58. Course Specification of Introduction to Biomedical Technology

I.Course Identification and General Information:

.1	Course Title:	Introduction to Biomedical Technology.					
.2	Course Code & Number:	MT310.					
.3	Credit hours:	C.H				Total Cr. Hrs.	
		Th.	Seminar	Pr.	Tu.		
		2	-		2	3	
.4	Study level/ semester at which this course is offered:	Fourth Year - Second Semester.					
.5	Pre –requisite (if any):	None.					
.6	Co –requisite (if any):	None.					
7.	Program (s) in which the course is offered:	Mechatronics Engineering Program.					
8.	Language of teaching the course:	English Language.					
.9	Location of teaching the course:	Mechatronics Engineering Department.					
.10	Prepared By:	Asst. Prof. Dr. Mohammed Abdullah Al-Olofi.					
11.	Date of Approval:						

II.Course Description:

This course aims to advance students' knowledge with the basic principles, concepts, and theories of the biomedical engineering and its applications in medical fields.
It includes a historical perspective of biomedical engineering BME, jobs carries in BME, area of research & development in BME, process of design commercial medical devices, basic components of medical instruments, biomedical sensors “biosensors”, bioinstrumentation, bio signal processing, biotechnology, and tissue engineering.

III.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Recognize the principles, concepts, and theories of biomedical engineering.	A1
a2.	Describe the theories of operations of medical equipment systems.	A2
a3.	Depict characteristics of biomedical systems and specifications related to Mechatronics.	A4

Head of the Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance	Rector of Sana’a University
Assoc. Prof. Dr. Abdul-Malik Momin	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad	Prof. Dr. Al-Qassim Mohammed Abbas

a4.	Classify the biomedical engineer responsibilities, and Biomedical practices safety issues.	A6
b1.	Categorize the biomedical engineering issues and analyze the available solutions.	B1
b2.	Examine innovate methods for monitoring, interfacing and automating of biomedical systems.	B3
c1.	Choose the information technology tools to solve the biomedical systems problems.	C2
d1.	Cooperate productively as an individual and as a member of a team / multi-disciplinary team.	D1
d2.	Rate effectively project tasks, time and resources.	D3
d3.	Judge in independent lifelong learning.	D5
d4.	Review effective technical reports and presentations.	D6

(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. principles, Recognize the and theories concepts, engineering. of biomedical	• Active Lectures. • Tutorials.	• Written Assessment. • Short Essays. • Final Exam.
Describe the theories of **a2.** operations of medical equipment systems.	• Hands on Laboratory Work. • Lectures.	• Practical Assessment. • Simulation. • Final Exam.
Depict characteristics of **a3.** biomedical systems and specifications related to Mechatronics.	• Case Studies. • Independent Learning and Work. • Lectures.	• Short Essays. • Project Reports. • Final Exam. • Assessment
Classify the biomedical **a4.** engineer responsibilities, and biomedical practices safety issues.	• Independent Learning and • Work. • Lectures.	• Project Reports. • Final Exam. • Assessment.

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

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies

the Categorize **b1.** biomedical engineering I ssues and analyze the available solutions.	• Design Work and Project. • Case Studies. • Lectures.	• Practical Assessment. • Reports. • Final Exam.
Examine innovate **b2.** methods for monitoring, interfacing and automating of biomedical systems.	• Active Lectures. • Independent Learning and • Work.	• Simulations. • Presentations. • Final Exam. • Assessment.

© **Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:**		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Choose the information **c1.** technology tools to solve the biomedical systems problems.	• The Use of Communication and Information Technology. • Lectures	• Simulations such as Computer Based Learning. • Final Exam.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Cooperate productively as an **d1.** and as a member of a individual disciplinary team. team / multi-	• Group Learning.	• Project Reports.
Rate effectively project tasks, time **d2.** and resources.	• Active Lectures.	• Presentations.
Judge in independent lifelong **d3.** learning.	• Active Lectures.	• Presentations.
Review effective technical reports **d4.** and presentations.	• Active Lectures.	• Presentations. • Written Assessments.

IV.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction to Biomedical Engineering (BME).	a1, a2, a3, a4	• A historical perspective of biomedical engineering BME. • Jobs carries in BME. • Area of research & development in BME.	2	4
2.	BME Fields.	a1, a2, a3, a4, b1, b2, c1	• Types. • Application. • Basic components of medical instruments. • Biosensors. • Bio instrument. • Biosignal processing. • Biotechnology. • Tissue engineering – biomaterials. • Radiation imaging – biomedical optics and lasers. • Clinical engineering. • Electrical safety.	7	14
3.	Mid-Term Exam.	a1, a2, a3, a4, b1, b2, c1	• The First 2 Chapters.	1	2
4.	Medical Devices.	a1, a2, a3, a4, b1, b2, c1	• Basic components of medical instruments. • Biomedical sensors. • Bioinstrumentation. • Biotechnology. • Tissue engineering.	4	8
5.	Final Report Presentation.	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4.	All the Chapters.	1	2
6.	Final Exam.	a1, a2, a3, a4, b1, b2, c1	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

Head of the Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance	Rector of Sana'a University
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B – Tutorial Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1.	Introduction to Biomedical Engineering (BME).	2	4	a.1, a.2, a.3, a.4
2.	BME Fields.	7	14	a.1, a.2, a.3, a.4, b.1, b.2, c.1
3.	Medical Devices.	4	8	a.1, a.2, a.3, a.4, b.1, b.2, c.1
4.	Final Report Presentation.	1	2	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4.
Number of Weeks /and Units Per Semester: 14			**28**	

V.Teaching strategies of the course:

In general, teaching and learning in undergraduate engineering education programs should use a variety of teaching methods, such as:

- Active Lectures (supported with discussions).
- Hands-on Laboratory Work.
- Independent Learning and Work.
- Group Learning and Problem-Based Learning.
- Field Classes.
- Independent Applications of Engineering Analysis.
- Seminars, Journal Clubs and Workshops.
- The Use of Communication and Information Technology.
- Computer and Web-Based Learning.
- Case Studies.

VI.Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Exercises & Home works (all the chapters-Tutorials).	a1, a2, a3, a4, b1, b2,d1, d3	Weekly	10
2.	Project (single/group).	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4	Quarter	5
3.	Participation.	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4	Weekly	5

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Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

Total		**20**

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.	Assessment (Tutorials).	Weekly	15	10%	a1, a2, a3, a4, b1, b2,d1, d3
2.	Project (single/group).	Quarter	7.5	5%	a1, a2, a3, a4, b1, b2, c1, d1, d2, d3, d4
3.	Participation & Presentation.	Weekly	7.5	5%	a1, a2, a3, a4, b1, b2, c1, d1, d2, d3, d4
4.	Mid-term Exam.	Week 10	15	10%	a1, a2, a3, a4, b1, b2, c1
5.	Final Exam.	Week 16	105	70%	a1, a2, a3, a4, b1, b2, c1
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).

- John Enderle, et al. "Introduction to Biomedical Engineering", 2nd ed., Academic Press.

2- Essential References.

- BME Handbook.

3- Electronic Materials and Web Sites *etc*.

1. http://www.sciencedirect.com/.
2. http://dl.acm.org/dl.cfm.
3. http://ieeexplore.ieee.org/Xplore/guesthome.jsp.
4. http://www.emeraldinsight.com.
5. http://www.scopus.com/home.url.
6. http://link.springer.com/.

IX.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 an approved statement from university 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 proved 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.**

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. Head of Mechatronics Engineering Department: Assoc. Prof. Dr. Abdul-Malik Momin.
	Deputy Rector for Academic Affairs Assoc. Prof. Dr. Ibrahim AlMutaa. Assoc. Prof. Dr. Ahmed Mujahed. Asst. Prof. Dr. Munaser Alsubari.

Elective Course (1)

Head of the Department Assoc. Prof. Dr. Abdul-Malik Momin	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

Template for Course Plan of Introduction to Biomedical Technology

I.Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Asst. Prof. Dr. Mohammed Abdullah Al-Olofi.	Office Hours					
Location& Telephone No.	00967-773703712.	SAT	SUN	MON	TUE	WED	THU
E-mail	Al_olfe2001@yahoo.com.	8-10					

II.Course Identification and General Information:

1.	Course Title:	Introduction to Biomedical Technology.				
2.	Course Number & Code:	MT310.				
3.	Credit hours:	C.H				Total Cr. Hrs.
		Th.	Seminar	Pr.	Tu.	
		2	-	-	2	3
4.	Study level/year at which this course is offered:	Fourth Year – Second Semester.				
5.	Pre –requisite (if any):	None.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechatronics 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:	Mechatronics Engineering Department.				

III.Course Description:

This course aims to advance student knowledge with the basic principles, concepts, and theories of the biomedical engineering and its applications in medical fields.
It includes a historical perspective of biomedical engineering BME, jobs carries in BME, area of research & development in BME, process of design commercial medical devices, basic components of medical instruments, biomedical sensors “biosensors”, bioinstrumentation, bio signal processing, biotechnology, and tissue engineering.

IV.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Recognize the principles, concepts, and theories of biomedical engineering.	A1
a2.	Describe the theories of operations of medical equipment systems.	A2
a3.	Depict characteristics of biomedical systems and specifications related to Mechatronics.	A4
a4.	Classify the biomedical engineer responsibilities, and Biomedical practices safety issues.	A6
b1.	Categorize the biomedical engineering issues and analyze the available solutions.	B1
b2.	Examine innovate methods for monitoring, interfacing and automating of biomedical systems.	B3
c1.	Choose the information technology tools to solve the biomedical systems problems.	C2
d1.	Cooperate productively as an individual and as a member of a team / multi-disciplinary team.	D1
d2.	Rate effectively project tasks, time and resources.	D3
d3.	Judge in independent lifelong learning.	D5
d4.	Review effective technical reports and presentations.	D6

V.Course Content:

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

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact hours
1.	Introduction to Biomedical Engineering (BME).	• A historical perspective of biomedical engineering BME. • Jobs carries in BME. • Area of research & development in BME.	1,2	4
2.	BME Fields.	• Types. • Application. • Basic components of medical instruments. • Biosensors.	3,4,5,6,7,8,9	14

		• Bioinstrument. • Biosignal processing. • Biotechnology. • Tissue engineering – biomaterials. • Radiation imaging – biomedical optics and lasers. • Clinical engineering. • Electrical safety.		
3.	Mid-Term Exam.	• The First 2 Chapters.	10	2
4.	Medical Devices.	• Basic components of medical instruments. • Biomedical sensors. • Bioinstrumentation. • Biotechnology. • Tissue engineering.	11,12,13,14	8
5.	Final Report Presentation.	All the Chapters.	15	2
6.	Final Exam.	All the Chapters.	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.	Introduction to Biomedical Engineering (BME).	1,2	4	a1, a2, a3, a4
2.	BME Fields.	3,4,5,6,7,8,9	14	a1, a2, a3, a4, b1, b2, c1
3.	Medical Devices.	10,11,12,13	8	a1, a2, a3, a4, b1, b2, c1
4.	Final Report Presentation.	14	2	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4
Number of Weeks /and Units Per Semester: 14			**28**	

VI.Teaching strategies of the course:

In general, teaching and learning in undergraduate engineering education programs should use a variety of teaching methods, such as:

- Active Lectures (supported with discussions).
- Hands-on Laboratory Work.
- Independent Learning and Work.
- Group Learning and Problem-Based Learning.
- Field Classes.
- Independent Applications of Engineering Analysis.
- Seminars, Journal Clubs and Workshops.
- The Use of Communication and Information Technology.
- Computer and Web-Based Learning.
- Case Studies.

VII.Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Exercises & Home works (all the chapters).	a1, a2, a3, a4, b1, b2,d1, d3	Weekly	10
2.	Project (single/group).	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4	Quarter	5
3.	Participation.	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4	Weekly	5
Total				**20**

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.	Assessment.	Weekly	15	10%	a1, a2, a3, a4, b1, b2,d1, d3
2.	(Project single/group).	Quarter	7.5	5%	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4
3.	Participation & Presentation .	Weekly	7.5	5%	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4

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Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

4.	Mid-Term Exam.	Week 10	15	10%	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4
5.	Final Exam.	Week 16	105	70%	a1, a2, a3, a4, b1,b2, c1, d1, d2, d3, d4
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).

- John Enderle, et al. "Introduction to Biomedical Engineering", 2nd ed., Academic Press.

2- Essential References.

- BME Handbook.

3- Electronic Materials and Web Sites *etc*.

1. http://www.sciencedirect.com/.
2. http://dl.acm.org/dl.cfm.
3. http://ieeexplore.ieee.org/Xplore/guesthome.jsp.
4. http://www.emeraldinsight.com.
5. http://www.scopus.com/home.url.
6. http://link.springer.com/.

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 an approved statement from university** **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 proved 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.**

59. Elective Course (2)

Course Specification of Air Conditioning and Refrigeration

I.Course Identification and General Information:						
.1	Course Title:	Air Conditioning and Refrigeration.				
.2	Course Code & Number:	MT404.				
.3	Credit hours:	C.H				TOTAL CR. HRS
		Th.	Seminar	Pr.	Tu.	
		2	-	-	2	3
.4	Study level/ semester at which this course is offered:	Fifth Year- First Semester.				
.5	Pre –requisite (if any):	Thermodynamics and Heat Transfer.				
.6	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Mechatronics Engineering Program.				
.8	Language of teaching the course:	English Language.				
.9	Location of teaching the course:	Mechatronics Engineering Department.				
10.	Prepared By:	Asst. Prof. Dr. Eng. Hamoud A. Al-Nehari.				
11.	Date of Approval:					

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

II.Course Description:

The course is designed to give fundamental knowledge of types of refrigeration, refrigeration cycles, refrigerants and behavior under various conditions, different air conditioning terms and load calculation, designing of components of air distribution system.

III.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1	Characterize fundamental principles of refrigeration and air conditioning systems.	A2
a2.	Define various refrigeration cycles.	
b1.	Design air conditioning system using cooling load calculations.	B1
b2.	Analyze problems, conclude software solutions associated with refrigeration and air conditioning.	
c1.	Apply calculations of psychometric properties, processes, heating and cooling load requirements.	C1
c2.	Choose various important components of the refrigeration and air conditioning systems.	
d1.	Cooperate in work successfully as a part of a team through training on simulation software and presentations.	D1
d2.	Examine results and defend ideas.	D6

(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. Characterize fundamental principles of refrigeration and air conditioning systems.	• Lectures. • Tutorials. • Interactive Class Discussion.	• Written Tests and Quizzes. • Homework and Assignments.
a2. Define various refrigeration cycles.		

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

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies

b1. Design air conditioning system using cooling load calculations.	• Lectures. • Tutorials. • Interactive Class Discussion.	• Written Tests and Quizzes. • Homework and Assignments.
b2. Analyze problems, conclude software solutions associated with refrigeration and air conditioning.		

© **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. Make calculations of psychometric properties, processes, heating and cooling load requirements.	• Lectures. • Tutorials. • Simulations using Computer Software	• Written Tests and Quizzes. • Homework and Assignments.
c2. Choose various important components of the refrigeration and air conditioning systems.		

(D) **Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:**		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
d1. Cooperate in work successfully as a part of a team through training on simulation software and presentations.	• Lectures. • Tutorials. • Simulations using Computer Software. • Group Learning.	• Written Tests and Quizzes. • Homework and Assignments. • Project Reports.
d2. Examine results and defend ideas.		

IV.Course Content:

A – Theoretical Aspect: Lectures and Exercises

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Introduction.	a1, a2, b1, b2	Brief history, need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems.	1	1

2.	Refrigerants and their Characteristics.	a1, a2, b1, b2	Classification, nomenclature, desirable properties, secondary refrigerants, future industrial refrigerants.		1
3.	Air Refrigeration.	a1, a2, b1, b2, c1, c2, d1, d2	Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of Simple; Bootstrap; Reduced ambient and Regenerative air refrigeration systems.	1	2
4.	Vapor Compression System.	a1, a2, b1, b2, c1, c2, d1, d2	Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle.	1	2
5.	Compound Compression System.	a1, a2, b1, b2, c1, c2, d1, d2	Compound compression with intercooler, flash gas removal and flash intercooler, multiple evaporators with back pressure valves and with multiple expansion valves without flash inter cooling, analysis of two evaporators with flash intercooler and individual expansion valve and multiple expansion valve, cascade refrigeration system.	2	4
6.	Absorption Refrigeration System.	a1, a2, b1, b2, c1, c2, d1, d2	Desirable **c**haracteristics of refrigerant, selection of pair, practical H2O -NH3 cycle, LiBr – H2O system and its working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer, throttling, Electrolux refrigeration system.	1	2

7.	Refrigeration System Components.	a1, a2, b1, b2, c1, c2, d1, d2	Types; construction; working; comparison and selection of compressors; condensers; expansion devices; and evaporators, refrigeration piping accessories, evacuation and charging of refrigerant, properties and classification of thermal insulation.	1	2
8.	Mid-Term Exam.	a1, a2, b1, b2, c1, c2	The First 7 Chapters.	1	2
9.	Psychrometry.	a1, a2, b1, b2, c1, c2, d1, d2	Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychometric chart, psychometric processes.	1	2
10.	Human Comfort.	a1, a2, b1, b2, c1, c2, d1, d2	Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions.	2	2
11.	Load Analysis.	a1, a2, b1, b2, c1, c2, d1, d2	Site survey, outdoor and indoor design conditions, classification of loads, flywheel effect of building material and its use in design, effect of wall construction on cooling load, instantaneous heat gain (IHG) and instantaneous cooling load (ICL) heat transmission through sunlit and shaded glass using tables, method of		2

			reduction of solar heat gain through glass, calculations of cooling load TETD due to sunlit and shaded roof and walls using tables, ventilation and air infiltration, load due to outside air, heat gain from occupants; electric lights; product; electric motor and appliances, load calculations for automobiles, use of load estimation sheet, introduction of CLTD method.		
12.	Duct Design and Air Distribution.	a1, a2, b1, b2, c1, c2, d1, d2	Function; classification and economic factors influencing duct layout, equal friction method of duct design, use of friction chart, dynamic losses and its determination, Requirements of air distribution system, air distribution, grills, outlets, application, location.	1	2
13.	Air-Conditioning Systems.	a1, a2, b1, b2, c1, c2, d1, d2	Classification, system components, all air; all water; and air-water systems, room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems.	1	2
14.	Controls and Applications.	a1, a2, b1, b2, c1, c2, d1, d2	Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation, Freeze Drying, A/c in textile, printing pharmaceutical industry and	2	4

			Hospitals, Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning.		
15.	Final Exam.	a1, a2, b1, b2, c1, c2	All the Chapters.	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.	Introduction.	1	2	a1, a2, b1, b2
2.	Refrigerants and their Characteristics.			a1, a2, b1, b2
3.	Air Refrigeration.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
4.	Vapor Compression System.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
5.	Compound Compression System.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
6.	Absorption Refrigeration System.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
7.	Refrigeration System Components.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
8.	Psychrometry.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
9.	Human Comfort.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
10.	Load Analysis.			a1, a2, b1, b2, c1, c2, d1, d2
11.	Duct Design and Air Distribution.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
12.	Air-Conditioning Systems.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
13.	Controls and Applications.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
Number of Weeks /and Units Per Semester		**14**	**28**	

V.Teaching strategies of the course:

1. Lectures.
2. Tutorials.
3. Simulations using Computer Software.
4. Interactive Class Discussion.

VI.Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Exercises & Home works (all the chapters)	a1, a2, b1, b2, c1, c2, d1, d2	Weekly	5 for all
2.	Project (single/group)	a1, a2, b1, b2, c1, c2, d1, d2	13	5
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.	Assignments (all the chapters).	Weekly	5	3.33 %	a1, a2, b1, b2, c1, c2,d1, d2
2.	Project (single/group).	13	5	3.33 %	a1, a2, b1, b2, c1, c2,d1, d2
3.	Quizzes.	7,12	15	10%	a1, a2, b1, b2, c1, c2,d1, d2
4.	Mid-Term Exam.	8	20	13.33 %	a1, a2, b1, b2, c1, c2,d1, d2
5.	Final Exam.	16	105	70 %	a1, a2, b1, b2, c1, c2,d1, d2
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. W.F. Stoecker and J. W. Jones, 1982 Refrigeration and Air Conditioning, McGraw-Hill.
2. C P Arora, 2015, Refrigeration and Air Conditioning, McGraw-Hill.

2- Essential References.

Refrigeration and Air-conditioning by Ramesh Arora.-1
ASHRAE Refrigeration Handbook.-2

3- Electronic Materials and Web Sites *etc*.

http://www.springer.com/engineering/mechanical+engineering/journal/231.

	IX.Course Policies:
.1	**Class Attendance:** - The students should have more than 75% of attendance according to rules and regulations of the faculty.
.2	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
.3	**Exam Attendance/Punctuality:** - The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final 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:** - If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries.
6.	**Plagiarism:** - If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university.
7.	**Other Policies:** - All the teaching materials should be kept out the examination hall and mobile phones are not allowed. - Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university.

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. Head of Mechatronics Engineering Department: Assoc. Prof. Dr. Abdul-Malik Momin.
	Deputy Rector for Academic Affairs Assoc. Prof. Dr. Ibrahim AlMutaa. Assoc. Prof. Dr. Ahmed Mujahed. Asst. Prof. Dr. Munaser Alsubari.

Head of the Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance	Rector of Sana'a University
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Elective Course (2)
Template for Course Plan of Air Conditioning and Refrigeration

I.Information about Faculty Member Responsible for the Course:								
Name of Faculty Member	Asst. Prof. Dr. Eng. Hamoud A. Al-Nehari.	**Office Hours**						
Location& Telephone No.	-	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	h_nahary@hotmail.com.	8-10					

II.Course Identification and General Information:						
1.	Course Title:	Air Conditioning and Refrigeration.				
2.	Course Number & Code:	MT404.				
3.	Credit hours:	C.H				Total Cr. Hrs
		Th.	Seminar	Pr.	Tu.	
		2	-	-	2	3
4.	Study level/year at which this course is offered:	Fifth Year- First Semester.				
5.	Pre –requisite (if any):	Thermodynamics and Heat Transfer.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechatronics 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:	Mechatronics Engineering Department.				

III.Course Description:

The course is designed to give fundamental knowledge of types of refrigeration, refrigeration cycles, refrigerants and behavior under various conditions, different air conditioning terms and load calculation, designing of components of air distribution system.

IV.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Characterize fundamental principles of refrigeration and air conditioning systems.	A2
a2.	Define various refrigeration cycles.	
b1.	Design air conditioning system using cooling load calculations.	B1
b2.	Analyze problems, conclude software solutions associated with refrigeration and air conditioning.	
c1.	Apply calculations of psychometric properties, processes, heating and cooling load requirements.	C1
c2.	Choose various important components of the refrigeration and air conditioning systems.	
d1.	Cooperate in work successfully as a part of a team through training on simulation software and presentations.	D1
d2.	Examine results and defend ideas.	D6

V.Course Content:

A – Theoretical Aspect: Lectures and Exercises

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction.	Brief history, need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems.	1	1
2.	Refrigerants and their Characteristics.	Classification, nomenclature, desirable properties, secondary refrigerants, future industrial refrigerants.		1
3.	Air Refrigeration.	Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of Simple; Bootstrap; Reduced ambient and Regenerative air refrigeration systems.	2	2
4.	Vapor Compression System.	Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle.	3	2

5.	Compound Compression System.	Compound compression with intercooler, flash gas removal and flash intercooler, multiple evaporators with back pressure valves and with multiple expansion valves without flash inter cooling, analysis of two evaporators with flash intercooler and individual expansion valve and multiple expansion valve, cascade refrigeration system.	4,5	4
6.	Absorption refrigeration System.	Desirable **c**haracteristics of refrigerant, selection of pair, practical H2O -NH3 cycle, LiBr – H2O system and its working, h-x diagram and simple calculation of various process like adiabatic mixing and mixing with heat transfer, throttling, Electrolux refrigeration system.	6	2
7.	Refrigeration System Components.	Types; construction; working; comparison and selection of compressors; condensers; expansion devices; and evaporators, refrigeration piping accessories, evacuation and charging of refrigerant, properties and classification of thermal insulation.	7	2
8.	Mid-Term Exam.	The First 7 Chapters.	8	2
9.	Psychrometry.	Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychometric chart, psychometric processes.	9	2
10.	Human Comfort.	Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions	10,11	2
11.	Load Analysis.	Site survey, outdoor and indoor design conditions, classification of loads, flywheel effect of building material and its use in design, effect of wall construction on cooling load, instantaneous heat gain (IHG) and instantaneous cooling load		2

		(ICL) heat transmission through sunlit and shaded glass using tables, method of reduction of solar heat gain through glass, calculations of cooling load TETD due to sunlit and shaded roof and walls using tables, ventilation and air infiltration, load due to outside air, heat gain from occupants; electric lights; product; electric motor and appliances, load calculations for automobiles, use of load estimation sheet, introduction of CLTD method		
12.	Duct Design and Air Distribution.	Function; classification and economic factors influencing duct layout, equal friction method of duct design, use of friction chart, dynamic losses and its determination, Requirements of air distribution system, air distribution, grills, outlets, application, location	12	2
13.	Air-Conditioning Systems.	Classification, system components, all air; all water; and air-water systems, room air conditioners, packaged air conditioning plant, central air conditioning systems, split air conditioning systems	13	2
14.	Controls and Applications.	Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation, Freeze Drying, A/c in textile, printing pharmaceutical industry and Hospitals, Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning	14,15	4
15.	Final Exam.	All the Chapters.	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.	Introduction.	1	2	a1, a2, b1, b2
2.	Refrigerants and their Characteristics.			a1, a2, b1, b2
3.	Air Refrigeration.	2	2	a1, a2, b1, b2, c1, c2, d1, d2
4.	Vapor Compression System.	3	2	a1, a2, b1, b2, c1, c2, d1, d2
5.	Compound Compression System.	4,5	4	a1, a2, b1, b2, c1, c2, d1, d2
6.	Absorption Refrigeration System.	6	2	a1, a2, b1, b2, c1, c2, d1, d2
7.	Refrigeration System Components.	7	2	a1, a2, b1, b2, c1, c2, d1, d2
8.	Psychrometry	8	2	a1, a2, b1, b2, c1, c2, d1, d2
9.	Human Comfort.	9,10	4	a1, a2, b1, b2, c1, c2, d1, d2
10.	Load Analysis.			a1, a2, b1, b2, c1, c2, d1, d2
11.	Duct Design and Air Distribution.	11	2	a1, a2, b1, b2, c1, c2, d1, d2
12.	Air-Conditioning Systems.	12	2	a1, a2, b1, b2, c1, c2, d1, d2
13.	Controls and Applications.	13,14	4	a1, a2, b1, b2, c1, c2, d1, d2
Number of Weeks /and Units Per Semester		**14**	**28**	

VI.Teaching strategies of the course:

1. Lectures.
2. Tutorials.
3. Simulations using Computer Software.
4. Interactive Class Discussion.

Assignments: VII.

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Exercises & Home works (all the chapters).	a1, a2, b1, b2, c1, c2, d1, d2	Weekly	5 for all
2.	Project (single/group).	a1, a2, b1, b2, c1, c2, d1, d2	13	5
Total				**10**

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

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3.	Quizzes.	7,12	15	10%	a1, a2, b1, b2, c1, c2,d1, d2
4.	Mid-Term Exam.	8	20	13.33 %	a1, a2, b1, b2, c1, c2,d1, d2
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Total			**150**	**100%**	

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