هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T4 2020

Course Specifications

Course Title:	**ADVANCED THERMODYNAMIC**
Course Code:	**CHEM531**
Program:	**Master**
Department:	**Chemistry**
College:	**College of Science**
Institution:	**King Saud University**

Table of Contents

A. Course Identification

1. Credit hours: 2
2. Course type **a.** University [ ] College [ ] Department [*] Others [ ] **b.** Required [*] Elective [ ]
3. Level/year at which this course is offered: 2nd Year (post graduation)
4. Pre-requisites for this course (if any)**:** CHEM231 (Chemical thermodynamic) + MATH111
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**	2	10
2	**Blended**	9	30
3	**E-learning**	9	30
4	**Distance learning**	9	30
5	**Other**	-	-

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	30
2	**Laboratory/Studio**	0
3	**Tutorial**	0
4	**Others** (specify)	0
	Total	30

B. Course Objectives and Learning Outcomes

1. Course Description

The course of advanced thermodynamics includes a generality on classical thermodynamics in order to refresh the memory then a brief reminder of mathematics in relation to matter, such as, for example, the relations of statistical mathematics (Bolzman equations, probability equations and Lagrande polynomial expansion) then develops, chapter by chapter, the physical concepts of statistical thermodynamics. Each paragraph ends with a series of exercises. Finally, 2 exams of medium duration and a final exam will be the subject of examining the students.

2. Course Main Objective

Teach students the transition from the thermodynamics of microscopic particles to the thermodynamics of macroscopic particles (microscopic state of matter and microscopic exchanges of energies) in order to better understands the phenomena of energy transfer in its macroscopic state.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	*Define the different states of matter and recognize the relationships between them* *Describe the properties of solutions (ideal and real);*	
1.2	*Describe the properties of solutions (ideal and real);*	
1.3	*Recognize and describe the phase diagrams (liquid-vapor, liquid-liquid and solid-liquid*	
2	**Skills :**	
2.1	*Interpret the phase diagrams and evaluate the critical points.*	
2.2	*Calculate and analyze the thermodynamic parameter of mixtures such as the partial molar parameters (volume, free enthalpy, enthalpy and entropy)*	
2.2	*Estimate the changes in the enthalpy, entropy and the Gibbs energy changes.*	
2.3	*Estimate colligative properties of solutions.*	
2.4	*Derive the thermodynamic function of mixture and determine the different molar parameters such as molar volume, free enthalpy expressions and calculate the partial molar volume of each constituent. Represent and interpret the experimental data*	
3	**Interpersonal Skills & Responsibility**	
3.1	*-Work independently and as in groups including leadership responsibilities;*	
3.2	*- Manage resources, time and other members of the group*	
3.3	*- Communicate results of work to other*	
3.4	*- Act responsibly in a personal manner; Display of ethical and high moral standards in both private and public environments.*	

CLOs		Aligned PLOs
3.5	*-Use sta- Manage resources, time and other members of the group*	
4	**Communication, Information Technology, Numerical**	
4.1	*Utilizing university electronic resources of learning.*	
4.2	*Interpretation of numerical, chemical and general scientific information.*	

C. Course Content

No	List of Topics	Contact Hours
	CHEM 531: ADVANCED THERMODYNAMIC	
1	**I. The distribution of molecular states** ***I.1 Configurations and weights*** I.1.1 Instantaneous configurations I.1.2 The Boltzmann distribution ***I.2 The molecular partition function*** I.2.1 An interpretation of the partition function I.2.2 Approximations and factorizations	5
2	**II. The internal energy and the entropy** ***II.1 The internal energy*** II.1.1 The relation between U and q II.1.2 The value of b ***II.2 The statistical entropy*** II.2.1 Impact on technology	5
3	**III. The canonical partition function** **III.1 The canonical ensemble** III.1.1 The concept of ensemble III.1.2 Dominating configurations III.1.3 Fluctuations from the most probable distribution **III.2 The thermodynamic information in the partition function** III.2.1 The internal energy III.2.2 The entropy **III.3 Independent molecules** III.2.3 Distinguishable and indistinguishable molecules III.2.4 The entropy of a monatomic gas **Exercises**	6
4	**IV Fundamental relations** **IV.1 The thermodynamic functions** IV.1.1 Helmholtz energy IV.1.2 The pressure IV.1.3 The enthalpy	6

	IV.1.3 The Gibbs energy **IV.2 The molecular partition function** IV.2.1 The translational contribution IV.2.2 The rotational contribution IV.2.3 The vibrational contribution IV.2.3 The electronic contribution IV.2.4 The overall partition function	
5	**V Using statistical thermodynamics** **V.1 Mean energies** V.1.1 The mean translational energy V.1.2 The mean rotational energy V.1.3 The mean vibrational energy **V.2 Heat capacities** V.2.1 The individual contributions V.2.2 The overall heat capacity **V.3 Equations of state** **V.4 Molecular interactions in liquids** V.4.1 The radial distribution function V.4.2 The calculation of g(r) V.4.3 The thermodynamic properties of liquids **V.5 Residual entropies** **V.6 Equilibrium constants** V.6.1 The relation between K and the partition function V. 6.2 A dissociation equilibrium V.6.3 Contributions to the equilibrium constant **Exercises**	8
Total		30

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 and Understanding**		
1.1	*-Define the different thermodynamic functions and recognize the relationships between them*	*Use interactive method (question-answer),* *Incorporation of the IT to develop the knowledge and particularly (the smart board, internet),* *Proposing stimulation questions*	*Homework assignments,* *Using active learning techniques,* *-Major final and two segmented midterm exams*
1.2	*-Describe the different thermodynamic systems*		
1.3	*Define the microscopic scales of the matter and recognize the relationships between the microscopic and the macroscopic states*		
2.0	**Skills**		
2.1	*Interpret the different thermodynamics functions using the mathematical concept.*		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
		- *Solving examples,* - *Class discussions,* - *Using modern methods of teaching such as the IT ways,*	*Following up students participations in class discussion activities.* *Major and final exams* *Problem solving by students on board*
2.2	*Calculate and analyze the thermodynamic functions (free enthalpy, enthalpy and entropy)*		
2.3	*Estimate the changes in the enthalpy, entropy and the Gibbs energy*		
2.4	*Demonstrate mathematically the releation between the different thermodynamics parameters*		
2.5	*Derive the thermodynamic function such as the enthalpy, enthropy, Gibbs enthalpy, internal energy mixture.*		
2.6	*Represent and interpret the theoretical data*		
3.0	**Values**		
3.1	*Resolution of problems*	*Give more exercises and problems to solve in group work.*	*MED: 1 and 2* *Final exam*
3.2	Exploitation of results	*Provide tables from experimental data and let the student draw the curves and deduce the important parameters.*	*Labs exam*
3.3	Communication of results	*Make the links between the results obtained and the translators.*	*MED: 1 and 2* *Final exam*

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
0			-
1	*Major Exam I*	*Week 4*	*30%*
2	*Major Exam II*	*Week 8*	*30%*
3	*General Revision*	*Week 10*	-
4	*Final Exam*	*Week 12*	*40%*
8			100%

***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 :

Daily individual consultations of students which takes place according to a program drawn up by the teacher according to his availability.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	Physical Chemistry, 9 Ed. Peter Atkins and Julio de Paula, Publisher : W.H. Freeman and Company, 2010
Essential References Materials	N.A.
Electronic Materials	N.A.
Other Learning Materials	*Software*: *Word, Excel, Power-Point presentations, Chemdraw, etc.*

1. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	*Laboratory (10 experimentations)*
Technology Resources (AV, data show, Smart Board, software, etc.)	*Using Smart board*
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	*N.A.*

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Faculty	*Administrators*	*Feed back*
Department	*Administrators*	*Feed back*
	Students	Feed back

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	25-01-2023