Course Specifications

Course Title:	**Thermodynamics**
Course Code:	**4022135-3**
Program:	**Chemistry and Industrial Chemistry**
Department:	**Chemistry**
College:	**Applied Science**
Institution:	**Umm Al-Qura University**

Table of Contents

A. Course Identification

1. Credit hours:	**3 (2 theoretical + 1 practical)**
2. Course type	
a.	University ☐ College ☐ Department ☑ Others ☐
b.	Required ☑ Elective ☐
3. Level/year at which this course is offered:	3rd level/2nd year
4. Pre-requisites for this course (if any)**:**	Volumetric Analytical Chemistry & Calculus
5. Co-requisites for this course (if any)**:**	---

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	√	100 %
2	**Blended**	---	---
3	**E-learning**	---	---
4	**Correspondence**	---	---
5	**Other**	---	---

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
Contact Hours		
1	**Lecture**	30
2	**Laboratory/Studio**	45
3	**Tutorial**	--
4	**Others** (specify)	--
	Total	**75**
Other Learning Hours*		
1	**Study**	52
2	**Assignments**	8
3	**Library**	4
4	**Projects/Research Essays/Theses**	6
5	**Others** (specify)	20
	Total	**90**

* The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

B. Course Objectives and Learning Outcomes

1. Course Description

The course deals with the basic principles of thermodynamics including heat, energy, laws of thermodynamics and their applications, exothermic and endothermic reactions as well as pontaneous and non spontaneous processes.

2. Course Main Objective

By the end of this course the students will be able to describe and explain:

1. Fundamental principles of thermodynamics.

2. Application of thermodynamic laws in various fields.
3. Physical intuition, mathematical reasoning, and problem solving skills.
4. Analyzing thermodynamic data and predicting the processes spontaneity.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge:**	
1.1	Recognize the intensive and extensive properties	K3
1.2	Know the classifications of thermodynamic systems	K1
1.3	Describe Joul and Joul-Thompson effects	K3
1.4	Familiar with systems and various dynamic processes.	K1
1.5	Identify the different thermodynamics functions	K3
1.6	Write thermal equations for various thermodynamic processes.	K3
1.7	Recognize the relationship between chemical equilibrium and spontaneity.	K1
1.8	Memorize different laws of thermodynamics	K3
1.9	Outline the different uses of thermodynamics functions	K2
1.10	Define exothermic and exothermic reactions	K1
2	**Skills :**	
2.1	Apply the thermodynamic laws	S1
2.2	Compare between various thermodynamic systems	S1
2.3	Explain the conversion of heat to work	S2
2.4	Analyze the thermodynamic data	S2
2.5	Predict the spontaneity of the reactions	S1
2.6	Evaluate the efficiency of various heat engines	S2
3	**Competence:**	
3.1	Work in a team to perform a specific experimental tasks.	C2
3.2	Work independently to handle chemicals.	C1
3.3	Communicate results of work to classmate and participation in class or laboratory discussions	C4
3.4	Work effectively both in a team, and independently on solving chemistry problems.	C3
3.5	Communicate with his lecturer and colleagues	C4

C. Course Content

No	List of Topics	Contact Hours
1	General concepts of thermodynamics.	**2**
2	Heat, energy and work (the mechanical equivalent of heat). Different types of systems	**2**
3	Thermodynamics variables and characteristics of intensive, extensive and thermodynamics processes.	**2**
4	Zero and first laws of thermodynamics and their applications.	**2**
5	The relationship between enthalpy change and internal energy change, heat capacity	**2**
6	The Jules-Thompson's effect, Adiabatic and isothermal expansions, Determination of Joule's coefficient from heat capacity measurements.	**2**
7	Thermochemistry. Exothermic and endothermic reactions. Kirchhoff's law, Hess's law and its applications.	**4**

8	The second law of thermodynamics and its applications.	2
9	Mid-term exam.	2
10	Spontaneous and non spontaneous processes. Heat machines and thermal efficiency	2
11	Heat transfer to work. Carnot cycle (efficiency and compression ratio) Otto cycle.	2
12	Entropy. Gibbs free energy, work function, Gibbs and Gibbs –Helmholtz Equations.	2
13	Van't Hoff Equations, Chemical Equilibrium and spontaneity.	2
14	Third law of thermodynamics and its applications.	2
Total		30

Practical part

• Instructions on rules and methods of safety at chemical lab.
• Introduction to the objectives of thermodynamics and various types of thermo-chemical reactions.
• Determination of the heat capacity and specific heat of the calorimeter using distilled water.
• Determination of the heat capacity of the calorimeter using solutions.
• Determination of the heat capacity for different concentration of sodium chloride solutions.
• Determination of the heat of neutralization between acid and alkali.
• Determination of the heat of salvation of ammonium chloride as an endothermic reaction at infinite dilution.
• Determination of the heat of salvation of sodium hydroxide as an exothermic reaction at infinite dilution.
• Hess's Law.
• Determination of the higher critical temperature for water-phenol system.
• Determination of the lower critical temperature in two component system.
• Three component systems.

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge**		
1.1	Recognize the intensive and extensive properties	Lecture and web-based study	Quiz
1.2	Know the classifications of thermodynamic systems	Lecture	Quiz
1.3	Describe Joul and Joul-Thompson effects	Lecture	Quiz
1.4	Familiar with systems and various dynamic processes.	Lecture	Exam
1.5	Identify the different thermodynamics functions	Lecture	Quiz
1.6	Write thermal equations for various thermodynamic processes.	Discussion	Quiz

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.7	Recognize the relationship between chemical equilibrium and spontaneity.	Discussion	Exam
1.8	Memorize different laws of thermodynamics	Library visits	Short essays
1.9	Outline the different uses of thermodynamics functions	Lecture	Quiz
1.10	Define exothermic and exothermic reactions	Web-based study	Exam
2.0	**Skills**		
2.1	Apply the thermodynamic laws	Discussion	Quiz
2.2	Compare between various thermodynamic systems	Lecture	Exam
2.3	Explain the conversion of heat to work	Library visits	Short essays
2.4	Analyze the thermodynamic data	Web-based study	Exam
2.5	Predict the spontaneity of the reactions	Lecture	Exam
2.6	Evaluate the efficiency of various heat engines	Library visits	Quiz
3.0	**Competence**		
3.1	Work in a team to perform a specific experimental tasks.	Discussion	Short essays
3.2	Work independently to handle chemicals	Lecture	Quiz
3.3	Communicate results of work to classmate and participation in class or laboratory discussions	Library visits	Exam
3.4	Work effectively both in a team, and independently on solving chemistry problems.	Lecture	Short essays
3.5	Communicate with his lecturer and colleagues	Discussion	Exam

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homework or activities.	--	10 %
2	Mid-term Exam.	9	20 %
3	Practical Exam.	14	30 %
4	Final Exam.(2 hours exam)	16	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- Weekly office hours for discussion with the students.

• Academic advising for students. • Availability of Staff members to provide counseling and advice.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	• Physical Chemistry, Amazon logo Silbey, R. R. Alberty, M. Bawendi, 4th ed., John Wiley & Sons, 2004. • Physical Chemistry, Peter Atkins & Julio de Paula, 10th ed., W. H. Freeman and Company, 2014. • Advanced Physical Chemistry, B. S. Bahl, S. Chand & Co., New Delhi, India, 1993.
Essential References Materials	Thermodynamics: an engineering approach, Yunus A. Cengel and Michael A. Boles, 7 th. SI ed., McGraw- Hill, London, 2011.
Electronic Materials	• http://www.chemweb.com • http://www.sciencedirect.com • http://www.rsc.org • Websites on the internet relevant to the topics of the course
Other Learning Materials	Not required

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Well-equipped lecture halls.
Technology Resources (AV, data show, Smart Board, software, etc.)	Computer and data show.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	No other requirements.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Quality of learning resources	Students	Complete the questionnaire evaluation of the course periodically.
Effectiveness of teaching and assessment.	Program Leaders	Observation of students performing a task.
Extent of achievement of course learning outcomes.	Peer Reviewer	Checking selected exam papers, and student assignments.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	
Reference No.	
Date	3/3/1441

Received by: Dr. Ismail Althagafi **Department Head**

Signature: **Date: 20/12/2019**