# Course Specification
## (Bachelor)

| | |
|---|---|
| Course Title: | Physical Chemistry (1) |
| Course Code: | CHM 1241 |
| Program: | Bachelor of Science in Chemistry |
| Department: | Chemistry |
| College: | Science |
| Institution: | Imam Mohammed Ibn Saud Islamic University |
| Version: | 2024 V1 |
| Last Revision Date: | 12 October 2024 |

## Table of Contents

## A. General information about the course:

### -1. Course Identification

| | | | | | |
|---|---|---|---|---|---|
| **1. Credit hours: (4)** | | | | | |
| **4 (1 Lectures, 3 Lab, 2 Tutorials)** | | | | | |
| **2. Course type** | | | | | |
| **A.** | ☐University | ☐College | ☒ Department | ☐Track | ☐Others |
| **B.** | ☒ Required | | ☐Elective | | |
| **3. Level/year at which this course is offered: Level 3/ Second year** | | | | | |
| **4. Course general Description:** | | | | | |
| **Topics covered in the course include the properties of ideal gas and some laws related to them and the real gas properties. First, second and third laws of thermodynamics, the equilibrium states, Application of the Gibbs function and the Planck function to some phase changes.** | | | | | |
| **5. Pre-requirements for this course** (if any)**:** | | | | | |
| **General Chemistry (2)/ CHM 1102** | | | | | |
| **6. Co-requisites for this course** (if any)**:** | | | | | |
| **None** | | | | | |
| **7. Course Main Objective(s):** | | | | | |
| ***At the end of the course, Students should be able:*** <br>• **To improve the student's knowledge of the laws of classical thermodynamics.** <br>• **To recognize the properties of gases, liquids, and solids and their solutions.** <br>• **To correlate the kinetic theory to gas laws.** <br>• **Describe the basic principles of chemical equilibria and relationships with thermodynamic function and pH of solutions.** | | | | | |

### 2. Teaching mode (mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | **90** | **100%** |
| 2 | E-learning | **0** | **0** |
| 3 | Hybrid <br>• Traditional classroom <br>• E-learning | **0** | **0** |
| 4 | Distance learning | **0** | **0** |

### 3. Contact Hours (based on the academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1. | **Lectures** | **15** |
| 2. | **Laboratory/Studio** | **45** |
| 3. | **Field** | **0** |
| 4. | **Tutorial** | **30** |
| 5. | **Others (specify)** | **0** |
| **Total** | | 90 |

## B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| **1.0** | **Knowledge and understanding** | | | |
| **1.1** | **To define the concept of standard state and thermodynamic functions of pure substances due to change of temperature and state main gas laws and their applications.** | **K1; K2; K3** | • Group discussion and assignments<br>• homework<br>• Lab-reports<br>• Virtual labs and demonstrations | • Oral tests<br>• Lab performance reports<br>• Sheets Marks<br>• Assignments<br>• Homework marks |
| **1.2** | **To describe the change of vapour pressure of pure liquids and solids due to change in temperature** | **K1** | • Group discussion<br>• Assignments<br>• Homework<br>• Lab-reports<br>• Virtual labs and demonstrations | • Oral tests<br>• Lab performance reports<br>• Sheets Marks<br>• Assignments<br>• Homework marks |
| **1.3** | **To list the thermodynamic concept of phase equilibrium, chemical equilibrium, entropy, and Gibb's free energy.** | **K1; K3** | • Numerical examples<br>• Laboratory experiments<br>• Group discussion | • Laboratory reports<br>• Oral tests<br>• Lab performance reports<br>• Homework marks |
| **2.0** | **Skills** | | | |
| **2.1** | **To summarize the heat of reaction from tabulated bond energy values and evaluate** | **S1; S2; S3** | • Lectures<br>• Laboratory experiments<br>• Group discussion | • Solved problem marks<br>• Oral tests<br>• Homework marks |

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | **the elevation in boiling point and depression in freezing point of solutions due to salt addition** | | | • Short quizzes<br>• Numerical problem |
| 2.2 | **To analyze data and results through analytical thinking, with an evaluation of the gained information.** | **S1; S2; S3** | • Group Discussions<br>• Brainstorming<br>• Self-study | • Work portfolio<br>• Homework |
| 2.3 | **To demonstrate skills to participate in class by asking questions and giving answers.** | **S3** | Motivate students to ask questions and to give response. | • Participation marks<br>• Short quizzes<br>•<br>• Homework |
| 2.4 | **To illustrate and diagram experimental data during laboratory classes, demonstrate technical writing and oral communication skills, and operate electronic mail and network in communication with classmates and teachers.** | S4; S3 | • Group discussions<br>• Lab experiments and reports<br>• Encourage students to use electronic mail to submit homework and assignments. | • Oral tests<br>• Lab performance, reports<br>• Sheets Marks<br>• Assignments<br>• Homework marks |
| **3.0** | **Values, autonomy, and responsibility** | | | |
| **3.1** | **To show effective contribution in teamwork and raise Knowledge during various evaluations, initiatives, and Lab-reports to uphold scientific integrity.** | **V1;V2** | • Group discussion and assignments<br>• homework<br>• Lab-reports<br>• Virtual labs and demonstrations | • Oral tests<br>• Lab performance, reports<br>• Sheets Marks<br>• Assignments Homework marks |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1. | **Nature of physical chemistry:** Classical mechanics and Properties of Gases:The Perfect Gas – States of gases. Gas laws, Individual Gases, Boyle's Law, Charles's and Gay-Lussac's law, Avogadro's Principle, Graham's law, Perfect (Ideal) Gas Equation, **Mixtures of Gases**. Dalton's Law, Mole Fractions, Real Gases, Molecular Interactions, Compression factor Boyle's Temperature, Critical Constants, van der Waals Equations. Kinetic Model of Gases. The Barometric Distribution Law, The Maxwell Distribution of Molecular Speeds and Translational Energies, | 12 |
| 2. | Introduction to Thermodynamics: Basic Concepts (Work, Heat and Energy), ZERO'th Law. The First Law of Thermodynamics - Conservation of Energy. Enthalpy, **Definition of Enthalpy**, Measurement of Enthalpy, Variation of Enthalpy with Temperature, Relation Between Heat Capacities, Adiabatic Change, Work of Adiabatic Change, | 12 |
| 3 | **The second law** of thermodynamics: Carnot Cycle and entropy: Entropy, Thermodynamic definition, Entropy as a State Function, The Clausius Inequality. Entropy of Phase Transition at the Transition Temperature, Expansion of the Perfect Gas, Variation of Entropy with Temperature, Measurement of Entropy, Entropy Changes in Reversible Processes, Entropy Changes in Irreversible Processest. Third Law of Thermodynamics, Nernst Heat Theorem, Third-Law Entropies, Helmholtz Energy, Maximum Work, Gibbs Energy. The Gibbs Function and Chemical Reactions, Pressure and Temperature. Helmholtz Functions. Chemical equilibrium in systems of variable composition. | 12 |
| 4 | **Simple Mixtures:** Thermodynamic Description of Mixtures, Partial Molar Quantities, Partial Molar Volume, Partial Molar Gibbs Energies. Application of the Gibbs function to chemical changes. | 9 |
| **Total** | | **45** |

| No | List of Experiments | Contact hours |
|---|---|---|
| 1 | •Safety and Laboratory equipment and measurements and reports | 3 |
| 2 | Boyle and Mariette's law (P, V), Amontons' law (P, T). | 3 |
| 3 | •Charles's law | |
| 4 | •Gay-Lussac's law (V, T), Avogadro's law (V, n) | 3 |
| 5 | •Calibration of a calorimeter and determination of the specific heat capacity of an unknown metal. | 3 |
| 6 | •Determination of the molar heat of reaction.<br>Enthalpy of reaction, Hess's law and thermal equation of state and critical point. | 3 |
| 7 | • Determination of the heat of dilution and solution by solubility. | 3 |
| 8 | •Determination of the heat of neutralization and formation of water | 3 |

| | | |
|---|---|---|
| 9 | Determination of the calorific value for heating oil and the gross calorific value for olive oil | 3 |
| 10 | •Boiling Point elevation | 3 |
| 11 | • Molecular weight determination by boiling point elevation | 3 |
| 12 | • Freezing Point Depression | 3 |
| 13 | • Molecular weight determination by freezing point depression | 3 |
| 14 | Partial Molar Volume Determination | 3 |
| 15 | Review | 3 |
| Total | | 45 |

## D. Students Assessment Activities

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| 1. | Midterm 1 | 6th/ 7th week | 10 % |
| 2. | Midterm 2 | 11th/ 12th week | 10 % |
| 3. | Quizzes, Home Works, class participation, and mini projects | During the semester | 10 % |
| 4. | Laboratory | All the semester | 30 % |
| 5. | Final Exam | 16-17th week | 40 % |
| 6. | Total | All weeks | 100 % |

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

## E. Learning Resources and Facilities

### 1. References and Learning Resources

| | |
|---|---|
| Essential References | **Physical Chemistry**, K. J. Laidler, J. H. Meiser, B. C. Sanctuary, 4th Ed, 2003,Houghton Mifflin Company [ISBN: 0618123415] |
| Supportive References | **Advanced Physical Chemistry Experiments**, J. N Gurtu, Amit Gurtu (2008) Meerut, India, Pragati Prakashan, ISBN:978-81-8398-527-7Chemical **Thermodynamics Basic Concepts and Methods**, Irving M. Klotz, Robert M. Rosenberg, - 7th edition-Wiley (2008). ISBN-10: 471780154<br>**Physical Chemistry**, P.W Atkins, and J. de Paula 8th Ed. 2001, New York, NY: W.H. Freeman and Company, ISBN: 9780716735397 |
| Electronic Materials | |

| Other Learning Materials | |
|---|---|

## 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| **facilities**<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | • Each of the class room should be equipped with a whiteboard and a projector, with a maximum of 20 students.<br>• In each laboratory, a list of safety and precautions are provided.<br>• In each lab has proper ventilation, and well equipped with instruments.<br>• In each lab, containers for solid waste, liquid waste, and crushed glasses.<br>• Each lab has a small pharmacy for first aid in case of an accident<br>• In each lab, the rules, conditions, and safety mechanism as well list of Risk, Safety precautions according to Merck Catalogue are hanging in the labs |
| **Technology equipment**<br>(projector, smart board, software) | The rooms are equipped with data show, Smart Board, WI-FI access. |
| **Other equipment**<br>(depending on the nature of the specialty) | • Appropriate Glasswares for carrying the requested experiments (conical flasks, beakers, measuring cylinders)<br>• Appropriate fine chemicals and solvents (distilled Water ammonium nitrate)<br>• Analytical balance (3 digits), Set gas laws with the glass jacket Data acquisition set for gas laws with glass jacket, PC, Windows® 95 or higher, calorimeter, thermometer, Filter papers , clamps, stands |

## F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of teaching | **Students** | **Direct:** Questionnaire. |
| | **Course Responsible** | **Direct:** Course e-Portfolio.<br>**Indirect:** Second examiner checklist-Course report. |
| | **Peer Reviewer** | **Direct:** Questionnaire.<br>**Indirect:** External assessor report. |
| Effectiveness of Students assessment | **Program Leaders** | **Direct:** Course e-Portfolio.<br>**Indirect:** Course report. |

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Quality of learning resources | **Students**<br>**Faculty ( Academic Advisory)**<br>**Program Leaders** | **Indirect:** Second examiner checklist-Course report.<br>**Direct:** course Entrance/Exit.<br>**Indirect:** Observations - Accreditation review.<br>**Direct:** Course e-Portfolio.<br>**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review. |
| The extent to which CLOs have been achieved | **Course Responsible** | Direct: Exams - Course e-Portfolio. |
| Lab Performance | **Students** | **Direct:** Lab reports, Final Lab exam, Course e-Portfolio. |

**Assessors** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval

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|---|---|
| **COUNCIL /COMMITTEE** | **COUNCIL OF DEPARTMENT OF CHEMISTRY** |
| **REFERENCE NO.** | **7 (NO. 2/3)** |
| **DATE** | **29/3/1446 - 2/10/2024** |