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

42. Course Specification of Thermodynamics - II

I. Course Identification and General Information:						
1.	Course Title:	Thermodynamics - II.				
2.	Course Code & Number:	ME 252.				
3.	Credit Hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar/Tu.	Pr	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	Third Year - Second Semester				
5.	Pre –requisite (if any):	Thermodynamics - I				
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. Abduljalil Al-Abidi**.**				
11.	Date of Approval:					

II. Course Description:

This course covers irreversibility and combustion. Thermodynamic principles are applied to the analysis of gas power generation cycles, steam power cycles, refrigeration, and air-conditioning systems (including Rankine Cycle, vapor compression cycle, Otto cycle, Diesel cycle, Brayton cycle). Thermodynamic analysis of non-reacting and reacting mixtures of Thermodynamic relations. Mixtures and solutions. Chemical reactions and combustion.

III. Alignments of the Course Intended learning outcomes (CILOs)		Referenced PILOs
a1	Describe the thermodynamics principles of power generation, refrigeration, air-conditioning, and combustion systems.	A.1
a2	Identify general principles of design and analysis of the power generation, refrigeration, air-conditioning, and combustion systems.	A.2

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b1	Analyze process involving energy and mass balances of power generation, refrigeration, air-conditioning, and combustion systems .	B.1
b2	Explore the first law, second law of thermodynamics to engineering processes of the power generation, refrigeration, air-conditioning, and combustion.	B.2
c1	Solve problems in the power generation, refrigeration, air-conditioning, and combustion systems	C.1
c2	Calculate efficiency and coefficient of performance of power generation, refrigeration, air-conditioning, and combustion systems	C.2
d1	Evaluate effective communication skill through oral and written modes.	D.1
d2	Justify ideas and work in a team in an efficient and effective manner under controlled supervision or independently.	D.2

(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- Describe the thermodynamics principles of power generation, refrigeration, air-conditioning, and combustion systems.	Lectures, Tutorial. Class Activity, Interactive, Class Discussion. Problem-Based Learning.	Homework and Assignments. Written Tests**.** (Mid and Final Terms Exam). Coursework Activities. Quizzes**.**
a2- Identify general principles of design and analysis of the power generation, refrigeration, air-conditioning, and combustion systems.	Lectures, Tutorial Class Activity, Interactive Class Discussion, Exercises and Homework, Problem-Based Learning.	Homework and Assignments. Written Tests**.** (Mid and Final Terms Exam). Coursework Activities. Quizzes**.**

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

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Analyze process involving energy and mass balances of power generation, refrigeration, air-conditioning, and combustion systems	Lectures, Tutorial Class Activity, Interactive Class Discussion, Exercises and Homework, Problem-Based Learning.	Homework and Assignments. Written Tests. (Mid and Final Terms Exam). Coursework Activities. Quizzes.
b2. Explore the first law, second law of thermodynamics to engineering processes of the power generation, refrigeration, air-conditioning, and combustion.	Lectures, Tutorial Class Activity, Interactive Class Discussion, Exercises and Homework, Problem-Based Learning.	Home Works and Assignments. Written Tests. (Mid and Final Terms Exam). Coursework Activities. Quizzes.

© 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 Solve problems in the power generation, refrigeration, air-conditioning, and combustion systems.	Lectures, Tutorial Class Activity, Interactive Class Discussion, Exercises and Homework, Problem-Based Learning.	Homeworkand assignments Written Tests. (Mid and Final Terms Exam). Coursework Activities. Quizzes.
c2 Calculate efficiency and coefficient of performance of power generation, refrigeration, air-conditioning, and combustion systems.	Lectures, Tutorial Class Activity, Interactive Class Discussion, Exercises and, Problem-Based Learning.	and Assignments. Written Tests. (Mid and Final Terms Exam). Coursework Activities. Quizzes.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:

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Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1. Evaluate effective communication skill through oral and written modes.	Lectures, Tutorial Class Activity, Interactive Class Discussion, Exercises and Homework, Problem-Based Learning.	Written Tests. Homework and Assignments Coursework Activities Report/Project/ Practical Lab Sessions.
d2. Justify ideas and work in a team in an efficient and effective manner under controlled supervision or independently.	Lectures, Interactive Class Discussion, Self-Study Assignments and Homework.	Written Tests. Homework and Assignments Coursework Activities Report/Project/ Practical Lab Sessions.

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Gas Power Cycles.	a1,a2,b1.b2, c1,c2 d1,d2	Concepts of Gas Power Cycles and their Applications: Otto cycle, Diesel cycle, Brayton cycle, Jet-propulsion cycles.	3	6
2.	Steam Power Cycles.	a1,a2,b1.b2, c1,c2 d1,d2	Concepts of Vapor Power Cycles and their Applications: Rankine Cycle for Steam Power Plants, Reheat Rankine Cycle, Regenerative Rankine Cycle.	3	6
3.	Refrigeration Cycles.	a1,a2,b1.b2, c1,c2 d1,d2	Concepts of Refrigeration Cycles and their Applications: Refrigerators and Heat Pumps,	1	2

			Vapor-Compression Refrigeration Cycle. Selection of the Right Refrigerant. Heat Pump Systems. Gas Refrigeration Cycles.		
4.	Mid-Term Exam.	a1,a2,b1.b2, c1,c2	The First 3 Chapters.	1	2
5.	Refrigeration Cycles.	a1,a2,b1.b2, c1,c2 d1,d2	Concepts of Refrigeration Cycles and their Applications: Refrigerators and Heat Pumps, Vapor-Compression Refrigeration Cycle. Selection of the Right Refrigerant. Heat Pump Systems. Gas Refrigeration Cycles.	1	2
6.	Gas Mixtures.	a1,a2,b1.b2, c1,c2 d1,d2	Composition of a Gas Mixture. P-V-T Behavior of Gas Mixtures. Thermodynamic Properties of Gas Mixtures.	2	4
7.	Air Conditioning.	a1,a2,b1.b2, c1,c2 d1,d2	Dry and Atmospheric Air. Specific and Relative Humidity of Air. Dew-point and Wet-Bulb Temperatures. The Psychometric Chart. Air-Conditioning Processes. Wet Cooling Towers.	2	4
8.	Chemical Reactions and Combustion.	a1,a2,b1.b2, c1,c2 d1,d2	Fuels, Combustion and their Applications. Theoretical and Actual Combustion Processes. Enthalpy of Formation and Enthalpy of Combustion. Steady-Flow and Closed Reacting Systems. First law Analysis of Reacting Systems. Adiabatic Flame Temperature.	2	4

			Second-Law Analysis of Reacting Systems.		
9.	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.	Tutorial: Gas Power Cycles.	3	6	a1, a2, b1, b2, c1, c2, d1, d2
2.	Tutorial: Steam Power Cycles.	3	6	a1, a2, b1, b2, c1, c2, d1, d2
3.	Tutorial: Refrigeration Cycles.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
4.	Tutorial: Gas Mixtures.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
5.	Tutorial: Air Conditioning.	2	4	a1, a2, b1, b2, c1, c2, d1, d2
6.	Tutorial: Chemical Reactions and Combustion.	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- Team Work (Group Learning).
4- Seminar/ Project/Presentation.
5- Problem Based Learning.
6- Interactive Class Discussions.

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VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Homework 1	a1, a2, b1, b2, c1, c2, d1, d2	2nd	0.75
2.	Homework 2	a1, a2, b1, b2, c1, c2, d1, d2	3rd	0.75
3.	Homework3	a1, a2, b1, b2, c1, c2, d1, d2	4th	0.75
4.	Homework 4	a1, a2, b1, b2, c1, c2, d1, d2	5th	0.75
5.	Homework5	a1, a2, b1, b2, c1, c2, d1, d2	6th	0.75
6.	Homework6	a1, a2, b1, b2, c1, c2, d1, d2	7th	0.75
7.	Homework7	a1, a2, b1, b2, c1, c2, d1, d2	8th	0.75
8.	Homework 8	a1, a2, b1, b2, c1, c2, d1, d2	9th	0.75
9.	Homework9	a1, a2, b1, b2, c1, c2, d1, d2	10th	0.75
10.	Homework 10	a1, a2, b1, b2, c1, c2, d1, d2	11th	0.75
Total				**7.5**

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.	Homework.	Weekly	7.5	5 %	b.1,b.2,c1,c2 d.1, d.2
2.	Project (Single/Group).	13	7.5	5 %	a1,a1,b.1,b.2, d.1, d.2
3.	Quizzes.	4, 12	15	10 %	a.1, a.2, b1,b.2,
4.	Mid-Term Exam.	8	30	20 %	a.1, a.2, b1,b.2,
5.	Final Exam.	16	90	60 %	a.1, a.2, b1,b.2,
Total:			**150**	**100 %**	

VIII. Learning Resources:

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

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1- Required Textbook(s) (maximum two).	
	1- Çengel, Yunus A. Boles, Michael A.| Kanoğlu, Mehmet, – 2019- Thermodynamics: An Engineering Approach – 9th Edition- United States of America - McGraw-Hill Education. 2- Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey., 2018- Fundamentals of Engineering Thermodynamics (9 th Edition), John Wiley.
2- Essential References.	
	1-Borgnakke, C. and Sonntag, R. E., 2009. Fundamentals of Thermodynamics, 7 th Ed., John Wiley & Sons. 2- T D Eastop; A McConkey, 2009. Applied Thermodynamics for Engineering Technologists 5 th Edition, Pearson Education.Ltd.
3- Electronic Materials and Web Sites *etc*.	
	1.https://www.coursera.org/learn/thermodynamics-intro#syllabus

I. 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 considerd 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 repeates 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
6	**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.
7	**Other policies:** - 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	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Assoc. Prof. Dr. Abdul-Malik Momin**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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

42. Template for Course Plan of Thermodynamics- II

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Asst. Prof. Dr. Abduljalil Al-Abidi	**Office Hours**					
Location& Telephone No.		**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail							

II. Course Identification and General Information:

1.	Course Title:	Thermodynamics – I.				
2.	Course Number & Code:	ME 252.				
3.	Credit Hours:	C.H				Total Cr. Hrs.
		Th.	Seminar/Tu.	Pr	Tr.	
		2	2	-	-	3
4.	Study level/year at which this course is offered:	Third Year - Second Semester.				
5.	Pre –requisite (if any):	Thermodynamics – I.				
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 and Tutorials.				
11.	Location of teaching the course:	Mechanical Engineering Department.				

III. Course Description:

This course covers irreversibility and combustion. Thermodynamic principles are applied to the analysis of gas power generation cycles, steam power cycles, refrigeration, and air-conditioning systems (including Rankine Cycle, vapor compression cycle, Otto cycle, Diesel

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cycle, Brayton cycle). Thermodynamic analysis of non-reacting and reacting mixtures of Thermodynamic relations. Mixtures and solutions. Chemical reactions and combustion.

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

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

1. Demonstrate an understanding of thermodynamic cycles of power generation, refrigeration, air-conditioning, combustion.
2. Identify general principles of design and analysis of the power generation, refrigeration, air-conditioning, and combustion systems
3. Analyze process involving energy and mass balances of power generation, refrigeration, air-conditioning, and combustion systems
4. Evaluate the thermal performance or coefficient of performance of thermodynamic cycles of power generation, refrigeration, air-conditioning, combustion.
5. Analyze different combustion processes and apply the first law of Thermodynamics on reacting systems
6. Characterize and solve problems in thermodynamics in various engineering applications
7. Conduct effective communication skill through oral and written modes.
8. Justify ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

V. Course Content:

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

A – Theoretical Aspect:

Order	Topics List	Sub Topics List	Week Due	Contact Hours
1.	Gas Power Cycles.	Concepts of Gas Power Cycles and their Applications: Otto cycle, Diesel cycle, Brayton cycle, Jet-propulsion cycles.	1st, 2nd, 3rd	6
2.	Steam Power Cycles.	Concepts of Vapor Power Cycles and their Applications: Rankine Cycle for Steam Power Plants, Reheat Rankine Cycle, Regenerative Rankine Cycle.	4th, 5th, 6th	6
3.	Refrigeration Cycles.	Concepts of Refrigeration Cycles and their Applications: Refrigerators and Heat Pumps, Vapor-Compression Refrigeration Cycle. Selection of the Right Refrigerant. Heat Pump Systems. Gas Refrigeration Cycles.	7th	4
4.	Mid-term Exam	The First 3 Chapters.	8th	2
5.	Refrigeration Cycles.	Concepts of Refrigeration Cycles and their Applications: Refrigerators and Heat Pumps, Vapor-Compression Refrigeration Cycle. Selection of the Right Refrigerant. Heat Pump Systems. Gas Refrigeration Cycles.	9th	4
6.	Gas Mixtures.	Composition of a Gas Mixture. P-V-T Behavior of Gas Mixtures. Thermodynamic	10 th, 11 th	4

		Properties of Gas Mixtures.		
7.	Air Conditioning.	Dry and Atmospheric Air. Specific and Relative Humidity of Air. Dew-point and Wet-Bulb Temperatures. The Psychometric Chart. Air-Conditioning Processes. Wet Cooling Towers.	12 th, 13 th	4
8.	Chemical Reactions and Combustion.	Fuels, Combustion and their Applications. Theoretical and Actual Combustion Processes. Enthalpy of Formation and Enthalpy of Combustion. Steady-Flow and Closed Reacting Systems. First law Analysis of Reacting Systems. Adiabatic Flame Temperature. Second-Law Analysis of Reacting Systems.	14 th, 15 th	4
9.	Final Exam	All the Chapters.	16 th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B – Tutorial Aspect:

Order	Topics List	Week Due	Contact Hours
1.	Tutorial: Gas Power Cycles	1st, 2nd, 3rd	6
2.	Tutorial: Steam Power Cycles.	4th, 5 th, 6 th	6
3.	Tutorial: Refrigeration Cycles.	7 th, 8 th	4
4.	Tutorial: Gas Mixtures.	10 th, 11 th	4
5.	Tutorial: Air Conditioning.	12 th, 13 th	4
6.	Tutorial: Chemical Reactions and Combustion.	14 th, 15 th	4
Number of Weeks /and Units Per Semester		**14**	**28**

VI. Teaching strategies of the course:

- Lectures.
- Tutorials.
- Team Work (Group Learning).
- Seminar/ Project/Presentation.
- Problem Based Learning.
- Interactive Class Discussions.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Homework 1	a1, a2, b1, b2, c1, c2, d1, d2	2nd	0.75
2.	Homework 2	a1, a2, b1, b2, c1, c2, d1, d2	3rd	0.75
3.	Homework3	a1, a2, b1, b2, c1, c2, d1, d2	4th	0.75
4.	Homework 4	a1, a2, b1, b2, c1, c2, d1, d2	5th	0.75
5.	Homework5	a1, a2, b1, b2, c1, c2, d1, d2	6th	0.75
6.	Homework6	a1, a2, b1, b2, c1, c2, d1, d2	7th	0.75
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9.	Homework9	a1, a2, b1, b2, c1, c2, d1, d2	10th	0.75
10.	Homework 10	a1, a2, b1, b2, c1, c2, d1, d2	11th	0.75
Total				**7.5**

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.	Exercises & Homework.	Weekly	7.5	5 %	b.1,b.2,c1,c2 d.1, d.2
2.	Project (Single/Group).	13	7.5	5 %	a1,a1,b.1,b.2, d.1, d.2

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3.	Quizzes.	4, 12	15	10 %	a.1, a.2, b1,b.2,
4.	Mid-Term Exam.	8	30	20 %	a.1, a.2, b1,b.2,
5.	Final Exam.	16	90	60 %	a.1, a.2, b1,b.2,
	Total:		**150**	**100 %**	

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2- Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey., Fundamentals of Engineering Thermodynamics (9 th Edition), John Wiley.

2- Essential References.

1-Borgnakke, C. and Sonntag, R. E., 2009. Fundamentals of Thermodynamics, 7 t John Wiley & Sons.
2- T D Eastop; A McConkey, 2009. Applied Thermodynamics for Engine Technologists
5 th Edition, Pearson Education.Ltd.

3- Electronic Materials and Web Sites *etc*.

1.https://www.coursera.org/learn/thermodynamics-intro#syllabus

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2	**Tardy:** - For lateness in attending the class, the student will be initially notified. If he repeates late in attending class he will be considered absent.

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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.
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