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	**0101322**	Course title	**Linear Algebra (2)**
Number of credit hours	**3**	Pre-requisite/co-requisite	**Linear Algebra (1) (0101221)**

Brief course description
The course introduces abstract vector spaces and linear transformations, similarity of matrices, eigenvalues and eigenvectors. The contents are of vital importance in all fields of mathematics and in science in general.

Course goals and learning outcomes	
Goal 1	Learn about and work with vector spaces and subspaces
Learning outcomes	1.1 Use the definition of vector space to determine if a given set of vectors is a vector space. 1.2 Determine if a subset of a vector space is a subspace 1.3 Determine if a given set of vectors is a basis for a vector space. 1.4 Determine the dimension of a subspace. 1.5 Find the column space, row space, and null space of a matrix.
Goal 2	Learn about inner products and their uses.
Learning outcomes	2.1 Compute the inner product of two vectors. 2.2 Find the length of a vector and the distance between two vectors. 2.3 Determine if sets of vectors are orthogonal and find orthogonal projections. 2.4 Apply Gram-Schmidt orthogonalization algorithm.
Goal 3	Learn to find and use eigenvalues and eigenvectors of a matrix.
Learning outcomes	3.1 Find the characteristic equation, eigenvalues and corresponding eigenvectors of a given matrix. 3.2 Determine if a given matrix is diagonalizable. 3.3 Identify special properties of symmetric matrices and orthogonal diagonalization of symmetric matrices. 3.4 Diagonalization of quadratic forms.
Goal 4	Learn about and work with linear transformations.
Learning outcomes	4.1 Determine if a transformation is linear. 4.2 Find matrix representations for a linear transformation. 4.3 Find the range and kernel of a transformation. 4.4 know the relation between the rank and nullity of a linear transformation.

Textbook	Elementary Linear Algebra, by Howard Anton, 8th Edition
Supplementary references	1. "Linear Algebra and its Applications", by David C. Lay and Steven R. Lay and Judi J. McDonald, 5th Ed., (2015), Addison-Wesley. 2. "Elementary Linear Algebra", B. Kolman and D. Hill, 9th Ed., (2008), Pearson. 3. "Linear Algebra with Applications", Steven J. Leon, 9th Ed., (2015), Pearson. 4. "Linear Algebra; An introduction", by R. Larson, 8th Ed., (2017), Cengage.

Course timeline

Week	Number of hours	Course topics	Pages (textbook)
01	1 1 1	**I. <u>Row space, Column space and Null space</u>** Consistency and the general solution of a linear system $AX=B$. Bases for the row space , column space and null space.	246-259
02	1 1 1	Rank and nullity of a matrix . Relatioship between rank and nullity (the dimension theorem)	259-270
03	1 1 1	**II. <u>Real Inner- Product Spaces</u>** Properties. Length and distance in an inner- product space.	275-286
04	1 1 1	Cauchy-Schwarz inequality . Triangle inequality . Angle between two vectors.	287-297
05	1 1 1	Orthogonality. Orthogonal and orthonormal sets . Gram-Schmidt Process.	298-311
06	1 1 1	Coordinates relative to orthonormal bases . QR – Decomposition of an m×n matrix .	298-311
07	1 1 1	**First Exam 20%** Orthogonal matrices. Change of bases and transition matrix	320-330
08	1 1 1	**III. <u>Eigenvalues, Eigenvectors and Diagonalization</u>** Bases for eigenspaces . Finding the eigenvalues of any positive integer power, the transpose and the inverse (if exists) of a square matrix.	337-346
09	1 1 1	Procedure for diagonalizing a matrix . Relationship between having distinct eigenvalues and diagonalizability. Diagonalization and computing powers of a matrix .	347-354
10	1 1 1	Orthogonal diagonalization. Symmetric matrices and orthogonal diagonalizability.	357-360

11	**1** **1** **1**	**IV. <u>Linear Transformations (L.Ts.)</u>** Finding linear transformations from images of bases vectors. Composition of linear transformations. Kernel and range of a L.T.	365-373
12	**1** **1** **1**	Rank and nullity of a L.T. Dimension theorem for L.Ts. One-to-one L.Ts and their inverse L.Ts.	376-387
13	**1** **1** **1**	**Second Exam. 20%** Matrices of general L.Ts. Similar matrices.	390-411
14	**1** **1** **1**	**V. <u>Applications to Quadratic Forms</u>** Matrix representation of quadratic forms . Positive definite quadratic forms.	447-453
15	**1** **1** **1**	Diagonalization of quadratic forms . Quadratic forms and conic Sections. Quadratic forms and quadric Surfaces.	454-467
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	Amal H. Al-Saket	**Office Number**	9114
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Office hours			