Sana'a University
Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

18. Course Specification of Linear Algebra

I. Course Identification and General Information:						
1.	Course Title:	Linear Algebra.				
2.	Course Code & Number:	BR121.				
3.	Credit hours:	C.H				TOTAL CR HRS
		Th.	Seminar/Tu	Pr	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	First Year- First Semester.				
5.	Pre –requisite (if any):	None.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	Location of teaching the course:	Mechanical Engineering Department.				
10.	Prepared By:	Asst. Prof. Dr. Adel Mohammed Al-Odhari.				
11.	Date of Approval:					

II. Course Description:

This is a course of linear algebra and its applications to Mechanical Engineering programs. Topics to be covered include: vectors; lines and planes; systems of linear equations; matrices; linear transformations and determinants; introduction to vector spaces; eigenvalues; eigenvectors; orthonormal bases; orthogonal decompositions of vectors; orthogonal matrices and Gram-Schmidt Algorithm.

III. Alignment course intended learning outcomes (CILOs) of the course		Referenced PILOs
a1	Recognize the basic concepts of matrices and its applications in solving engendering problems.	A1
a2	Identify mathematical tools and analytical skills in solving problems relevant to Mechanical Engineering.	A4
b1	Examine mathematical and engineering problems in different contexts of topics.	B1

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b2	Analyze mathematical reasoning skill in interpreting mathematical theories and linking them in the interpretation of Mechanical engineering applications.	B3
c1	Apply some software programing and calculators to solve system of linear equations and representations of matrices in software programing.	, C2
c2	Prescribe engineering phenomena, network and nodal incidence matrix in team project, mesh incidence matrix and electrical networks in team project.	C1
d1	Assess tasks, time, processes and resources of mechanical engineering problems depend electrical networks, pipe and traffic flow, data fitting.	D2

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1- Recognize the basic concepts of matrices and its applications in solving engendering problems.	Lectures, Tutorials	Examinations, Homework Presentations
a2- Identify Mathematical tools and analytical skills in solving problems relevant to Electrical Engineering.	Lectures, Tutorials and Self-Learning Problems	Examinations, Test, Course Work, Assignments,

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Examine mathematical and engineering problems in different contexts of topics.	Lectures and Tutorials	Examinations, Test, Course Work, Assignments,
b2- Analyze mathematical reasoning skill in interpreting mathematical theories and linking them in the interpretation of electrical engineering applications.		

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

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Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1- Apply some software programing and calculators to solve system of linear equations and representations of matrices in software programing.	Lectures, Case Study	Examinations, Test, Course Work, Assignments
c2- Prescribe engineering phenomena, network and nodal incidence matrix in team project, mesh incidence matrix and electrical networks in team project.		

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(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Assess to tasks, time, processes and resources of mechanical engineering problems depend electrical networks, pipe and traffic flow, data fitting.	Tutorials, Case Study	Presentations, Reports.

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1	Matrices	a1, a2, b1, b2	▪ Matrices. ▪ Operations of Matrices. ▪ Special Matrices. ▪ Random Walks in Crystals. ▪ Matrices for Engineering Applications: Electrical networks in Team Project. ▪ Elementary Row operations of Matrices. ▪ Reduced Row Echelon Form of Matrices. ▪ Row and Column Space. ▪ Rank of Matrix. ▪ Complex Matrices and Forms.	3	6
2	Linear Systems	a1, a2, b1, b2, c1,d1	▪ Homogeneous Linear Systems. ▪ Solving Homogenous Linear Systems.	3	6

			▪ Nonhomogeneous Linear Systems. ▪ Solving. Nonhomogeneous Linear Systems. ▪ Matrix Inverses. ▪ Least Square vectors and data Fitting. ▪ LU Factorization. ▪ Linear Transformations.		
3	Vectors	a1, a2, b1, b2,	▪ Vectors in the plane and 3-Space. ▪ Dot Product, Norm, Cross Product, Lines and Planes, Projections. ▪ Geometric Transformations, Inverse Mappings, Vector Spaces, Subspaces and Spanning Sets Subspace. ▪ Linear Independence, Basis and Dimension.	1	2
4	Mid Term Exam	a1, a2, b1, b2, d1	• The First 3 Lectures	1	2
5	Vectors	a1, a2, b1, b2,	▪ Vectors in the plane and 3-Space. ▪ Dot Product, Norm, Cross Product, Lines and Planes, Projections. ▪ Geometric Transformations, Inverse Mappings, Vector Spaces, Subspaces and Spanning Sets Subspace. ▪ Linear Independence, Basis and Dimension.	2	4

6	Determinates	a1, a2, b1, b2, c2	▪ Evaluation of Determents. ▪ Cramer's Rule. ▪ Matrix Inverse.	2	4
7	Eigenvalues and Eigenvectors	a1, a2, b1, b2,c1,d1	▪ Definitions and Some examples ▪ Computation of eigenvalues and eigenvectors Problems. ▪ Diagonalizable matrices.	1	2
8	Orthonormal Bases and Orthogonal Projections.	a1, a2, b1, b2, .c1,c2	▪ Orthogonality and normalization. ▪ Orthogonal Bases. ▪ Orthogonal decompositions of vectors. ▪ Orthogonal matrices. ▪ Gram-Schmidt Algorithm	2	4
9	Final Exam	a1, a2, b1, b2, c1,c2,d1	• All Topics	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Tutorial Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1	▪ Solving problems of matrices by different operations. ▪ Solving problems of random walks in crystals and electrical networks in team project ▪ Computations of matrices by elementary row operations. ▪ Computations of matrices by elementary row operations. ▪ Computations of matrices by reduced row echelon form.	3	6	a1, a2, b1, b2, c1, d1

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	▪ Computations of rank of matrix. ▪ Describe complex matrices.			
2	▪ Solving homogenous linear systems. ▪ Solving nonhomogeneous linear systems. ▪ Computations of inverse matrix. ▪ Computations of least square vectors and data fitting. ▪ Computation LU Factorization. ▪ Computation of linear transformations	3	6	a1, a2, b1, b2, c1, d1
3	▪ Computations of Dot Product, Norm, Cross Product, ▪ Computation Linear independence and dependence; Basis and Dimension. ▪ Geometric representation of lines and planes, projections and transformations.	3	6	a1, a2, b1, b2, c1,c2 d1
4	▪ Computation determinates. ▪ Solving by Cramer's Rule. ▪ Finding inverse matrix by determinates.	2	4	a1, a2, b1 , b2, c1,c2 d1
5	▪ Computation of eigenvalues and eigenvectors Problems. ▪ Computation of diagonalizable matrices.	1	2	a1, a2, b1 , b2, c1,c2 d1
6	▪ Computation of orthogonal bases. ▪ Computation of orthogonal decompositions of vectors. ▪ Computation of orthogonal matrices and Gram-Schmidt Algorithm	2	4	a1, a2, b1, b2, c1,c2 d1
Number of Weeks /and Units Per Semester:		**14**	**28**	

V. Teaching strategies of the course:

- Lectures, Tutorials, Self-Learning Problems and Case Study
- Examinations, test, course work, assignments, group and individual reports.

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VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Oral presentations explaining the following essential mathematical concepts: random walks in crystals; matrices for engineering applications: electrical networks in team project. vector spaces and properties of vectors; systems of linear systems; eigenvalues and eigenvectors; in additions, orthonormal bases and orthogonal projection.	a1, a2, b1 , b2, c1, c2 d1	2nd, 4th, 6th 8th 10th 12th weeks	10
2	Individual written assignments or in groups to solve Problems of: matrices, electrical networks, computation Linear Independence and dependence; Basis and Dimension**,** Gram-Schmidt Algorithm.	a1, a2, b1 , b2, c1, c2 d1	3rd 5th 7th 9th 11th 13th weeks	10
3	Show solutions to selected problems from engineering applications related to the mathematical aspect.	a1, a2, b1 , b2, c1, c2 d1	4th 8th 12th weeks	10
Total				**30**

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VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignments	weekly	30	20 %	a1, a2, b1, b2, c1, c2 d1
2	Mid-Term Exam	8th	30	20 %	a1, a2, b1, b2, c1, c2 d1
3	Final Exam	16th	90	60 %	a1, a2, b1, b2, c1, c2 d1
Total			**150**	**100 %**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. David Cherney, Tom Denton, Rohit Thomas and Andrew Waldron, 2013, Linear Algebra, 1st – Edition, Davis California.
2. Dennis G. Zill- 2018- Advance Engineering Mathematics-6th -Edition- Jones & Bartlett Learning, LLC.

2- Essential References.

1. Peter V. O' Neil, 2011, Advance Engineering Mathematics, 7th -Edition- Cengage.com.
2. Erwin Kreyszig, 2011, Advance Engineering Mathematics, 10th –Edition, John Wiley & Sons, Inc.

1- Electronic Materials and Web Sites etc.

1. http://joshua.smcvt.edu/linearalgebra
2. https://www.khanacademy.org/math/linear-algebra
3. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/

IX. Course Policies:

1. **Class Attendance:**
-A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic

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2.	**Tardy:** - For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** - A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating**: - For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Assoc.Prof. Dr. Khalil Al-Hatab**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

Head of Department Asst. Prof. Dr. Adel Ahmed Al-Shakiri	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad	Rector of Sana'a University Prof. Dr. Al-Qassim Mohammed Abbas

18. Template for Course Plan of Linear Algebra

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Asst. Prof. Dr. Adel Mohammed Alodhari	**Office Hours**					
Location& Telephone No.	777654885	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	ass.prof.adel@gmail.com						

II. Course Identification and General Information:

1.	Course Title:	Linear Algebra.				
2.	Course Number & Code:	BR121.				
3.	Credit hours:	C.H				TOTAL CR HRS
		Th.	Seminar/Tu	Pr	Tr.	
		2	2	-	-	3
4.	Study level/year at which this course is offered:	First Year- First Semester.				
5.	Pre –requisite (if any):	None				
6.	Co –requisite (if any):	None				

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7.	Program (s) in which the course is offered	Mechanical Engineering Program
8.	Language of teaching the course:	English Language
9.	System of Study:	Semesters.
10	Mode of delivery:	Lectures and Tutorials.
11	Location of teaching the course:	Mechanical Engineering Department.

III. Course Description:

This is a course of linear algebra and its applications to Mechanical Engineering programs. Topics to be covered include: vectors; lines and planes; systems of linear equations; matrices; linear transformations and determinants; introduction to vector spaces; eigenvalues; eigenvectors; orthonormal bases; orthogonal decompositions of vectors; orthogonal matrices and Gram-Schmidt Algorithm.

IV. Intended learning outcomes (ILOs) of the course:

Brief summary of the knowledge or skill the course is intended to develop**:**

1. Recognize the basic concepts of matrices and its applications in solving engendering problems.
2. Identify mathematical tools and analytical skills in solving problems relevant to Mechanical Engineering.
3. Examine mathematical and engineering problems in different contexts of topics.
4. Analyze mathematical reasoning skill in interpreting mathematical theories and linking them in the interpretation of Mechanical engineering applications.
5. Apply some software programing and calculators to solve system of linear equations and representations of matrices in software programing.
6. Prescribe engineering phenomena, network and nodal incidence matrix in team project, mesh incidence matrix and electrical networks in team project.
7. Assess to tasks, time, processes and resources of mechanical engineering problems depend electrical networks, pipe and traffic flow, data fitting.

V. Course Content:

- Distribution of Semester Weekly Plan of Course Topics/Items and Activities.

A – Theoretical Aspect:

Order	Topics List	Sub –topics	Week Due	Contact Hours
1	Matrices	▪ Matrices. ▪ Operations of Matrices. ▪ Special Matrices. ▪ Random Walks in Crystals. ▪ Matrices for Engineering Applications: Electrical networks in Team Project. ▪ Elementary Row operations of Matrices. ▪ Reduced Row Echelon Form of Matrices. ▪ Row and Column Space. ▪ Rank of Matrix. ▪ Complex Matrices and Forms	1st, 2nd & 3rd weeks	6
2	Linear Systems	▪ Homogeneous Linear Systems. ▪ Solving Homogenous Linear Systems. ▪ Nonhomogeneous Linear Systems. ▪ Solving. Nonhomogeneous Linear Systems. ▪ Matrix Inverses. ▪ Least Square vectors and data Fitting. ▪ LU Factorization. ▪ Linear Transformations.	4th, 5th & 6th weeks	6
3	Vectors	▪ Vectors in the plane and 3-Space. ▪ Dot Product, Norm, Cross Product, Lines and Planes, Projections. ▪ Geometric Transformations, Inverse Mappings, Vector Spaces, Subspaces and Spanning Sets Subspace.	7th	2

		▪ Linear Independence, Basis and Dimension.		
4	Mid Term Exam	▪ The First 3 Lectures	8th week	2
5	Vectors	▪ Vectors in the plane and 3-Space. ▪ Dot Product, Norm, Cross Product, Lines and Planes, Projections. ▪ Geometric Transformations, Inverse Mappings, Vector Spaces, Subspaces and Spanning Sets Subspace. ▪ Linear Independence, Basis and Dimension.	9th ,10th weeks	6
6	Determinates	▪ Evaluation of Determents. ▪ Cramer's Rule. ▪ Matrix Inverse.	11th & 12th weeks	4
7	Eigenvalues and Eigenvectors	▪ Definitions and Some examples ▪ Computation of eigenvalues and eigenvectors Problems. ▪ Diagonalizable matrices.	13th week	2
8	Orthonormal Bases and Orthogonal Projections.	▪ Orthogonally and normalization. ▪ Orthogonal Bases. ▪ Orthogonal decompositions of vectors. ▪ Orthogonal matrices. ▪ Gram-Schmidt Algorithm	14th and 15th weeks	4
9	Final Exam	▪ All Topics	16th week	2
Number of Weeks /and Units Per Semester			**16**	**32**

B – Tutorial Aspect:

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Order	Topics List	Week Due	Contact Hours
1	▪ Solving problems of matrices by different operations. ▪ Solving problems of random walks in crystals and electrical networks in team project ▪ Computations of matrices by elementary row operations. ▪ Computations of matrices by elementary row operations. ▪ Computations of matrices by reduced row echelon form. ▪ Computations of rank of matrix. ▪ Describe complex matrices.	1st, 2nd & 3rd weeks	6
2	▪ Solving homogenous linear systems. ▪ Solving nonhomogeneous linear systems. ▪ Computations of inverse matrix. ▪ Computations of least square vectors and data fitting. ▪ Computation LU Factorization. ▪ Computation of linear transformations	4th, 5th & 6th weeks	6
3	▪ Computations of Dot Product, Norm, Cross Product, ▪ Computation Linear independence and dependence; Basis and Dimension. ▪ Geometric representation of lines and planes, projections and transformations.	7th, 8th & 9th weeks	6
4	▪ Computation determinates. ▪ Solving by Cramer's Rule. ▪ Finding inverse matrix by determinates.	10th & 11th weeks	4
5	▪ Computation of eigenvalues and eigenvectors Problems. ▪ Computation of diagonalizable matrices.	12th week	2

6	▪ Computation of orthogonal bases. ▪ Computation of orthogonal decompositions of vectors. ▪ Computation of orthogonal matrices and Gram-Schmidt Algorithm	13^{th} and 14^{th} weeks	4
Number of Weeks /and Units Per Semester		**14**	**28**

VI. Teaching strategies of the course:

- Lectures, Tutorials, Self-Learning Problems and Case Study
- Examinations, test, course work, assignments, group and individual reports.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Oral presentations explaining the following essential mathematical concepts: random walks in crystals; matrices for engineering applications: electrical networks in team project. vector spaces and properties of vectors; systems of linear systems; eigenvalues and eigenvectors; in additions, orthonormal bases and orthogonal projection.	a1, a2, b1 , b2, c1,c2 d1	2nd 4th 6th 8th 10th 12th weeks	10
2	Individual written assignments or in groups to solve Problems of: matrices, electrical networks, computation Linear Independence and dependence; Basis and Dimension, Gram-Schmidt Algorithm.	a1, a2, b1 , b2, c1,c2 d1	3rd 5th 7th 9th 11th 13th weeks	10
3	Show solutions to selected problems from engineering applications related to the mathematical aspect.	a1, a2, b1 , b2, c1,c2 d1	4th 8th 12th weeks	10
Total				**30**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Assignments	weekly	30	20 %
2	Mid-Term Exam	8th week	30	20%
3	Final Exam	16th week	90	70%
Total			**150**	**100%**

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IX. Learning Resources:

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2. Dennis G. Zill- 2018- Advance Engineering Mathematics-6th -Edition- Jones & Bartlett Learning, LLC.

2- Essential References.

1. Peter V. O' Neil, 2011, Advance Engineering Mathematics, 7th -Edition- Cengage.com.
2. Erwin Kreyszig, 2011, Advance Engineering Mathematics, 10th –Edition, John Wiley & Sons, Inc.

3- Electronic Materials and Web Sites *etc*.

1. http://joshua.smcvt.edu/linearalgebra
2. https://www.khanacademy.org/math/linear-algebra
3. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/

X. Course Policies:

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2.	**Tardy:** - For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
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4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating**:

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	- For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
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