Sana'a University
Faculty of Engineering
Electrical Engineering Department
B.Sc. of Computer and Control Engineering

16. 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
		Th.	Tu.	Pr.	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	2nd year / 1st semester				
5.	Pre –requisite (if any):	None				
6.	Co –requisite (if any):	None				
7.	Program (s) in which the course is offered:	Electrical Engineering				
8.	Language of teaching the course:	English and Arabic				
9.	Location of teaching the course:	Faculty of Engineering				
10.	Prepared By:	Asst. Prof. Dr. Adel Mohammed Al-Odhari				
11.	Date of Approval					

II. Course Description:

This is a course on linear algebra and its applications to Electrical Engineering's 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.

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	Asst. Prof. Dr. Adel Ahmed Al-Shakiri	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

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	III. Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1	Demonstrate knowledge and understanding of basic concepts of matrices, using matrices in application engendering problems; rank of matrix, complex matrices; matrix inverse; vectors in spaces; dot product, norm, cross product, lines and planes, projections; linear independence, basis and dimension; eigenvalue and eigenvectors; orthonormal bases and orthogonal projections.	A1, A2
a2	Understand knowledge Mathematical tools and analytical skills in solving problems relevant to Electrical Engineering.	A1, A2
b1	Solve mathematical and engineering problems in different contexts of topics.	B1, B2
b2	Practice mathematical reasoning skill in interpreting mathematical theories and linking them in the interpretation of electrical engineering applications.	B1, B2
c1	Use some software programing and calculators to solve system of linear equations and representations of matrices in software programing.	C1
c2	Explain engineering phenomena, network and nodal incidence matrix in team project, mesh incidence matrix and electrical networks in team project.	C1
d1	Work of group and individual reports about resources of electrical engineering problems depend on electrical networks, pipe and traffic flow, data fitting.	D1, D4

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

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a1- Demonstrate knowledge and understanding of basic concepts of matrices, using matrices in application engendering problems; rank of matrix, complex matrices; matrix inverse; vectors in spaces; dot product, norm, cross product, lines and planes, projections; linear independence, basis and dimension; eigenvalue and eigenvectors; orthonormal bases and orthogonal projections.	▪ Lectures, ▪ Tutorials laboratory, ▪ Seminars	▪ Examinations, ▪ Laboratory reports, ▪ Homework presentations
a2- Understand Knowledge Mathematical tools and analytical skills in solving problems relevant to Electrical Engineering.	▪ Lectures, ▪ Tutorials ▪ Self-learning	▪ Examinations, ▪ Test, ▪ Course work, ▪ Assignments, ▪ Group and Individual Reports.

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

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Solve mathematical and engineering problems in different contexts of topics.	▪ Lectures, ▪ Tutorials	▪ Examinations, ▪ Test, ▪ Course work, ▪ Assignments, ▪ Group and Individual Reports.
b2- Practice mathematical reasoning skill in interpreting mathematical theories and linking them in the interpretation of electrical engineering applications.		

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© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1- Use some software programing and calculators to solve system of linear equations and representations of matrices in software programing.	▪ Lectures, ▪ Laboratory, ▪ Seminars, ▪ Projects, ▪ Small group	▪ Examinations, ▪ Laboratory reports, Presentations, ▪ Individual and Group Project Reports.
c2- Explain engineering phenomena, network and nodal incidence matrix in team project, mesh incidence matrix and electrical networks in team project.		

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Work of group and individual reports about resources of electrical engineering problems depend electrical networks, pipe and traffic flow, data fitting.	▪ tutorials, ▪ Laboratory, ▪ Seminars, ▪ Projects, ▪ Small group	▪ 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,	▪ Matrices.	3	6

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		b1, b2	▪ 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.		
2.	Linear Systems	a1, a2, b1, b2, c1, d1	▪ 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.	3	6
3.	Vectors	a1, a2, b1, b2,	▪ Vectors in the plane and 3-Space. ▪ Dot Product, Norm, Cross Product, Lines and Planes, Projections.	3	6

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			▪ Geometric Transformations, Inverse Mappings, Vector Spaces, Subspaces and Spanning Sets Subspace. ▪ Linear Independence, Basis and Dimension.		
4.	Determinates	a1, a2, b1, b2, c2	▪ Evaluation of Determents. ▪ Cramer's Rule. ▪ Matrix Inverse.	2	4
5.	Eigenvalues and Eigenvectors	a1, a2, b1, b2, c1, d1	▪ Definitions and Some examples ▪ Computation of eigenvalues and eigenvectors Problems. ▪ Diagonalizable matrices.	1	2
6.	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
Number of Weeks /and Units Per Semester				**14**	**28**

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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. ▪ Computations of rank of matrix. ▪ Describe complex matrices.	3	6	a1, a2, b1, b2, c1, d1
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

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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:

1- Lectures, Tutorials and self-learning
2- Examinations, test, course work, assignments, group and individual reports.

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	3

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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	4
3.	Show solutions to selected problems from engineering applications related to the mathematical aspect.	a1, a2, b1 , b2, c1, c2 d1	4th 8th 12th	3
	Total			**10**

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.	Oral presentations of students	3, 5,8,10,12	7.5%	5	a1, a2, b1, b2, c1, c2 d1
2.	Individual written assignments or in groups	3rd ,5th,7th 9th,11th,13th	7.5%	5	a1, a2, b1, b2, c1, c2 d1
3.	Mid-term Exam	7th	30%	20	a1, a2, b1, b2, c1, c2 d1
4.	Final Exam	16th	105%	70	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).

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	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.
3- Electronic Materials and Web Sites etc.	
	1. http://joshua.smcvt.edu/linearalgebra 2. https://www.khanacademy.org/math/linear-algebra 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
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-

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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. Riyad A. Muharram.**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

Prepared by	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

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16. Template for Course Plan of Linear Algebra

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	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
		Th.	Tu.	Pr.	Tr.	
		2	2	-	-	3
4.	Study level/year at which this course is offered:	2nd year / 1st semester				
5.	Pre –requisite (if any):	None				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Electrical Engineering				
8.	Language of teaching the course:	English and Arabic				
9.	System of Study:	semester				
10.	Mode of delivery:	Lecture				
11.	Location of teaching the course:	Classes at the Faculty of Engineering				

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III. Course Description:

This is a course on linear algebra and its applications to Electrical Engineering's 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. Demonstrate knowledge and understanding of basic concepts of matrices, using matrices in application engendering problems; rank of matrix, complex matrices; matrix inverse; vectors in spaces; dot product, norm, cross product, lines and planes, projections; linear independence, basis and dimension; eigenvalue and eigenvectors; orthonormal bases and orthogonal projections .
2. Understand knowledge Mathematical tools and analytical skills in solving problems relevant to Electrical Engineering.
3. Solve mathematical and engineering problems in different contexts of topics.
4. Practice mathematical reasoning skill in interpreting mathematical theories and linking them in the interpretation of electrical engineering applications.
5. Use some software programing and calculators to solve system of linear equations and representations of matrices in software programing.
6. Explain engineering phenomena, network and nodal incidence matrix in team project, mesh incidence matrix and electrical networks in team project.
7. Work of group and individual reports about resources of electrical engineering problems depend on electrical networks, pipe and traffic flow, data fitting.

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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	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	6
3.	Mid Term Exam	▪	7th	2
4.	Vectors	▪ Vectors in the plane and 3-Space.	8th ,9th &	6

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		▪ 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.	10th	
5.	Determinates	▪ Evaluation of Determents. ▪ Cramer's Rule. ▪ Matrix Inverse.	11th & 12th	4
6.	Eigenvalues and Eigenvectors	▪ Definitions and Some examples ▪ Computation of eigenvalues and eigenvectors Problems. ▪ Diagonalizable matrices.	13th	2
7.	Orthonormal bases and Orthogonal projections.	▪ Orthogonally and normalization. ▪ Orthogonal Bases. ▪ Orthogonal decompositions of vectors. ▪ Orthogonal matrices. ▪ Gram-Schmidt Algorithm	14th & 15th	4
8.	Final Exam		16	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	1st ,2nd ,3rd	6	a1, a2, b1, b2, c1, d1

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	▪ 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.			
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	4^{th} ,5^{th} ,6^{th}	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.	7^{th} ,8^{th} ,9^{th}	6	a1, a2, b1, b2, c1,c2 d1
4.	▪ Computation determinates. ▪ Solving by Cramer's Rule. ▪ Finding inverse matrix by determinates.	10^{th} ,11^{th}	4	a1, a2, b1 , b2, c1,c2 d1
5.	▪ Computation of eigenvalues and eigenvectors Problems. ▪ Computation of diagonalizable matrices.	12^{th}	2	a1, a2, b1 , b2, c1,c2 d1
6.	▪ Computation of orthogonal bases. ▪ Computation of orthogonal decompositions of vectors. ▪ Computation of orthogonal matrices and	13^{th} ,14^{th}	4	a1, a2, b1, b2, c1,c2 d1

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	▪ Gram-Schmidt Algorithm			
Number of Weeks /and Units Per Semester		**14**	**28**	

VI. Teaching strategies of the course:

1. Lectures, Tutorials and self-learning
2. 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	3
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	4
3.	Show solutions to selected problems from engineering applications related to the mathematical aspect.	a1, a2, b1 , b2, c1, c2 d1	4th 8th 12th	3
	Total			**10**

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Oral presentations of students	3, 5,8,10,12	7.5	5%	a1, a2, b1, b2, c1, c2 d1
2.	Individual written assignments or in groups	3^{rd} ,5^{th},7^{th} 9^{th},11^{th},13^{th}	7.5	5%	a1, a2, b1, b2, c1, c2 d1
3.	Mid-term Exam	7^{th}	30	20%	a1, a2, b1, b2, c1, c2 d1
4.	Final Exam	16^{th}	105	70%	a1, a2, b1, b2, c1, c2 d1
	Total		**150**	**100 %**	

IX. 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- 1^{st} - 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.

3- Electronic Materials and Web Sites etc.

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

X. 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
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 fail. 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

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	- Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

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