective	In order to create the mathematical background required to follow the other courses in the graduate programs and to provide the students with formal mathematical reasoning, the main topics in the courses of undergraduate Reel Analysis and Linear Algebra courses are dealt with in a deeper analysis and understanding.
Course Learning Outcomes	1. Learning basic knowledge and proof techniques about propositional logic and applying them in later topics such as sets, functions and elementary analysis 2. Learning basic features of sets and functions as abstract algebra subject 3. Learning of the properties of $\cup$ and $\cap$ as a set, ordered field and metric space and applying $\varepsilon - \delta$ technique to continuity, sequence and function limits. 4. To learn the basic properties of metric spaces and standard features such as Euclidean spaces as well as some of the topological concepts related to metric spaces 5. Learning the basic results of the convergence tests, absolute convergence and changing the order of the index of the series and solving related problems. 6. To learn the main concepts of vector spaces, matrices and linear transformations and to prove the basic results in the subjects. 7. Learning the basic properties and results related to inner product, norm, orthogonality, eigenvalues and positive definitivity and solving related problems.
Course Content	• Propositional Logic and Proof Techniques, • Sets and functions • Properties of $\cup$ and $\cap$, • Metric spaces, • Series, • Vector spaces, matrices and linear transformations, • Inner product, norm, orthogonality, • Eigenvalue, determinant and positive definitivity.

WEEKLY SUBJECTS AND RELATED PRELIMINARY PREPARATION PAGES

Week	Subjects	Preliminary
1	**Propositional Logic and Proof Techniques:** Propositions, logical conjunctions, logic rules; Analogies between logic, sets and bit operations; Negation of a proposition, inverse of negation; Open proposition, existential and universal quantifiers, nested quantifier.	
2	**Propositional Logic and Proof Techniques:** Direct proof, indirect proof, conditional proof, proof by contraposition, proof by contradiction, counter example, proof by cases, constructive proofs including sets and functions.	
3	**Sets, relations and functions:** Function definition of symbolic logic, using one-to-one and onto	

	definitions of sets in limit definition; properties of $\cup$ and $\cap$, image and inverse image of a set under a function; Countable and uncountable sets; Definition of relation and reflection, symmetry	
4	**Properties of $\cup$ and $\cap$:** Properties of of $\cup$ and $\cap$ as a set and ordered field; minimum, maximum, minimum upper bound, maximum lower bound properties of a set and whether they are in that set (especially for subclasses of $\cup$ and $\cap$); properties of the smallest upper bound and the largest lower bound; series and subsequences in $\cup$ and $\cap$	
5	**Properties of $\cup$ and $\cap$:** Sequence and function limits of the $\varepsilon - \delta$ technique and its role in continuous functions; properties of $\cup$ and $\cap$ as a metric space (without mentioning the concept of metric space): for example, open and closed sets, accumulation point, isolated points, Bolzano-Weierstrass theorem.	
6	**Properties of $\cup$ and $\cap$:** Convergence of sequences, Cauchy sequences, basic results on the convergence of sequences, definitions and properties of Lim inf and Lim sup.	
7	**Metric Spaces:** Metric space definition and Euclidean space, discrete metric space, metric spaces, C [a, b] (real valued and set of continuous functions in [a, b]), B (S) (A set of real valued and limited functions defined on a set of S) And the uniform convergence distance over it, as metric space examples; Limit of defined sequences in metric space, convergence and properties of these sequences.	
8	**Metric Spaces:** The basic topological features of metric spaces are: open and closed sets, open or closed spheres, inner, outer and boundary clusters, closure of a set, accumulation point, compact sets, perfect sets, linked sets; Compact sets features; Heine-Borel theorem, properties of complete metric spaces.	
9	**Metric Spaces:** Continuity of functions defined between two metric spaces; Uniform continuity; The relation of compactness and continuity to continuous functions.	
10	**Series:** Convergence tests related to the series; Absolute and conditional convergence, changing the index order of the series.	
11	**Midterm Exam**	
12	**Vector spaces, matrices and linear transformations:** Basic characteristics of matrices; Elementary row operations; Gauss elimination, Gauss-Jordan elimination, solutions of linear equation systems; Vector spaces, subspaces, linearly dependent and linear independent vectors, base and size of a vector space, coordinate and base change.	
13	**Vector spaces, matrices and linear transformations:** Row, column and kernel spaces of a matrix, rank of a matrix, linear transformations and matrices; linear transformation of the kernel and image spaces; matrix representation of linear transformation.	
14	**Inner product, norm and orthogonality:** Inner product, norm, orthogonality of vectors and vector spaces, complement of subvector spaces; Gram-Schmidt operation; trace of a vector that is an outline that encompasses another vector; trace of a vector to a vector space stretched by a set of vectors; Least Square Approach; Moore-Penrose (pseudo) inverse of a matrix.	
15	**Eigenvalues, determinant and positive definiteness:** Properties of determinants, co-factor expansion; Eigenvalues and eigenvectors of matrices; Diagonal form of the matrix; Quadratic forms, positive definite quadratic forms with matrices and their applications to the conic sections and the extreme values of functions.	

16	**Final Exam**	

SOURCES	
Lecture Notes	Lecture notes and slides of the course will be shared with students during the semester via CANVAS system.
Other Sources	**Textbooks:** 1. Kenneth H. Rosen, *Discrete Mathematics and its Applications*, 7th Edition, McGraw-Hill Companies Inc., 2011. 2. Walter Rudin, *Principles of Mathematical Analysis*, Pearson Prentice Hall, 2006. 3. Tosun Terzioğlu, *An Introduction to Real Analysis*, METU Publications, Ankara. 4. David C. Lay, Steven R. Lay, Judi J. McDonald, *Linear Algebra and Its Applications*, 5th Edition, Pearson Education Inc., 2016. **Supplementary Textbooks:** 1. Erhan Çınlar and Robert J. Vanderbei, *Mathematical Methods of Engineering Analysis*. http://www.princeton.edu/~rvdb/506book/book.pdf 2. Levent Kandiller, *Principles of Mathematics in Operations Research*, Springer, 2007. 3. Bernard Kolman and David R. Hill, *Elementary Linear Algebra with Applications*, 9th Edition, Pearson Education Inc., 2008.

MATERIAL SHARING	
Documents	will be shared with students during the semester via CANVAS system.
Homework	will be shared with students during the semester via CANVAS system.
Exams	1 (one) midterm exam and 1 (one) final exam. 2 exams in total

EVALUATION SYSTEM		
ACTIVITIES	**QUANTITY**	**WEIGHT**
Quiz	1	%30
Homework	10	%30
Final Exam	1	%40
TOTAL		%100
Term Activities Percentage		%60
Final Exam Percentage		%40
TOTAL		%100

Course Category	
Natural Sciences and Mathematics	%90
Engineering Sciences	%10
Social Sciences	%0

LEARNING OUTCOMES AND PROGRAM QUALIFICATIONS RELATIONSHIP						
No	Program Qualification	Contribution Level				
		1	2	3	4	5
1	PQ1.				x	
2	PQ2.				x	
3	PQ3.					x
4	PQ4.		x			
5	PQ5.			x		
6	PQ6.	x				

* Increasing from 1 to 5

ECTS / WORK LOAD TABLE			
Activities	Activity	Duration (Hour)	Total Work Load
Course Duration (including exam week: 16x total course hours)		3	48
Out-of-class Study Time (Pre-study, practice)		3	48
Reading		1,5	15
Internet browsing, library work		1	10
Homework		10	100
Midterm		30	30
Final Exam		50	50
Total Work Load			301
Total Work Load / 30			10,03
Course ECTS CREDIT			10