QF01/0408-4.0E	Course Plan for Bachelor program - Study Plan Development and Updating Procedures/ Mathematics Department

Study plan No.	**2021/2022**		**University Specialization**		**Bachelor of Mathematics**	
Course No.	**0101322**		**Course name**		**Linear Algebra (2)**	
Credit Hours	**3**		**Prerequisite/ Co-requisite**		**Linear Algebra (1)**	
Course type	☐ MANDATORY UNIVERSITY REQUIREMENT	☐ UNIVERSITY ELECTIVE REQUIREMENTS	☐ FACULTY MANDATORY REQUIREMENT	☐ Support course family requirements	✓ **Mandatory requirements**	☐ Elective requirements
Teaching style	☐ Full online learning		✓ **Blended learning**		☐ Traditional learning	
Teaching model	☐ 1 Synchronous: 1 asynchronous		✓ **1 face to face : 1 asynchronous**		☐ 2 Traditional	

Faculty member and study divisions' information (to be filled in each semester by the subject instructor)

Name	Academic rank	Office No.	Phone No.	E-mail	
Division number	**Time**	**Place**	**Number of students**	**Teaching style**	**Approved model**

Brief description

General vector space, Row space, Column space and Null space, Rank and nullity, Eigenvalues and eigenvectors, Similar matrices and diagonalization, Inner products, Inner products generated by matrices, Angle and orthogonality in inner product spaces, Orthonormal bases, Gram–Schmidt process, QR – decomposition, Diagonalization and quadratic forms, General linear transformations, Kernel and range, Inverse linear transformations

Learning resources

Course book information (Title, author, date of issue, publisher ... etc)	Elementary Linear Algebra, by Howard Anton, 8th Edition			
Supportive learning resources (Books, databases, periodicals, software, applications, others)	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.			
Supporting websites	1- https://en.wikipedia.org/wiki/Linear_algebra 2- http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/ 3- http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/			
The physical environment for teaching	✓ **Class room**	☐ labs	✓ **Virtual educational platform**	☐ Others
Necessary equipment and software				

Supporting people with special needs	
For technical support	

Course learning outcomes (S= *Skills, C= Competences K= Knowledge,)*

No.	Course learning outcomes	The associated program learning output code
	Knowledge	
K1	Recognize the notion of row space, column space and null space	MK1
K2	Recognize the notion of eigenvalues, eigenvectors and diagonalization	MK1
K3	Recognize the notion of linear transformation.	MK1
K4	Describe the different type of linear transformations.	MK2
K5	Memorize the properties of inner product spaces.	MK1
K6	Recognize quadratic forms.	MK2
	Skills	
S1	Justify whether a matrix is triangular, diagonalizable, symmetric, and/or orthogonal	MS1
S2	Use the definition and properties of similar matrices	MS2
S3	Analyze whether a linear transformation is one-to-one or onto.	MS4
S4	Verify the Cauchy-Schwarz Inequality, the Triangle Inequality, and the Pythagorean Theorem	MS5
	Competences	
C1	Work independently to solve assignments in the course.	MC1
C2	Develop the individual's ability to communicate and interact with other mathematical courses.	MC 2

Mechanisms for direct evaluation of learning outcomes

Type of assessment / learning style	Fully electronic learning	Blended learning	Traditional Learning (Theory Learning)	Traditional Learning (Practical Learning)
Midterm exam	30%	**30%**	40%	30%
Participation / practical applications	0	**0**	10%	30%
Asynchronous interactive activities	30%	**20%**	0	0
Final exam	40%	**50%**	50%	40%

Schedule of simultaneous / face-to-face encounters and their topics

Week	Subject	learning style	Reference
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.	Lecture	246-259
2	Rank and nullity of a matrix. Relationship between rank and	Lecture	

	nullity(the dimension theorem)		259-270
3	**II. Real Inner- Product Spaces** Properties. Length and distance in an inner- product space.	Lecture	275-286
4	Cauchy-Schwarz inequality. Triangle inequality. Angle between two vectors.	Lecture	287-297
5	Orthogonality. Orthogonal and orthonormal sets. Gram-Schmidt Process.	Lecture	298-311
6	Coordinates relative to orthonormal bases. QR – Decomposition of an m×n matrix.	Lecture	298-311
7	Orthogonal matrices. Change of bases and transition matrix.	Lecture	320-330
8	**III. Eigenvalues, Eigenvectors and Diagonalization** Bases for eigenspaces. Finding the eigenvalues of any positive integer power, the transpose and the inverse (if exists) of a square matrix. **Midterm Exam**	Lecture	337-346
9	Procedure for diagonalizing a matrix. Relationship between having distinct eigenvalues and diagonalizability. Diagonalization and computing powers of a matrix.	Lecture	347-354
10	Orthogonal diagonalization. Symmetric matrices and orthogonal diagonalizability.	Lecture	357-360
11	**IV. Linear Transformations (L.Ts.)** Finding linear transformations from images of bases vectors. Composition of linear transformations. Kernel and range of a L.T.	Lecture	365-373
12	Rank and nullity of a L.T. Dimension theorem for L.Ts. One-to-one L. Ts and their inverse L.Ts.	Lecture	376-387
13	Matrices of general L.Ts. Similar matrices.	Lecture	390-411
14	**V. Applications to Quadratic Forms** Matrix representation of quadratic forms. Positive definite quadratic forms.	Lecture	447-453
15	Diagonalization of quadratic forms.Quadratic forms and conic Sections. Quadratic forms and quadric Surfaces.	Lecture	454-467
16	**Final Exam**		

Schedule of asynchronous interactive activities (in the case of e-learning and blended learning)

Week	Task / activity	Reference	Expected results
1	Background	On vector space and bases. Students Notes or any Linear algebra book	Self-reading and Discussion
2	Video 1 Solving exercises	E-learning	Discussion in the class
3	Home work1: On the subjects studied on the first three weeks	(Lecture notes)	Submit a pdf or word sheet
4	Quiz 1	On the subjects studied on the first three weeks	Submitting on the E-learning
5	Assignment 1: On the rank and nullity.	Internet sources and the other Supportive learning resources	Presentation

6	Video 2	Solving exercises	Discussion in the class
7	Homework 2 On the subjects studied in the weeks 4,5 and 6	(Lecture notes)	Submit a pdf or word sheet
8	Assignment 2: On orthogonal vectors.	Internet sources and the other Supportive learning resources	Submitted with the midterm
9	Self-reading	Linear Transformations	Talk
10	Video3 Solving exercises	E-learning	Discussion in the class
11	Homework 3: On the subjects studied after the midterm	(Lecture notes)	Submit a pdf or word sheet
12	Self-reading	Rank and nullity of a L.T. Dimension theorem for L.Ts.	Talk
13	Quiz 2	On the subjects studied on the subject studied after midterm	Submitting on the E-learning
14	Matrix representation of quadratic forms. Positive definite quadratic forms.	Internet sources and the reference book	Video
15	Video 4 Revision of all the course	E-learning	
16	**Final Exam**		