



Course Specification of Biomedical Equipment

Maintenance

Course Code (BE471)

I. Course Identification and General Information:						
1	Course Title:	Biomedical Equipment Maintenance				
2	Course Code & Number:	BE471				
3	Credit hours:	C.H			TOTAL	
		Th.	Seminar	Pr		Tr.
		2	--	2	--	3
4	Study level/ semester at which this course is offered:	5 th Level / 1 st Semester				
5	Pre –requisite (if any):	Electrical Circuit I (BE111), Electrical Circuit II (BE112), Electronics I (BE122), Electronics II (BE223), Biomedical Hazards & Safety (637), Biomedical Equipment I (BE263), Biomedical Equipment II (BE 364)				
6	Co –requisite (if any):	Medical Imaging System I (BE468)				
7	Program (s) in which the course is offered:	Biomedical Engineering Program				
8	Language of teaching the course:	English				
9	Location of Teaching the Course:	Faculty of Engineering				
10	Prepared by:	Dr. Waleed Al-talabi				
11	Reviewed by:	Dr. Mohammed Al-olofi				
12	Date of Approval:					

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



I. Course Description:

The course aims to introduce students the methods, types of maintenance for medical equipment, and maintenance strategy. The students learn the logical approaches to troubleshooting. Hence, the student's ability to deal with the malfunctions, repair, and calibration will be increased. The course covers the main topics including: an introduction to maintenance management, fundamentals of troubleshooting, maintenance and calibration for several equipment in laboratory, medication delivery systems and aspirators devices, sterilizing, infant care, patient monitoring systems, diagnostic, cardiology, respiratory care, and medical imaging equipment.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)	Referenced PILOs (Only write code number of referenced Program Intended learning outcomes)
--	---

Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:

a1	Demonstrate understanding of the principles, concepts, theories, and basics managerial of maintenance. The importance of maintenance in health facilities, targets of maintenance and ways of executing maintenance tasks in hospitals.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Identify the reasons for equipment malfunctions and troubleshooting techniques.	A4 Understand and give examples of design methods, knowledge tools, analytical skills, measurement techniques and methodologies for innovative and creative engineering solutions applied to healthcare problems and quality of life issues.

B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



b1	<p>Identify and determine preventive maintenance procedures, safety testing and calibration of common medical equipment used in healthcare institutions as well as competence in the corrective maintenance of biomedical equipment.</p>	<p>B2 Identify, formulate and solve the complex problems related to the Biomedical Engineering fields in a creative and innovative manner by using a systematic and analytical thinking methods.</p>
b2	<p>Evaluate the different modes of equipment and distinguish among appropriate of different types of maintenance.</p>	<p>B5 Distinguish the main characteristics of biomedical systems, apply diagnostic skills and technical knowledge and perform failure analysis to these systems.</p>
<p>C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:</p>		
c1	<p>Use an electrical, electronic, mechanical skills, and troubleshooting techniques, as well as use of test and measuring instruments, and special tools required in the performance of repair and calibrate medical equipment.</p>	<p>C1 Apply integrally knowledge of mathematics, life science, IT, design, business context and engineering practice to solve problems and to design systems/processes relevant to Biomedical Engineering.</p>
c2	<p>Conduct appropriate experimentation and training related to biomedical equipment maintenance and patient safety, and utilize information gathered through troubleshooting process to develop an action plan in goal to decrease medical equipment downtime, to increase patient safety, and to correct user issues in a timely and efficiently.</p>	<p>C3 Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, collect, analyze and interpret data and present results in the biomedical systems practice.</p>

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



c3	Dis-assembly and re-assembly of medical equipment, troubleshoot, repair and maintain biomedical systems and products using medical as well as industry-standard tools and practices.	C5 Demonstrate basic organizational and project management skills, apply quality assurance procedures, practice neatness and aesthetics and follow codes and standards to improve biomedical products design or services.
D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
d1	Develop self-learning initiatives and integrate learned knowledge for problem solving.	D3 Recognize the needs for, and engage in life-long self-learning.

(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. Demonstrate understanding of the principles, concepts, theories, and basics managerial of maintenance. The importance of maintenance in health facilities, targets of maintenance and ways of executing maintenance tasks in hospitals.	<ul style="list-style-type: none"> • Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Directed self- study, • Team work (cooperative learning), • Field visits/training. 	<ul style="list-style-type: none"> • Written tests (mid and final terms and quizzes), • Short reports, • Home works and assignments, • Presentations.
a2. Identify the reasons for equipment malfunctions and troubleshooting techniques.	<ul style="list-style-type: none"> • Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, 	<ul style="list-style-type: none"> • Written tests (mid and final terms and quizzes), • Short reports, • Home works and

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



	<ul style="list-style-type: none"> • Team work (cooperative learning), • Field visits/training. 	<ul style="list-style-type: none"> • assignments, • Presentations.
--	---	--

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

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
<p>b1. Identify and determine preventive maintenance procedures, safety testing and calibration of common medical equipment used in healthcare institutions as well as competence in the corrective maintenance of biomedical equipment.</p>	<ul style="list-style-type: none"> • Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Laboratory/Practical experiments based session, • Workshops practices, • Team work (cooperative learning), • Field visits/training. 	<ul style="list-style-type: none"> • Written tests (mid and final terms and quizzes), • Oral exams, • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Home works and assignments, • Presentations.
<p>b2. Evaluate the different modes of equipment and distinguish among appropriate of different types of maintenance.</p>	<ul style="list-style-type: none"> • Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Laboratory/Practical experiments based session, • Workshops practices, • Directed self- study, 	<ul style="list-style-type: none"> • Written tests (mid and final terms and quizzes), • Oral exams, • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



	<ul style="list-style-type: none"> • Team work (cooperative learning), • Field visits/training. 	<ul style="list-style-type: none"> • assessment, • Home works and assignments, • Presentations.
--	---	--

(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
<p>c1. Use an electrical, electronic, mechanical skills, and troubleshooting techniques, as well as use of test and measuring instruments, and special tools required in the performance of repair and calibrate medical equipment.</p>	<ul style="list-style-type: none"> • Interactive lectures & examples, • Videos demonstrations, • Presentation/seminar, • Laboratory/Practical experiments based session, • Workshops practices, • Team work (cooperative learning), • Field visits/training. 	<ul style="list-style-type: none"> • Written tests (mid and final terms and quizzes), • Oral exams, • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Home works and assignments, • Presentations.
<p>c2. Conduct appropriate experimentation and training related to biomedical equipment maintenance and patient safety, and utilize information gathered through troubleshooting process to develop an action plan in goal to decrease medical equipment</p>	<ul style="list-style-type: none"> • Interactive lectures & examples, • Presentation/seminar, • Interactive class discussions, • Laboratory/Practical experiments based session, • Workshops practices, • Team work (cooperative 	<ul style="list-style-type: none"> • Written tests (mid and final terms and quizzes), • Short reports, • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment,

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



downtime, to increase patient safety, and to correct user issues in a timely and efficiently.	learning), <ul style="list-style-type: none"> Field visits/training. 	<ul style="list-style-type: none"> Home works and assignments, Presentations.
c3. Dis-assembly and re-assembly of medical equipment, troubleshoot, repair and maintain biomedical systems and products using medical as well as industry-standard tools and practices.	<ul style="list-style-type: none"> Interactive lectures & examples, Videos demonstrations, Presentation/seminar, Interactive class discussions, Laboratory/Practical experiments based session, Workshops practices, Team work (cooperative learning), Field visits/training. 	<ul style="list-style-type: none"> Written tests (mid and final terms and quizzes), Oral exams, Short reports, Lab\Project report Practical lab performance assessment, Coursework activities assessment, Presentations.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1. Develop self-learning initiatives and integrate learned knowledge for problem solving.	<ul style="list-style-type: none"> Interactive lectures & examples, Presentation/seminar, Interactive class discussions, Directed self- study. 	<ul style="list-style-type: none"> Written tests (mid and final terms and quizzes), Home works and assignments, Presentations.

IV. Course Content:

A – Theoretical Aspect:

Orde	Units/Topics List	Sub Topics List	Number	contact	Learning Outcomes
------	-------------------	-----------------	--------	---------	-------------------

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



r			of Weeks	hours	
1	Introduction	<ul style="list-style-type: none"> – Introduction to the course. – Course outlines. – Project description. – Theory and practice of maintenance. 	1	2	a1,
2	Introduction to Maintenance Management	<ul style="list-style-type: none"> – Area of maintenance. – The horizons of maintenance management: (breakdown, corrective, and preventive maintenance). – Reports from maintenance. – Maintenance stores and inventory control. – Computer in maintenance. – Maintenance skills training. – Test and measuring instruments, special tools. 	1	2	a1, b1,
3	Fundamentals of Biomedical Equipment Troubleshooting	<ul style="list-style-type: none"> – Reading drawings and diagrams (Block diagram, circuit diagram, and wiring diagram). – Dis-assembly and re-assembly of equipment. – Equipment failures and causes. – Nature of faults, fault location procedure, and fault finding aids (service and maintenance manuals and instruction manuals). – Troubleshooting techniques. – Approaching components for 	1	2	a1, a2, c2, c1, d1

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



		tests.			
4	Laboratory Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> - Clinical Centrifuges, - Spectrophotometer, - Clinical chemistry instrumentation, - Cell counter, - Microscopes. 	1	2	a2, b2, b1, c2, c1, c3,
5	Medication Delivery Systems and Aspirators Devices: Maintenance and Calibration	<ul style="list-style-type: none"> - Infusion pumps, - Syringe pumps, - Aspirators, - Suction machine. 	1	2	a2, b2, b1, c2, c1, c3,
6	Sterilizing Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> - Steam sterilizers, - Autoclave, - Hot air ovens. 	1	2	a2, b2, b1, c2, c1, c3,
7	Infant Care Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> - Infant incubators, - Infant warmers. 	1	2	a2, b2, b1, c2, c1, c3,
8	Mid-Term Theoretical Exam	- -All previous topics.	1	2	a1, a2, b2, b1,
9	Patient Monitoring Systems: Maintenance and Calibration	<ul style="list-style-type: none"> - Non-invasive blood pressure & vital signs monitors, - Pulse oximeter, - Bedside monitors. 	1	2	a2, b2, b1, c2, c1, c3,
10	Diagnostic Equipment: Maintenance and	<ul style="list-style-type: none"> - Electrocardiograph ECG, - Electroencephalograph EEG, 	1	2	a2, b2, b1, c2, c1, c3,

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



	Calibration	– Ophthalmoscope.			
11	Cardiology Equipment: Maintenance and Calibration	– Defibrillators, – Heart lung machine.	1	2	a2, b2, b1, c2, c1, c3,
12	Respiratory Care Equipment: Maintenance and Calibration	– Ventilators, – Nebulizer, – Oxygen concentrator.	1	2	a2, b2, b1, c2, c1, c3,
13	Imaging Equipment: Maintenance and Calibration	– Ultrasound Systems, – X-ray machine.	1	2	a2, b2, b1, c2, c1, c3,
14	Project Presentation	– Student's presentations.	2	4	a1, a2, b2, b1, d1
15	Final Theoretical Exam	– All topics.	1	2	a1, a2, b2, b1,
Number of Weeks /and Units Per Semester			16	32	

B - Practical Aspect:				
Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	Test and measuring instruments, special tools.	1	2	c1
2	Soldering techniques.	1	2	c1
3	Grounding systems in medical equipment.	1	2	c2, c1
4	- Passive Components and Their Testing: Resistors, Capacitors, Inductors Failures in fixed resistors, testing of resistors, variable resistors, variable resistors as potentiometers, failures in potentiometers,	2	4	c2, c1

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



	testing of potentiometers, servicing potentiometers, LDRs and thermistors Types of capacitors and their performance, Failures in capacitors, testing of capacitors and precautions therein, variable capacitor types, Testing of inductors and inductance measurement.			
5	<p>- Testing of Semiconductor Devices:</p> <p>Types of semiconductor devices, Causes of failure in semiconductor devices, Types of failure, Test procedures for diodes, Special types of diodes, Bipolar junction transistors, Field effect transistors, Thyristors, Operational amplifiers, Fault diagnosis in op-amp circuits.</p>	3	6	c2, c1
6	Mid-Term Practical Exam	1	2	c2, c1
7	<p>- Medical Instruments Troubleshooting & Testing:</p> <p>AC, DC power supply, grounding, shielding, guarding, insulation testing, insulation resistance measurement, testing of electronic components, troubleshooting of PCB boards, calibration of analog and digital sensor probe, display interface, safe electrical practice, cables and standard, fuse, transformer testing, CT and PT, Panel wiring, troubleshooting of Power supply, X-ray machines, and ECG recorders.</p>	4	8	a2, b2, b1, c2, c1, c3, d1
8	Maintenance of PC Based Medical Instruments: Introduction to PC based medical instruments, system configuration and BIOS, identification and troubleshooting of PC components: motherboard, HDD, FDD, CD-ROM, monitor, printers, modems, ports etc.	1	2	c1, c3, d1
9	Final Practical Exam	1	2	a2, b2, b1, c2, c1, c3, d1
Number of Weeks /and Units Per Semester		15	30	



V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Videos demonstrations,
- Presentation/seminar,
- Interactive class discussions,
- Exercises and home works,
- Laboratory/Practical experiments based session,
- Workshops practices,
- Directed self- study,
- Team work (cooperative learning),
- Field visits/training.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Oral exams,
- Short reports,
- Lab\Project report
- Practical lab performance assessment,
- Coursework activities assessment,
- Home works and assignments,
- Presentations.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Lectures 1,2,3, and 4 Assignment	a1, a2, b2, b1, c2, c1, c3, d1	5	2
2	Lectures 5,6,7, and 9 Assignment	a2, b2, b1, c2, c1, c3,	10	2
3	Lectures 10,11,12, and 13 Assignment	a2, b2, b1, c2, c1, c3	14	2

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



4	Project/ Presentation	a1, a2, b2, b1, d1	15	4
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	Project/ Assignments	5,10,14,15	10	6.67%	a1, a2, b2, b1, c2, c1, c3, d1
2	Quiz 1	4	5	3.33%	a1, a2,
3	Midterm Theoretical Exam	8	20	13.33%	a1, a2, b2, b1,
4	Quiz 2	12	5	3.33%	a1, a2, b2, b1
5	Midterm Practical Exam	9	20	13.33%	c2, c1
6	Final Practical Exam	15	30	20%	a2, b2, b1, c2, c1, c3, d1
7	Final Theoretical Exam	16	60	40%	a1, a2, b2, b1,
Total			150	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two).	
	<ol style="list-style-type: none"> John G. Webster, Amit J. Nimunkar, 2020, “Medical Instrumentation: Application and Design”, 5th Ed., USA, John Wiley & Sons Ltd. R. Keith Mobley, Lindley R. Higgins, Darrin J. Wikoff, 2008 “Maintenance Engineering Handbook”, 7th Ed., USA, McGraw-Hill Companies, Inc.
2- Essential References.	
	<ol style="list-style-type: none"> Ernesto Iadanza, 2020, “Clinical Engineering Handbook”, 2nd Ed., USA, Elsevier Academic Press.

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



2. Justin Cooper, Alex Dahinten, 2013, “**Medical Equipment Troubleshooting Flowchart Handbook**”, 6th Ed., USA, Engineering World Health.
3. Crown Agents, 2010, “**Medical Equipment Maintenance Manual**”, India, Ministry of Health and Family Welfare.

3- Electronic Materials and Web Sites etc.

Websites:

- 1- www.frankshospitalworkshop.com is a private and noncommercial website which can be used for self-study. It is a collection of documents, experiences, best-practice procedures and teaching and learning materials about biomedical technology.
<http://www.frankshospitalworkshop.com/>
- 2- DOTmed.com is the world's leading public trading platform for buying and selling medical equipment, parts and services. Many of the original features on DOTmed.com were free, and still are today.
<https://www.dotmed.com/>

Journals:

- 1- One of the world's largest fully open access journal publishers.
<https://www.hindawi.com/journals/jhe/>
- 2- BMC is part of **Springer Nature**, giving us greater opportunities to help authors everywhere make more connections with research communities across the world.
<https://biomedical-engineering-online.biomedcentral.com/>

Other Web Sources:

- 1- *Health Facilities Management*, a publication of the **American Hospital Association**, is the most trusted and credible publication in its field.
<https://www.hfmmagazine.com/articles/1493-medical-equipment-maintenance/>

X. Course Policies:

1

Class Attendance:

A student should attend not less than 75 % of total hours of the subject; otherwise he/she 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 a proof statement from university

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



	Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	Tardy: For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	Exam Attendance/Punctuality: A student should attend the exam on time. He/she 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: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
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 proofed a plagiarism of a student, he/she 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 or according to the university roles.
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 might be given directly to students using soft or hard copy.



Template for Course Plan (Syllabus)

Biomedical Equipment Maintenance BE471

I. Course Identification and General Information:					
1	Course Title:	Biomedical Equipment Maintenance			
2	Course Code & Number:	BE471			
3	Credit Hours:	Credit Hours	Theory Hours		Lab. Hours
			Lecture	Exercise	
		3	2	--	2
4	Study Level/ Semester at which this Course is offered:	5 th Level / 1 st Semester			
5	Pre –Requisite (if any):	Electrical Circuit I (BE111), Electrical Circuit II (BE112), Electronics I (BE122), Electronics II (BE223), Biomedical Hazards & Safety (637), Biomedical Equipment I (BE263), Biomedical Equipment II (BE 364)			
6	Co –Requisite (if any):	Medical Imaging System I (BE468)			
7	Program (s) in which the Course is Offered:	Bachelor of Biomedical Engineering			
8	Language of Teaching the Course:	English			
9	Location of Teaching the Course:	Faculty of Engineering			
10	Prepared by:	Dr. Waleed Al-talabi			
11	Reviewed by:	Dr. Mohammed Al-olofi			
12	Date of Approval:				



II. Course Description:

The course aims to introduce students the methods, types of maintenance for medical equipment, and maintenance strategy. The students learn the logical approaches to troubleshooting. Hence, the student's ability to deal with the malfunctions, repair, and calibration will be increased. The course covers the main topics including: an introduction to maintenance management, fundamentals of troubleshooting, maintenance and calibration for several equipment in laboratory, medication delivery systems and aspirators devices, sterilizing, infant care, patient monitoring systems, diagnostic, cardiology, respiratory care, and medical imaging equipment.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:

- | | |
|----|---|
| a1 | Demonstrate understanding of the principles, concepts, theories, and basics managerial of maintenance. The importance of maintenance in health facilities, targets of maintenance and ways of executing maintenance tasks in hospitals. |
| a2 | Identify the reasons for equipment malfunctions and troubleshooting techniques. |

B. Intellectual Skills: Upon successful completion of the course, students will be able to:

- | | |
|----|--|
| b1 | Identify and determine preventive maintenance procedures, safety testing and calibration of common medical equipment used in healthcare institutions as well as competence in the corrective maintenance of biomedical equipment. |
| b2 | Evaluate the different modes of equipment and distinguish among appropriate of different types of maintenance. |

C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:

- | | |
|----|--|
| c2 | Use an electrical, electronic, mechanical skills, and troubleshooting techniques, as well as use of test and measuring instruments, and special tools required in the performance of repair and calibrate medical equipment. |
| c2 | Conduct appropriate experimentation and training related to biomedical equipment |



III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)	
	maintenance and patient safety, and utilize information gathered through troubleshooting process to develop an action plan in goal to decrease medical equipment downtime, to increase patient safety, and to correct user issues in a timely and efficiently.
c3	Dis-assembly and re-assembly of medical equipment, troubleshoot, repair and maintain biomedical systems and products using medical as well as industry-standard tools and practices.
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Develop self-learning initiatives and integrate learned knowledge for problem solving.

IV. Course Contents:				
A. Theoretical Aspect:				
No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	Introduction	<ul style="list-style-type: none"> – Introduction to the course. – Course outlines. – Project description. – Theory and practice of maintenance. 	1	2
2	Introduction to Maintenance Management	<ul style="list-style-type: none"> – Area of maintenance. – The horizons of maintenance management: (breakdown, corrective, and preventive maintenance). – Reports from maintenance. – Maintenance stores and inventory control. – Computer in maintenance. – Maintenance skills training. 	1	2



IV. Course Contents:				
A. Theoretical Aspect:				
No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> – Test and measuring instruments, special tools. 		
3	Fundamentals of Biomedical Equipment Troubleshooting	<ul style="list-style-type: none"> – Reading drawings and diagrams (Block diagram, circuit diagram, and wiring diagram). – Dis-assembly and re-assembly of equipment. – Equipment failures and causes. – Nature of faults, fault location procedure, and fault finding aids (service and maintenance manuals and instruction manuals). – Troubleshooting techniques. – Approaching components for tests. 	1	2
4	Laboratory Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Clinical Centrifuges, – Spectrophotometer, – Clinical chemistry instrumentation, – Cell counter, – Microscopes. 	1	2
5	Medication Delivery Systems and Aspirators Devices: Maintenance and Calibration	<ul style="list-style-type: none"> – Infusion pumps, – Syringe pumps, – Aspirators, – Suction machine. 	1	2

University of Sana'a
 Faculty of Engineering
 Department: Biomedical Engineering
 Title of the Program: Biomedical Engineering



IV. Course Contents:				
A. Theoretical Aspect:				
No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
6	Sterilizing Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Steam sterilizers, – Autoclave, – Hot air ovens. 	1	2
7	Infant Care Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Infant incubators, – Infant warmers. 	1	2
8	Mid-Term Theoretical Exam	– -All previous topics.	1	2
9	Patient Monitoring Systems: Maintenance and Calibration	<ul style="list-style-type: none"> – Non-invasive blood pressure & vital signs monitors, – Pulse oximeter, – Bedside monitors. 	1	2
10	Diagnostic Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Electrocardiograph ECG, – Electroencephalograph EEG, – Ophthalmoscope. 	1	2
11	Cardiology Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Defibrillators, – Heart lung machine. 	1	2
12	Respiratory Care Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Ventilators, – Nebulizer, – Oxygen concentrator. 	1	2



IV. Course Contents:				
A. Theoretical Aspect:				
No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
13	Imaging Equipment: Maintenance and Calibration	<ul style="list-style-type: none"> – Ultrasound Systems, – X-ray machine. 	1	2
14	Project Presentation	Student's presentations.	2	4
15	Final Theoretical Exam	All topics.	1	2
Number of Weeks /and Units Per Semester			16	32

B. Case Studies and Practical Aspect:			
No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	Test and measuring instruments, special tools.	1	2
2	Soldering techniques.	1	2
3	- Grounding systems in medical equipment.	1	2
4	<ul style="list-style-type: none"> - Passive Components and Their Testing: - Resistors, Capacitors, Inductors Failures in fixed resistors, testing of resistors, variable resistors, variable resistors as potentiometers, failures in potentiometers, testing of potentiometers, servicing potentiometers, LDRs and thermistors Types of capacitors and their performance, Failures in capacitors, testing of capacitors and precautions therein, variable capacitor 	2	4

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



B. Case Studies and Practical Aspect:			
No.	Tasks/ Experiments	Number of Weeks	Contact Hours
	types, Testing of inductors and inductance measurement.		
5	<ul style="list-style-type: none"> - Testing of Semiconductor Devices: - Types of semiconductor devices, Causes of failure in semiconductor devices, Types of failure, Test procedures for diodes, Special types of diodes, Bipolar junction transistors, Field effect transistors, Thyristors, Operational amplifiers, Fault diagnosis in op-amp circuits. 	3	6
6	- Mid-Term Practical Exam	1	2
7	<ul style="list-style-type: none"> - Medical Instruments Troubleshooting & Testing: AC, DC power supply, grounding, shielding, guarding, insulation testing, insulation resistance measurement, testing of electronic components, troubleshooting of PCB boards, calibration of analog and digital sensor probe, display interface, safe electrical practice, cables and standard, fuse, transformer testing, CT and PT, Panel wiring, troubleshooting of Power supply, X-ray machines, and ECG recorders. 	4	8
8	<ul style="list-style-type: none"> - Maintenance of PC Based Medical Instruments: Introduction to PC based medical instruments, system configuration and BIOS, identification and troubleshooting of PC components: motherboard, HDD, FDD, CD-ROM, monitor, printers, modems, ports etc. 	1	2
9	Final Practical Exam	1	2
Number of Weeks /and Units Per Semester		15	30



V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Videos demonstrations,
- Presentation/seminar,
- Interactive class discussions,
- Exercises and home works,
- Laboratory/Practical experiments based session,
- Workshops practices,
- Directed self- study,
- Team work (cooperative learning),
- Field visits/training.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Oral exams,
- Short reports,
- Lab\Project report
- Practical lab performance assessment,
- Coursework activities assessment,
- Home works and assignments,
- Presentations.

VII. Assignments:

No.	Assignments	Week Due	Mark
1	Lectures 1,2,3, and 4 Assignment	5	2
2	Lectures 5,6,7, and 9 Assignment	10	2



VII. Assignments:			
No.	Assignments	Week Due	Mark
3	Lectures 10,11,12, and 13 Assignment	14	2
4	Project/ Presentation	15	4
Total			10

VIII. Schedule of Assessment Tasks for Students During the Semester:				
No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Project/ Assignments	5,10,14, 15	10	6.67%
2	Quiz 1	4	5	3.33%
3	Midterm Theoretical Exam	8	20	13.33%
4	Quiz 2	12	5	3.33%
5	Midterm Practical Exam	9	20	13.33%
6	Final Practical Exam	15	30	20%
7	Final Theoretical Exam	16	60	40%
Total			150	100%

IX. Learning Resources:	
1- Required Textbook(s) (maximum two).	
	1. John G. Webster, Amit J. Nimunkar, 2020, “ Medical Instrumentation: Application and Design ”, 5 th Ed., USA, John Wiley & Sons Ltd. 2. R. Keith Mobley, Lindley R. Higgins, Darrin J. Wikoff, 2008 “ Maintenance Engineering Handbook ”, 7 th Ed., USA, McGraw-Hill Companies, Inc.
2- Essential References.	

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



1. Ernesto Iadanza, 2020, “**Clinical Engineering Handbook**”, 2nd Ed., USA, Elsevier Academic Press.
2. Justin Cooper, Alex Dahinten, 2013, “**Medical Equipment Troubleshooting Flowchart Handbook**”, 6th Ed., USA, Engineering World Health.
3. Crown Agents, 2010, “**Medical Equipment Maintenance Manual**”, India, Ministry of Health and Family Welfare.

3- Electronic Materials and Web Sites etc.

Websites:

- 1- www.frankshospitalworkshop.com is a private and noncommercial website which can be used for self-study. It is a collection of documents, experiences, best-practice procedures and teaching and learning materials about biomedical technology.
<http://www.frankshospitalworkshop.com/>
- 2- DOTmed.com is the world's leading public trading platform for buying and selling medical equipment, parts and services. Many of the original features on DOTmed.com were free, and still are today.
<https://www.dotmed.com/>

Journals:

- 1- One of the world's largest fully open access journal publishers.
<https://www.hindawi.com/journals/jhe/>
- 2- BMC is part of [Springer Nature](https://www.springer.com), giving us greater opportunities to help authors everywhere make more connections with research communities across the world.
<https://biomedical-engineering-online.biomedcentral.com/>

Other Web Sources:

- 1- *Health Facilities Management*, a publication of the [American Hospital Association](https://www.ahahospital.org), is the most trusted and credible publication in its field.
<https://www.hfmmagazine.com/articles/1493-medical-equipment-maintenance/>

X. Course Policies:

1

Class Attendance:

A student should attend not less than 75 % of total hours of the subject; otherwise he/she 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 a proof statement from university Clinic. If the absent is more

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering



	than 25% of a course total contact hours, student will be required to retake the entire course again.
2	Tardy: For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	Exam Attendance/Punctuality: A student should attend the exam on time. He/she 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: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
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 proofed a plagiarism of a student, he/she 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 or according to the university roles.
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 might be given directly to students using soft or hard copy.