



62. Elective 1

Course Specification of Maintenance of Mechanical Systems.

I. Course Identification and General Information:						
1.	Course Title:	Maintenance of Mechanical Systems.				
2.	Course Code & Number:	ME302				
3.	Credit hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar/Tu.	Pr	Tr.	
		2	-	-		
4.	Study level/ semester at which this course is offered:	Fourth 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. Thabet M. Al-Ghaberi and Assoc. Prof. Dr. Abdul-Malik Momin.				
11.	Date of Approval:					

II. Course Description:

This course is designed to teach students the modern requirements standards for design and preparation **and** structural and technical plans for maintenance centers and installations. Standard use of operating and maintenance manuals, industrial diagrams and graphs related to the design and locations of mechanical systems and their components and repair defects of mechanical systems.

By the end of the course, the students will be able to:

Collect and build a database of automated systems for energy monitoring and management, control of equipment and devices, data records and documentation, **writing** reports, presentations, technical recommendations, proposed alternatives and costs for repairs and maintenance, and apply modern and advanced technologies methods for mechanical detect, diagnosis and crashes troubleshooting.

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III. Alignments of the Course Intended learning outcomes (CILOs)		Referenced PILOs)
a1	Identify knowledge of maintenance operations of mechanical systems and quality of the performance of mechanical machines.	A3
a2	Describe skills to offer the optimal solutions problems for defects, malfunctions and crashes of mechanical engineering systems and its components.	A4
b1	Explore acquired knowledge in designing and updating systems for maintenance, repair and rehabilitation of mechanical systems and components.	B2
b2	Propose the modern principles of management to work correctly and professionally.	B3
c1	Apply the modern standard techniques, and different skills, experience necessary for repairing of mechanical systems.	C1
c2	Prescribe the laws, regulations, legislation, industrial safety requirements, procedures in maintenance and repair operations of mechanical systems.	C3
d1	Assess the knowledge necessary for effectively and successfully to manage time of mechanical engineering processes.	D2
d2	Cooperate successfully for both orally and in writing technical reports, presentations, recommendations, proposed alternatives and costs for repairs and maintenance.	D5

(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- Identify knowledge of maintenance operations of mechanical systems and quality of the performance of mechanical machines.	<ul style="list-style-type: none"> Lectures & Examples. Tutorials and Problem Solving. Class Attendance & Participation. 	<ul style="list-style-type: none"> Homework. Quizzes. Major Exams. Presentation & Discussions. Practical Assessment.

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<p>a2- Describe skills to offer the optimal solutions problems for defects, malfunctions and crashes of mechanical engineering systems and its components.</p>	<ul style="list-style-type: none"> • Homework • Quizzes. • Presentation & Discussions. • Practical Assessment. • Class Attendance & Participation. 	<ul style="list-style-type: none"> • Homework. • Quizzes. • Major Exams. • Presentation & Discussions. • Practical Assessment.

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(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Explore acquired knowledge in designing and updating systems for maintenance, repair and rehabilitation of mechanical systems and components.	<ul style="list-style-type: none"> • Lectures & Class Activity. • Practical Work at Class. • Problem-Based Learning. 	<ul style="list-style-type: none"> • Homework. • Quizzes. • Major Exams. • Problem Sets (Exercises). • Reports.
b2- Propose the modern principles of management to work correctly and professionally.	<ul style="list-style-type: none"> • Lectures & Class Activity. • Practical Work at Class. • Problem-Based Learning. 	<ul style="list-style-type: none"> • Homework. • Quizzes. • Major Exams. • Problem Sets (Exercises). • Reports.

(C) 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- Apply the modern standard techniques, and different skills, experience necessary for repairing of mechanical systems.	<ul style="list-style-type: none"> • Lectures & Class Activity. • Collaborative /Discovery Based on Practical Training. 	<ul style="list-style-type: none"> • Homework. • Quizzes. • Major Exams. • Problem Sets (Exercises).
c2- Prescribe the laws, regulations, legislation, industrial safety requirements, procedures in maintenance and repair operations of mechanical systems.	<ul style="list-style-type: none"> • Lectures & Class Activity. • Collaborative /Discovery Based on Practical Training. 	<ul style="list-style-type: none"> • Homework. • Quizzes. • Major Exams. • Problem Sets (Exercises).

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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 the knowledge necessary for effectively and successfully to manage time of mechanical engineering processes.	<ul style="list-style-type: none"> • Lectures & Class Activity. • Practical Training. 	<ul style="list-style-type: none"> • Reports. • Assigned Practical Problems.
d2- Cooperate successfully for both orally and in writing technical reports, presentations, recommendations, proposed alternatives and costs for repairs and maintenance.	<ul style="list-style-type: none"> • Lectures & Class Activity. • Practical Training. 	<ul style="list-style-type: none"> • Reports. • Assigned Practical Problems.

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IV. Course Content:					
A – Theoretical Aspect:					
Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction and Orientation to the Course.	a1, a2, d1, d2	<ul style="list-style-type: none"> • Introduction. • Maintenance and Maintenance Engineering Objective. • Maintenance Terms and Definitions. • Elements of Effective Maintenance Management. 	1	2
2.	Organization and Management of the Maintenance Function.	a1, a2, b1, b2, c1, c2, d1, d2	<ul style="list-style-type: none"> • Introduction to the Theory and Practice of Maintenance. • Operating Policies of an Effective Maintenance. • Reliability Based Maintenance. • Job Planning and Scheduling. 	1	2
3.	Maintenance Process.	a1, a2, b2, c1	<ul style="list-style-type: none"> • Introduction to Maintenance Processes Methods. • Standards for Structural and Technical Plans. • Maintenance Centers and Layouts. 	1	2
4.	Maintenance of Mechanical Equipment.	a1, a2, b1, b2, c1	<ul style="list-style-type: none"> • Plain Bearings. • Belt Drives. 	1	2

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			<ul style="list-style-type: none"> • Chains for Power Transmission. • Flexible Coupling for Power Transmissions. • Gear Drives and Speed Reducers. 		
5.	International Laws, Regulations, and Legislation	a1,a2,b1,c 1	<ul style="list-style-type: none"> • International Laws Regulations. • Governing Maintenance Operations and Activities. 	1	2
6.	Standard use of Operation and Maintenance.	a2,b2,c1,c 2	<ul style="list-style-type: none"> • Methods, Standard use of Operation. • Maintenance Manuals. • Industrial Diagrams and Graphs. • Locations of Mechanical Systems and their Components. 	1	2
7.	The Main Major Technical and Procedural Steps.	a1,a2,c1,c 2	<ul style="list-style-type: none"> • Monitoring. • Inspection, Testing and Evaluation. • Examination Diagnosis. • Identification, Repair and Maintenance. • Management and Supervision. 	1	2
8.	Mid-Term Exam	a1, a2, b1, b2, c1, c2	<ul style="list-style-type: none"> • The First 7 Chapters. 	1	2
9.	The Main Types of Maintenance.	a1,a2,c1	<ul style="list-style-type: none"> • Predictive Maintenance. • Preventive Maintenance. • Periodic Maintenance. • Simplified Failure Modes and Effective Analysis 	1	2

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10.	Management and Supervision.	b2,c1,c2	<ul style="list-style-type: none"> Maintenance Operations and Work Cost. Performance Quality Costs. 	1	2
11.	Build a Database of Automated Systems for Energy Monitoring and Management.	a1,a2,b2,c1	<ul style="list-style-type: none"> Methods and Techniques. Processes Controlling of Equipment and Devices. Data Records and Documentation. 	1	2
12..	Writing Reports, Presentations, Technical Recommendation.	a1,a2,b1,b2,c1, d1, d2	<ul style="list-style-type: none"> Technical Writing Reports. Presentation and Recommendation. 	1	2
13.	Standard Program for Maintenance and Repair.	a1,a2,c1,c2	<ul style="list-style-type: none"> Reliability Program for Operations, Maintenance and repair. Rehabilitation and Technical Readiness of Mechanical Systems and Components. 	1	2
14.	Modern and Advanced Technologies Methods for Diagnosis.	a1,b1,b2,c1	<ul style="list-style-type: none"> Mechanical Technologies Methods. Computers, Thermal Charts. Analysis of the Causes. 	1	2
15.	Maintenance and Repair of Mechanical Systems and Safety Systems.	a1,b1,b2,c1	<ul style="list-style-type: none"> Mechanical Systems. Electrical. Hydraulic and Pneumatic. Electronic Circuits. Safety Systems. 	1	2

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			• Firefighting.		
16.	Final Exam.	a1, a2, b1, b2, c1, c2	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				16	32

V. Teaching Strategies of the Course:

- Lectures & Examples.
- Tutorials and Problem Solving
- Class Attendance & Participation.
- Practical Work at Class.
- Collaborative /Discovery Based on Class Practical Training.
- Reports.

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Assignment 1	a1,a2,b1,b2, c1,c2,d1,d2	2 nd	2
2.	Assignment 2	a1,a2,b1,b2, c1,c2,d1,d2	3 rd	2
3.	Assignment 3	a1,a2,b1,b2, c1,c2,d1,d2	4 th	2
4.	Assignment 4	a1,a2,b1,b2, c1,c2,d1,d2	5 th	2
5.	Assignment 5	a1,a2,b1,b2, c1,c2,d1,d2	6 th	2
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.	Quizzes.	Weekly.	10	10 %	ea1,a2,b1,b2,c1
2.	Assignments & Homework	Weekly.	10	10 %	a1,a2,b1,b2,c1
3.	Mid-Term Exam.	8 th	15	15 %	a1,a2,b1,b2,c1, c2
4.	Scientific Research Work.	13 th	5	5 %	a1,a2,b1,b2,

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					c1,c2,d1,d2
5.	Final Exam.	16 th	60	60 %	a1,a2,b1,b2,c1, c2
	Total		100	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. Krishna B. Misra, 2016, "Maintenance Engineering and Maintainability: An Introduction", RAMS Consultants, India.
2. R. Keith Mobley, 2014, "Maintenance Engineering Handbook", Eight Edition, McGraw Hill.

2- Essential References.

1. B.S. Dhillon, 2002, "Engineering Maintenance: A Modern Approach", CRC Press, Washington, D.C.

3- Electronic Materials and Web Sites etc.

1. CDs & Videos Tapes
2. www.researchgate.net
3. www.crcpress.com

I. Course Policies:

1	<p>Class Attendance:</p> <p>- The student should be attending not less than 75% of total contact hours of the subject, otherwise he will not able to take exam and be considered as an exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic.</p>
2	<p>Tardy:</p> <p>- For lateness in attending the class, the student will be initially notified. If he repeats late in attending class he will be considered absent.</p>
3	<p>Exam Attendance/Punctuality:</p> <p>- The student should attend the exam on time. He is permitted to attend the exam half one hour from exam beginning, after that he/she will not be permitted to take exam and he/she is considered absent in the exam.</p>
4	<p>Assignments & Projects:</p> <p>- In general one assignment is given after each chapter of a course. The student should submit the assignment on time, mostly one week after giving the assignment</p>

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5	<p>Cheating:</p> <p>- For cheating in exam, the student is considered as failure. In case the cheating is repeated three times during study the student will be disengaged from the Faculty</p>
6	<p>Plagiarism:</p> <p>Plagiarism is the attending of the student the exam of a course instead of other 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 Affair Council of the university.</p>
7	<p>Other policies:</p> <ul style="list-style-type: none"> - The mobile phone is not allowable to be used during class lecture. It must be switched off, otherwise the student will be ordered to leave the lecture room. - The mobile phone is not allowed to be taken during the examination time. - Lecture notes and assignments may be given directly to students using soft or hard copy.

Reviewed By	<p><u>Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat</u></p> <p><u>President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi</u></p> <p><u>Name of Reviewer from the Department: Assoc. Prof. Dr. Abdul-Malik Momin</u></p>
	<p><u>Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa</u></p> <p><u>Assoc. Prof. Dr. Ahmed Mujahed</u></p> <p><u>Asst. Prof. Dr. Munasar Alsubri</u></p>

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62.Template for Course Plan of Maintenance of Mechanical Systems

I. Information about Faculty Member Responsible for the Course:								
Name of Faculty Member	Asst. Prof. Dr. Thabet M. Al-ghaberi.		Office Hours					
Location & Telephone No.			SAT	SUN	MON	TUE	WED	THU
E-mail	Dr.ghaberythabit@gmail.com							

II. Course Identification and General Information:						
1.	Course Title:	Maintenance of Mechanical Systems.				
2.	Course Number & Code:	ME302				
3.	Credit Hours:	C.H				Total Cr. Hrs
		Th.	Seminar/Tu.	Pr	Tr.	
		2	-	-	-	
4.	Study level/year at which this course is offered:	Fourth 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.	System of Study:	Semesters.				
10.	Mode of delivery:	Lectures.				
11.	Location of teaching the course:	Mechanical Engineering Department.				

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III. Course Description:

This course is designed to teach students the modern requirements standards for design and preparation and structural and technical plans for maintenance centers and installations, Standard use of operating and maintenance manuals, industrial diagrams and graphs related to the design and locations of mechanical systems and their components and repair defects of mechanical systems.

By the end of the course, the students will be able to:

Collect and build a database of automated systems for energy monitoring and management, control of equipment and devices, data records and documentation, Writing reports, presentations, technical recommendations, proposed alternatives and costs for repairs and maintenance, and apply modern and advanced technologies methods for mechanical detect, diagnosis and crashes troubleshooting.

IV. Course Intended learning outcomes (CILOs) of the course

1.	Identify knowledge of maintenance operations of mechanical systems and quality of the performance of mechanical machines.
2.	Describe skills to offer the optimal solutions problems for defects, malfunctions and crashes of mechanical engineering systems and its components.
3.	Explore acquired knowledge in designing and updating systems for maintenance, repair and rehabilitation of mechanical systems and components.
4.	Propose the modern principles of management to work correctly and professionally.
5.	Apply the modern standard techniques, and different skills, experience necessary for repairing of mechanical systems.
6.	Prescribe the laws, regulations, legislation, industrial safety requirements, procedures in maintenance and repair operations of mechanical systems.
7.	Assess the knowledge necessary for effectively and successfully to manage time of mechanical engineering processes.
8.	Cooperate successfully for both orally and in writing technical reports, presentations, recommendations, proposed alternatives and costs for repairs and maintenance.

V. Course Content:

A – Theoretical Aspect:				
Order	Units/Topics List	Sub Topics List	Week Due	Contact Hours

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1.	Introduction and Orientation to the Course.	<ul style="list-style-type: none"> • Introduction. • Maintenance and Maintenance Engineering Objective. • Maintenance Terms and Definitions. Elements of Effective Maintenance Management.	1 st	2
2.	Organization and Management of the Maintenance Function.	<ul style="list-style-type: none"> • Introduction to the Theory and Practice of Maintenance. • Operating Policies of an Effective Maintenance. • Reliability Based Maintenance. • Job Planning and Scheduling. 	2 nd	2
3.	Maintenance Process.	<ul style="list-style-type: none"> • Introduction to Maintenance Processes Methods. • Standards for Structural and Technical Plans. • Maintenance Centers and Layouts. 	3 rd	2
4.	Maintenance of Mechanical Equipment.	<ul style="list-style-type: none"> • Plain Bearings. • Belt Drives. • Chains for Power Transmission. • Flexible Coupling for Power Transmissions. Gear Drives and Speed Reducers.	4 th	2
5.	International Laws, Regulations, and Legislation	<ul style="list-style-type: none"> • International Laws Regulations. Governing Maintenance Operations and Activities.	5 th	2
6.	Standard use of Operation and Maintenance.	<ul style="list-style-type: none"> • Methods, Standard use of Operation. • Maintenance Manuals. • Industrial Diagrams and Graphs. Locations of Mechanical Systems and their Components.	6 th	2
7.	The Main Major Technical and Procedural Steps.	<ul style="list-style-type: none"> • Monitoring. • Inspection, Testing and Evaluation. • Examination Diagnosis. • Identification, Repair and Maintenance. Management and Supervision.	7 th	2

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8.	Mid-Term Exam	The First 7 Chapters.	8 th	2
9.	The Main Types of Maintenance.	<ul style="list-style-type: none"> • Predictive Maintenance. • Preventive Maintenance. • Periodic Maintenance. • Simplified Failure Modes and Effective Analysis 	9 th	2
10.	Management and Supervision.	<ul style="list-style-type: none"> • Maintenance Operations and Work Cost. • Performance Quality Costs. 	10 th	2
11.	Build a Database of Automated Systems for Energy Monitoring and Management.	<ul style="list-style-type: none"> • Methods and Techniques. • Processes Controlling of Equipment and Devices. • Data Records and Documentation. 	11 th	2
12.	Writing Reports, Presentations, Technical Recommendation.	<ul style="list-style-type: none"> • Technical Writing Reports. • Presentation and Recommendation. 	12 th	2
13.	Standard Program for Maintenance and Repair.	<ul style="list-style-type: none"> • Reliability Program for Operations, Maintenance and repair. • Rehabilitation and Technical Readiness of Mechanical Systems and Components. 	13 th	2
14.	Modern and Advanced Technologies Methods for Diagnosis.	<ul style="list-style-type: none"> • Mechanical Technologies Methods. • Computers, Thermal Charts. • Analysis of the Causes. 	14 th	2
15.	Maintenance and Repair of Mechanical Systems and Safety Systems.	<ul style="list-style-type: none"> • Mechanical Systems. • Electrical. • Hydraulic and Pneumatic. • Electronic Circuits. • Safety Systems. • Firefighting. 	15 th	2

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16.	Final Exam.	All the Chapters.	16 th	2
Number of Weeks /and Units Per Semester			16	32

VI. Teaching Strategies of the Course:	
<ul style="list-style-type: none"> • Lectures & Examples. • Tutorials and Problem Solving • Class Attendance & Participation. • Practical Work at Class. • Collaborative /Discovery Based on Class Practical Training. • Reports. 	

VII. Assignments:				
No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Assignment 1	a1,a2,b1,b2, c1,c2,d1,d2	2 nd	2
2.	Assignment 2	a1,a2,b1,b2, c1,c2,d1,d2	3 rd	2
3.	Assignment 3	a1,a2,b1,b2, c1,c2,d1,d2	4 th	2
4.	Assignment 4	a1,a2,b1,b2, c1,c2,d1,d2	5 th	2
5.	Assignment 5	a1,a2,b1,b2, c1,c2,d1,d2	6 th	2
Total				10

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.	Quizzes.	Weekly.	10	10 %	a1,a2,b1,b2,c1
2.	Assignments & Homework,	Weekly.	10	10 %	a1,a2,b1,b2,c1
3.	Mid-Term Exam.	8 th	15	15 %	a1,a2,b1,b2,c1, c2
4.	Scientific Research Work.	13 th	5	5 %	a1,a2,b1,b2, c1,c2,d1,d2
5.	Final Exam.	16 th	60	60 %	a1,a2,b1,b2,c1, c2
Total			100	100 %	

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IX. Learning Resources:	
<ul style="list-style-type: none"> Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher). 	
1- Required Textbook(s) (maximum two).	
	<ol style="list-style-type: none"> Krishna B. Misra, 2016, "Maintenance Engineering and Maintainability: An Introduction", RAMS Consultants, India. R. Keith Mobley, 2014, "Maintenance Engineering Handbook", Eight Edition, McGraw Hill.
2- Essential References.	
	<ol style="list-style-type: none"> B.S. Dhillon, 2002, "Engineering Maintenance: A Modern Approach", CRC Press, Washington, D.C.
3- Electronic Materials and Web Sites etc.	
	<ol style="list-style-type: none"> CDs & Videos Tapes www.researchgate.net www.crcpress.com

II. Course Policies:	
1	Class Attendance: - The student should be attending not less than 75% of total contact hours of the subject, otherwise he will not able to take exam and be considered as an exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic.
2	Tardy: - For lateness in attending the class, the student will be initially notified . If he repeats late in attending class he will be considered absent .
3	Exam Attendance/Punctuality: - The student should attend the exam on time. He is permitted to attend the exam half one hour from exam beginning, after that he/she will not be permitted to take exam and he/she is considered absent in the exam.
4	Assignments & Projects: - In general one assignment is given after each chapter of a course. The student should submit the assignment on time, mostly one week after giving the assignment
5	Cheating: - For cheating in exam, the student is considered as failure . In case the cheating is repeated three times during study the student will be disengaged from the Faculty

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Academic
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Rector of Sana'a
 University
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 Mohammed Abbas



6	<p>Plagiarism: Plagiarism is the attending of the student the exam of a course instead of other 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 Affair Council of the university.</p>
7	<p>Other policies:</p> <ul style="list-style-type: none"> - The mobile phone is not allowable to be used during class lecture. It must be switched off, otherwise the student will be ordered to leave the lecture room. - The mobile phone is not allowed to be taken during the examination time. - Lecture notes and assignments may be given directly to students using soft or hard copy.

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