



المملكة العربية السعودية
وزارة التعليم
الجامعة الإسلامية بالمدينة المنورة
(١٤٣٢)
كلية العلوم
قسم الكيمياء

Faculty of Science

Chemistry Department

Study Plan

Master of Science in Chemistry

(2023 AD\1445 H)



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Faculty: Science	Department: Chemistry
Program: Master of Science in Chemistry	
Program Degree: Master	
Program Vision: Leadership and academic and research excellence in chemistry sciences and harnessing them to serve communities. Program Mission: Providing a distinguished academic program in chemical sciences that contributes to the knowledge industry and preparing qualified cadres for the labor market within the framework of a scientific and research environment that stimulates innovation, sustainability and community partnership.	



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Master of Science in Chemistry (Two-semesters system)

Method of study in the new program:

Master's Degree :	Courses and Thesis
-Number of course hours in the plan: 27 credit hours -Number of hours of thesis or research project: 10 credit units -Total Program Hours: 37 credit hours	
Degree Requirements: To obtain a master's degree in chemistry, the student must complete at least (37) accredited study units, including a master's thesis - provided that the student submits an acceptable research thesis in his field of specialization - distributed as follows: A. (13) credit units distributed over five courses taught at the first level B. (14) credit units distributed over five courses taught at the second level C. (10) accredited units for the master's thesis	



Compulsory Courses (15 Credit Hours)

COURSE TITLE		CODE/NO.	ARABIC CODE/NO.	C.H.
1	Advanced organic chemistry	CHEM 5151	كيم 5151	3
2	Advanced physical chemistry	CHEM 5152	كيم 5152	3
3	Advanced analytical chemistry	CHEM 5153	كيم 5153	3
4	Advanced inorganic chemistry	CHEM 5154	كيم 5154	3
5	Computational Chemistry	CHEM 5155	كيم 5155	2
6	Research methods	SCI 5110	ساين 5110	1
Total				15

Elective Courses (Student elects 12 Credit Hours)

COURSE TITLE		CODE/NO.	ARABIC CODE/NO.	C.H.
1	Organic spectroscopy	CHEM 5161	كيم 5161	3
2	Heterocyclic chemistry	CHEM 5162	كيم 5162	3
3	Physical organic chemistry	CHEM 5163	كيم 5163	3
4	Bioorganic chemistry	CHEM 5164	كيم 5164	3
5	Bioactive natural products and process of analysis	CHEM 5165	كيم 5165	3
6	Medicinal chemistry	CHEM 5166	كيم 5166	3
7	Green chemistry	CHEM 5167	كيم 5167	3
8	Nano materials chemistry	CHEM 5168	كيم 5168	3
9	Selected topics in organic chemistry	CHEM 5169	كيم 5169	3
10	Chemical kinetics	CHEM 5171	كيم 5171	3
11	Chemical thermodynamic	CHEM 5172	كيم 5172	3
12	Molecular spectroscopy	CHEM 5173	كيم 5173	3
13	Quantum chemistry	CHEM 5174	كيم 5174	3
14	Surface, catalysis and colloids chemistry	CHEM 5175	كيم 5175	3
15	Electrochemistry	CHEM 5176	كيم 5176	3
16	Photochemistry	CHEM 5177	كيم 5177	3
17	Analytical Spectroscopy	CHEM 5178	كيم 5178	3
18	Electroanalytical Chemistry	CHEM 5181	كيم 5181	3
19	Chromatography and separation techniques	CHEM 5182	كيم 5182	3
20	Automated and miniaturized analytical techniques	CHEM 5183	كيم 5183	3
21	Bioanalytical chemistry	CHEM 5184	كيم 5184	3



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22	Chemometrics	CHEM 5185	كيم 5185	3
23	Selected topics in analytical chemistry	CHEM 5186	كيم 5186	3
24	Bioinorganic chemistry	CHEM 5191	كيم 5191	3
25	Inorganic reaction mechanism	CHEM 5192	كيم 5192	3
26	Organometallic chemistry	CHEM 5193	كيم 5193	3
27	Inorganic catalysis	CHEM 5194	كيم 5194	3
28	Industrial inorganic chemistry	CHEM 5195	كيم 5195	3
29	Selected topics in inorganic chemistry	CHEM 5196	كيم 5196	3
Total				87

-The courses are distributed over two semesters in the first year and the thesis over two semesters in the second year as follows:



1st Semester Courses

COURSE TITLE		CODE/NO.	ARABIC CODE/NO.	C.H.
1	Advanced organic chemistry	CHEM 5151	كيم 5151	3
2	Advanced physical chemistry	CHEM 5152	كيم 5152	3
3	Advanced analytical chemistry	CHEM 5153	كيم 5153	3
4	Advanced inorganic chemistry	CHEM 5154	كيم 5154	3
5	Research methods	SCI 5110	ساين 5110	1
Total				13

2nd Semester Courses

COURSE TITLE		CODE/NO.	ARABIC CODE/NO.	C.H.
1	Computational Chemistry	CHEM 5155	كيم 5155	2
2	Elective course (1)	CHEM 51xx	كيم 51xx	3
3	Elective course (2)	CHEM 51xx	كيم 51xx	3
4	Elective course (3)	CHEM 51xx	كيم 51xx	3
5	Elective course (4)	CHEM 51xx	كيم 51xx	3
Total				14

3rd - 4th Semester (Thesis)

COURSE TITLE		CODE/NO.	ARABIC CODE/NO.	UNITS		C.H.
				Th.	Pr.	
1	Thesis	CHEM 5291	كيم 5291	-	10	10
Total				-	10	10

-The procedures for registering the thesis and appointing the supervisor are explained in the university's graduate studies regulations.

-The student must choose the elective courses from the previous list, and the approval of the department is required to choose these courses.



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Short course specification

1. Mandatory Courses



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5151	Advanced Organic Chemistry	3	-	3	

Course Objectives:

- The mechanical aspects of advance organic chemistry.
- Introduction to the study of the different mechanisms of organic interactions and the different methods used to identify them, and how they applied to known and new interactions.
- Study of the stability of compounds, intermediate compounds, resonance, aromatic nucleophile reactions, addition, oxidation and reduction reactions.

Course Description:

The course aims to give the student the skill to study the chemical efficiency and the factors affecting it, the mechanisms of interaction, and matching, and the relationships of structure interaction, with organic reaction mechanism including stereochemistry: substitution, addition, elimination reactions.

Main Text Book:

- 1- March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure (Sixth Edition), by Michael B. Smith and Jerry March (Wiley, 2007), or earlier editions of March.
- 2- Advanced Organic Chemistry, Part A: Structure and Mechanisms (Fifth Edition), by Francis Carey and Richard Sundberg (Springer, 2007), or any other edition.
- 3- Structure and Reactivity in Organic Chemistry, by Mark G. Moloney, 2008, Wiley-Blackwell, ISBN: 978-1-4051-1451-6.

Subsidiary Books:

1. Guidebook to Mechanism in Organic Chemistry, by peter Sykes, 6th Ed., 2010, Publisher: Longman Scientific and Technical.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5152	Advanced physical chemistry	3	-	3	

Course Objectives:

This course aims to:

1. Build upon and extend the theoretical concepts in physical chemistry introduced during the bachelor degree program.
2. Develop the competence of the students in different areas of physical chemistry.

Course Description:

Concepts of chemical thermodynamics; Theory of chemical reaction rates, kinetic studies of simple and complex systems; Fundamental principles of surface chemistry and catalysis; Basic concepts of materials sciences; Some specific applications.

Main Text Book:

1. Physical Chemistry, 10th Ed., By Peter Atkins and Julio De Paula, Oxford University Press, 2014.
2. Surface Chemistry: Basic Concepts and Techniques, By Herbert Over, Wiley-VCH, 2019.

Subsidiary Books:

1. Physical Chemistry, 3rd Ed., By Thomas Engel and Philip Reid, Pearson, 2013.
2. Fundamentals of Interface and Colloid Science, Lyklema J., Academic Press, Vol. 1-5, 1995.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5153	Advanced analytical chemistry	3	-	3	

Course Objectives:

- 1- The general goals that have been achieved in this course is the way of thinking like a scientist and a familiarity with the fundamental principles and use of modern instrumental methods that will allow a student to solve practical problems using the knowledge gained in this course as well as to use knowledge and scientific discipline to understand and apply new analytical techniques to meet new experimental challenges.
- 2- Understand the basic methods of sample preparation.
- 3- Know how to ensure, monitor and evaluate the quality of chemical analysis processes

Course Description:

The focus of this course is to study some topics in detail with an emphasis on understanding the fundamental principles. Topics which will be covered in this course included an overview on basic concepts of analytical chemistry, sampling preparation, quality assurance, kinetic methods and introduction to the modern instrumental methods. The course will be developed through the update papers.

Main Text Book:

- 1- - Fundamentals of Analytical Chemistry, 8th edition , Douglas A. Skoog, 2014

Subsidiary Books

- 1-Analytical Chemistry, 6th edition, Gary D. Christian, Wiley, 2004, ISBN: 97804712147
- 2- Analytical Chemistry: a Modern Approach to Analytical Science, by Robert Kellner, 2nd Edition, 2004, Wiley
- 3-Quantitative Chemical Analysis, by Daniel C. Harris, 8th Edition 2011, W.H. Freeman



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5154	Advanced inorganic chemistry	3	-	3	-

Course Objectives:

- 1-The ways of bonding in covalent and coordination compounds.
- 2- lattice energy and solubility of ionic compounds.
- 3- Defects in crystal lattice.
- 4- Binary and ternary complexes and application in catalytic reactions.

Course Description:

Bonding theories in covalent and coordination compounds such as VB, CFT, MO as well as the splitting of orbitals (d) in complexes with different geometric shapes and the factors affecting them - Defects in geometric shapes of crystals and types of defects. Binary and ternary complexes and factors affecting their formation – Reactions of coordinated ligands in complexes- Catalytic hydrolysis of coordinated amino acid esters and peptides.

Main Text Book:

- 1-Chemical structure and reactivity: An integrated approach, By: J. Keeler and P. Wothers, Oxford, 2014

Subsidiary Book:

- 1-Advanced Inorganic Chemistry: A comprehensive Text, By: F.A. Cotton and G. Wilkinson, John Wiley & Sons, Inc, 1972.
- 2- Inorganic Chemistry (3rd ed.), James E. House, Academic Press, 2019.



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5155	Computational Chemistry	3	-	3	

Course Objectives:

The objective of this course is to broaden the scope of students in the use Computational Chemistry for research and Drug design.

Course Description:

The course deals with the use of computer programs in solving chemistry problems as well as drug design by medicinal chemists. It is an interdisciplinary course that cuts across Chemistry, Physics and Computer Science. Subjects intended to be covered are the use of ChemDraw, Computational Chemistry using Gaussian software and introductory to molecular docking.

Main Text Book:

3. Introduction to Computational Chemistry, Frank Jensen, 3rd Edition, 2017, John Wiley & Sons Inc.
4. Essentials of Computational Chemistry Theories and Models, 2nd Edition, 2004 by C. J. Cramer, John Wiley & Sons Inc.

Subsidiary Books:

1. Exploring Chemistry with Electronic Structure Methods 3rd Edition 2015, by J. B. Foresman and A. E Frisch. Gaussian, Inc.: Wallingford, CT.

Electronic Materials:

1. Gaussian 16 software 2016, developed by M. J. Frisch et al. Gaussian, Inc.: Wallingford, CT.
2. GaussView, Version 6, 2016 by Dennington, Roy; Keith, Todd A.; Millam, John M. Semichem Inc., Shawnee Mission, KS
3. ChemDraw 16.0 by PerkinElmer Informatics Inc.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
SCI 5110	Research Methods	1	-	1	-

Course Objectives:

Enable students to possess the necessary skills required in academic research studies, in addition to critical evaluation of published research.

Course Description:

A research methods course that is taught to students of the academic and professional master's programs at the first level and provides an introduction that includes research techniques in previous studies, classification of samples, research design, organization of the research project, research ethics, measurement techniques, analysis of quantitative and qualitative data, presentation of results and learning to write proposals Research paper and research paper.

Main Textbook:

1-N. Walliman, Research Methods: The Basics, Routledge (2011)

S. Rajasekar, Research methodology, www.researchgate.net/publication/2174858

Subsidiary Books:

R.Kumar, Research methodology a step -by -step Guide for beginners 3rd edition, Sage (2011)



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2. Elective Courses



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5161	Organic spectroscopy	3	-	3	

Course Objectives:

The aim of this course is to improve the student in advance skills for the elucidation of molecular structure using modern spectroscopic instrumentations.

Course Description:

Structure determination of organic compounds by Ultraviolet and visible spectroscopy, Infrared spectroscopy, Nuclear magnetic resonance spectroscopy (NMR), Carbon-13 NMR Spectroscopy, two dimension 2D NMR spectroscopy: COSY, NOESY, DEPT, INEPT, APT and INADEQUATE, and Mass spectrometry.

Main Text Books:

1-Spectrometric Identification of Organic Compounds, By Robert M. Silverstein, 8th Edition, Wiley, 2014, ISBN: 978-0-470-61637-6

Subsidiary Books:

1-Structure Elucidation by Modern NMR A Workbook, By H. Duddeck, 3rd Edition, Springer, 1998, ISBN: 978-3-7985-111-8

2-Structure Elucidation in Organic Chemistry : The Search for the Right Tools, By Bravo, Jorge., John Wiley, 2015, ISBN: 9783527333363



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5162	Heterocyclic chemistry	3	-	3	

Course Objectives:

- Develop the skill of heterocyclic organic compounds that have one or two hetero atoms in a triple, quadruple, five or hexagonal ring
- Methods of preparation, interactions, and biological importance pyrrole, furan, thiophene, pyridine and its derivatives.

Course Description:

This course introduces the naming and synthesis of derivatives of the advance heterocyclic organic compounds that have one or two heteroatom substituted compound and some methods of preparation, interactions and their biological importance.

Main Text Book:

- 1- Organic chemistry, by Graham SolomonsTw, Craig B Fryhle, 11th Ed., 2014. Publisher: WILEY.
- 2- Heterocyclic Chemistry, Rakesh K Parashar 2010, Ane Books India.

Subsidiary Books:

1. Heterocyclic Chemistry, J.A. Joule and Keith Mills, 5th Edition, 2010, Wiley.
2. Heterocyclic Chemistry At A Glance Wiley; J.A. Joule and Keith Mills , 2 edition (October 1, 2012)



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5163	physical organic chemistry	3	-	3	

Course Objectives:

The main objectives of this course are that to identify and predict the mechanism of organic reaction using molecular orbital symmetry and to apply Hammett equation to speculate a mechanism of organic reaction.

Course Description:

- 1- The course involves general Symmetry Controlled Reaction (Pericyclic Reactions)
- 2- Phase and Symmetry of Orbitals (Molecular orbital theory - Conservation of orbital symmetry- Symmetry correlation diagram - Frontier orbital approach - Generalized Woodward-Hoffmann selection rules - Aromaticity of nonbenzoid aromatics - Hückel and Möbius aromaticity)
- 3- Electrocyclic Reactions
- 4- Cycloaddition Reaction ($2\pi + 2\pi$, $4\pi + 2\pi$, 1,3-Dipolar cycloaddition)
- 5- Sigmatropic rearrangements (1,3-H-shift & 1,5-H-shift, 1,3-C-shift & 1,5-C-shift)
- 6- Linear free energy relationships
- 7- Hammett equation (Derivation of Hammett equation- Substituent constant σ , Reaction constant ρ - Factors affecting on sign and magnitude of substituents – Steric effects)
- 8- Uses of Hammett equation (Calculation of k and K values- Deviation from linear plots- Concave upward deviations-Concave downward deviations)
- 9- Taft equation

Main Text Book:

- 1-Michael B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Wiley; 8 edition (February 19, 2020).
- 2-Robert V. Hoffmann, Organic Chemistry An Intermediate Text, 2nd ed., John Wiley & Sons, Inc. New York, 2004.

Subsidiary Books:

- 1- Paula Y. Bruice, Organic Chemistry, 4th ed., Pearson Education, Inc, US, 2004.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5164	Bioorganic chemistry	3	-	3	

Course Objectives:

The study of the basics structures of biomolecules and their chirality like carbohydrates, fats, amino acids, proteins and nucleic acids includes important concepts. Studying of kinetics and mechanisms of enzymes, DNA Copy, and Protein Construction will be focused. Lipids, amino acid and nucleotides metabolism.

Course Description:

The course includes an introduction to biochemistry, such as carbohydrates: definition, their sections, and their natural and chemical properties. The important reactions of these compounds are considered. Nucleic acids: definition, physical and chemical properties and their vital importance, DNA copies, and protein construction. Proteins: Definition, amino acids, their constituents, and their natural and chemical properties. Kinetics and mechanisms of enzymes is considered. Knowledge of nitrogen bases and nucleotides synthesis is focused. Lipids: Definition, their sections, and their natural and chemical properties.

Main Text Book:

1. Basic Concepts in Biochemistry: A Student's Survival Guide, Second Edition, 2013, Hiram Gilbert, McGraw Hill.

Subsidiary Books:

Biochemistry by: Jermy Berg, John Tymoczko and Lubert Stryer , 7th Ed, 2012 W.H. Freeman & Company



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5165	Bioactive natural products and process of analysis	3	-	3	

Course Objectives:

This course will focus on the extraction of biologically active molecules from natural products and the process of analysis. student will be able to analyze and structural elucidate the bioactive natural products molecules using sophisticated techniques.

Course Description:

Types of biologically active compounds, processes of extraction, structural elucidation using Nuclear Magnetic Resonance (NMR), 2D NMR, Mass Spectroscopy (MS), UV, IR, and analysis of natural products using liquid chromatography coupled with Mass spectrometry LC/MS and gas chromatography couples with Mass spectrometry GC/MS.

Main Text Books:

1. Bioactive Compounds from Natural Sources: Isolation, Characterization and Biological Properties 1st Edition, by Corrado Tringali, CRC Press, 2000; ISBN 9781482289268

Subsidiary Books:

1. Natural Products Isolation, By Satyajit D. Sarker Lutfun Nahar, Humana Press Springer, 2012, ISBN: 978-1-61779-624-1
2. Pharmacological Assays of Plant-Based Natural Products, By K.D. Rainsford, Springer, 20016, ISBN 978-3-319-26810-1



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5166	Medicinal chemistry	3	-	3	

Course Objectives:

This course is designed to expose with the fundamentals of organic medicinal chemistry.

Course Description:

Topics include: Drug Targets, Physicochemical properties and metabolism, selected topics on: structure-activity relationships: Antiviral, anticancer and antibacterial and antihistamines; An overview principle of drug design.

Main Text Books:

- 1- An Introduction to Medicinal Chemistry. Graham L. Patrick, Oxford University Press; 5th Ed, 2013
- 2- Foye's Principles of Medicinal Chemistry. by David A. Williams, Thomas L. Lemke, Thomas L. Lemke, William O. Foye. Publisher: Lippincott Williams & Wilkins Publishers; 7th Ed, 2012

Subsidiary Books:

- 1- Gareth Thomas Medicinal Chemistry, An Introduction, 2nd Edition. Wiley-Interscience (2008)



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5167	Green chemistry	3	-	3	

Course Objectives:

This course will survey key aspects of green chemistry in modern research and development both in academia and industry, as well as relevant implications for the environment, technology, and public policy.

Course Description:

Case studies will be emphasized that illustrate the use of alternative feedstocks, reagents, and reaction media, recent developments in environmentally benign catalysis and synthetic methods, and broader considerations of energy utilization, government regulation, and the impacts on biogeochemical processes

Main Text Book:

- 1.Lancaster, M. Green Chemistry: An Introductory Text; The Royal Society of Chemistry: Cambridge, UK, 2002.
- 2.P. T. Anastas, J. C. Warner, "Green Chemistry. Theory and Practice", Oxford University Press, 1998
- Ahluwalia, V. K.

Subsidiary Books:

- 1.Ahluwalia, V. K. Green Chemistry: Environmentally Benign Reactions; CRC Press: Boca Raton, FL, 2008.
- 2.Manahan, S. E. Green Chemistry and the Ten Commandments of Sustainability; ChemChar Research, Inc.: Columbia, Missouri, 2005.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5168	Nano materials chemistry	3	-	3	

Course Objectives:

The objectives of this course are to increase the students' understanding of the fundamental aspects of the chemistry of nanomaterials. A brief introduction to nanotechnology and nanomaterials will be discussed as well as its unique properties as compared to the bulk materials. The applications of nanomaterials in medicine and renewable energy arenas will be investigated.

Course Description:

- 1- Introduction to nanotechnology and nanomaterials
- 2- Properties and advantages of nanomaterials
- 3- Synthesis and characterization of nanomaterials
- 4- Applications of nanomaterials
- 5- Examples of self-assembled nanomaterials.

Main Text Book:

1-Nanomaterials: An Introduction to Synthesis, Properties and Applications (2nd edition) 2013, by Dieter Vollath

Subsidiary Books:

1-Nanochemistry: A Chemical Approach to Nanomaterials , 2013, by Geoffrey A Ozin



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5169	Selected topics in organic chemistry	3	-	3	

Course Objectives:

This course introduces advanced topics in Organic chemistry.

Course Description:

Topics are selected by the supervisor/staff member as to help master students in their theses.

Main Text Book:

Determined by Supervisor according to topics of course



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5171	Chemical kinetics	3	-	3	

Course Objectives:

This course intends to increase the students' understanding of the fundamental aspects of kinetics with the emphasis on the methods of collecting and manipulating experimental data to obtaining standard kinetic quantities.

Course Description:

This course intends to increase the students' understanding of the fundamental aspects of kinetics with the emphasis on the methods of collecting and manipulating experimental data to obtaining standard kinetic quantities.

Main Text Book:

1. Guy B. Marin, Gregory S. Yablonsky, Denis Constaes, Kinetics of chemical Reactions (2nd ed.) Wiley, 2018.

Subsidiary Books:

1. Paul L. Houston, Chemical Kinetics and Reaction Dynamics, Dover Publications Inc., 2006.
2. KatjaLindenberg, Ralf Metzler and GlebOshanin, Chemical kinetic: Beyond the textbook, World Scientific Publishing Europe Limited, 2019.
3. Atkins' Physical Chemistry (Tenth Edition), by Peter Atkins and Julio De Paula (Oxford university Press, 2014).



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5172	Chemical thermodynamic	3	-	3	

Course Objectives:

This course aims to provide students with understanding the fundamental laws and concepts of thermodynamics with application to specific problems in chemical systems.

Course Description:

Thermodynamics principles. Properties of gases. Thermochemistry. Mixtures and solutions. Chemical and phase equilibria. Thermodynamics of electrochemical cells. Systematic methods of deriving thermodynamic equations. Concept and determination of Fugacity. Non-ideal systems: Debye-Hückel theory. Non-equilibrium thermodynamic. Heat capacities and Einstein theory. Statistical thermodynamic (Einstein model and Debye Model). Fermi-energy determination. Reversible and irreversible processes. Distribution of energy between systems in equilibrium. Isolated system. System in contact with heat reservoir. Canonical distribution and its simple applications. Maxwell-Boltzmann distribution for energies, Bose-Einstein, and Fermi-Dirac statistics. Partition function, rotational, translational, vibrational, and electronic partition functions for diatomic molecules. Statistical basis of entropy, Calculations of thermodynamic parameters and equilibrium constants using spectral data and partition function. Electromagnetic radiation in thermal equilibrium inside an enclosure. Consequences of Fermi-Dirac equation. Lattice vibration and normal modes Debye approximation. Applications of statistical thermodynamics to activated complex theory.

Main Text Book:

1. Atkins' Physical Chemistry, By P. Atkins and J. De Paula 9th Ed., Oxford University Press, New York, 2010.
2. Physical Chemistry, By J. de Paula and P. Atkins, 10th Ed., 2014, Oxford University Press, 2014.
3. Chemical thermodynamics for process simulation, By J. Gmehling, B. Kolbe, M. Kleiber and J. Rarey, Wiley-VCH, 2012.
4. Chemical Thermodynamics: Basic Concepts and Methods, 7th Ed., By Irving M. Klotz, Robert M. Rosenberg, John Wiley & Sons, Inc, 2007.

Subsidiary Books:

1. Physical Chemistry, By Thomas Engel and Philip Reid, 3rd Ed., Pearson, 2013.
2. Physical Chemistry, By Ira N. Levine, 6th Ed., McGraw-Hill, New York, 2009.



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5173	Molecular spectroscopy	3	-	3	

Course Objectives:

This course aims to:

1. Highlight modern advances in instrumentation and techniques in optical spectroscopy and their specific applications.
2. Develop the competence and confidence of the students in optical spectroscopy.
3. Identify appropriate experimental procedures and spectroscopic methods for particular applications.
4. Apply the principles of spectroscopy for the structural determination of molecules.

Course Description:

Concepts of the interaction of radiation with matter based on energy. Rotational Spectroscopy and Rotational Raman spectra. Vibrational spectroscopy and Vibrational Raman spectra. Electronic transition. Radio frequency spectroscopy. Time domain and frequency domain methods in optical spectroscopy are discussed. Recent developments in optical spectroscopy of transient species including advances in laser spectroscopy are presented. Typical applications of particular optical spectroscopic techniques in different areas of chemistry, biochemistry, physics, astrophysics, medicine, environmental and forensic sciences are used as examples.

Main Text Book:

1. Atkins' Physical Chemistry, 10th Ed., By Peter Atkins and Julio De Paula, Oxford University Press, 2014.
2. Atomic and Molecular Spectroscopy: Basic Concepts and Applications, By Rita Kakkar, Cambridge University Press, 2015.
3. Principles of Fluorescence Spectroscopy, 3rd Ed., By Joseph R. Lakowicz, Springer, New York, 2010.
4. Laser Spectroscopy 1: Basic Principles, 5th Ed., By Wolfgang Demtröder, Springer, 2014.

Subsidiary Books:

1. Physical Chemistry (3rd Edition), Thomas Engel and Philip Reid (Pearson, 2013).
2. Perspectives in Modern Chemical Spectroscopy, D.L. Andrews (Ed), Springer, Berlin, 1990.
3. Introduction to Laser Spectroscopy, H. Abramczyk, Elsevier, 2005.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5174	Quantum chemistry	3	-	3	

Course Objectives:

This course aims at broadening the knowledge of students in quantum mechanics with emphasis on its application in chemistry.

Course Description:

Postulates of quantum mechanics. Schrodinger equation, simple quantum mechanical systems as applied to a particle in one, two and three dimensional box. Concept of eigenfunctions and operators. Atomic wave functions. Angular momentum. Orbital and molecular orbital theory. Perturbation theory.

Main Text Book:

1. Molecular Quantum Mechanics, Peter W. Atkins, Ronald S. Friedman, 5th Edition, 2011, Oxford University Press, New York.
2. Atkins' Physical Chemistry, P. Atkins & J. De Paula 10th Edition, Oxford University Press, New York, 2014.

Subsidiary Books:

1. Quantum Chemistry, Donald A. McQuarrie 2nd Edition, Univesity Science Books, California USA, 2008.
2. Physical Chemistry, Ira N. Levine, 6thed., McGraw-Hill, New York, 2009.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5175	Surface, catalysis and colloids chemistry	3	-	3	

Course Objectives:

1. Understand the theoretical basic concepts of the surface chemistry, Catalysis technology and Colloids science.
2. Discuss some different applications related to these concepts.
3. Present some scientific papers related to these concepts to show the importance of these sciences.

Course Description:

This course presents concepts of surface, catalysis and colloids chemistry. At the same time, the course will discuss the scientific relation between the three main technologies and their different scientific applications.

Main Text Book:

1. Catalysis: An Integrated Textbook for Students, By Ulf Hanefeld and Leon Lefferts, Wiley-VCH, Weinheim, 2017.
2. Surface and Colloid Chemistry: Principles and Applications, By K.S. Birdi, CRC Press, 2010.

Subsidiary Books:

1. Fundamentals of interface and colloid science, Academic Press, Vol. I-V, 1995-2005.
2. Nanoparticles and catalysis, By Didier Astruc, Wiley – VCH, Vol. 1, 2008.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5176	Electrochemistry	3	-	3	

Course Objectives:

The aim of the course is to increase the understanding of students in the principles and the application of Electrochemistry.

Course Description:

Electrochemical thermodynamics of cells, Electric double layer and adsorption on electrode surface, Mechanism of electrode reaction and mass transport, Kinetics of cell reaction, Techniques for measurements based on potential and current control, Applications of electrochemistry, Electrochemical corrosion.

Main Text Book

1. Physical Electrochemistry: Fundamentals, Techniques, and Applications, 2nd Ed., By Noam Eliaz and Eliezer Gileadi, Wiley, 2019.
2. Electrochemistry, 2nd Ed., Carl H. Hamann, Andrew Hamnett, Wolf Vielstich, Wiley, 2007.

Subsidiary Books:

1. Introduction to Corrosion Science, By E. McCafferty, Springer, 2010.
2. Atkins' Physical Chemistry, By P. Atkins & J. De Paula 9th Ed., Oxford University Press, New York, 2010.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5177	Photochemistry	3	-	3	

Course Objectives:

This course aims to:

1. Understand the fundamental concepts of photochemistry.
2. Discuss some different applications of photochemistry.
3. Present some scientific papers related to these concepts.

Course Description:

Photochemical reactions, light absorption, determination of absorbed light intensity, laws of photochemistry, primary and secondary reactions, quantum yield (or quantum efficiency), calculation of quantum yield, photophysical and photochemical processes, photosensitized reactions, deactivation of excited states, some applications of photochemistry.

Main Text Book:

1. Physical Chemistry (10th Edition), Peter Atkins and Julio De Paula, Oxford University Press, 2014.
2. Principles and Applications of Photochemistry, By Brian Wardle, Wiley-VCH, 2010.
3. Principles of Fluorescence Spectroscopy (3rd Edition), J.R. Lakowicz, Springer, New York, 2010.

Subsidiary Books:

1. Fundamentals of Photophysics, Photochemistry, and Photobiology, Ulrich E. Steiner, Springer-Verlag Berlin Heidelberg, 2014.
2. Principles of Molecular Photochemistry: An introduction (1st edition), N.J. Turro, J.C. Scaiano, V. Ramamurthy, University Science Books, Sausalito Calif, 2008.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5178	Analytical spectroscopy	3	-	3	

Course Objectives:

- 1- Understand the theoretical concepts underlying optical measurements.
- 2- Understand and appreciate the role of spectrometry techniques in solving the chemical problems quantitatively and qualitatively by making appropriate choices among the various instruments.
- 3- Development of research and presentation skills

Course Description:

This course covers modern analytical spectrometry techniques and their application to solving research problems. This course will focus on instrumentation and applications of various spectroscopic methods of analysis including molecular and atomic spectroscopy. The course will be developed through the research papers.

Main Text Book:

1-Skoog,.Principles of Instrumental Analysis, 9th edition,2014.

Subsidiary Books:

1. Introduction to analytical chemistry (Chinese Edition) /Douglas A. Skoog, 2011
- 2- Fundamentals of Analytical Chemistry, 8th edition , Douglas A. Skoog, 2014
- 3- Hand Book of Green Chemistry and Technology, J. Clark and Mccquarrie Eds., 1stEdn. 2002



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5181	Electroanalytical chemistry	3	-	3	

Course Objectives:

The course is intended to develop:

- 1-The ability to describe principles and applications of modern electroanalytical techniques.
- 2-The ability to describe the structure and function of different instrument components,.
- 3-The ability to produce, characterize and apply chemically and biochemically modified electrodes.

Course Description:

This course provides students with advanced electroanalytical methods and their recent applications in analytical chemistry. It covers Introduction to analytical chemistry and electrochemical methods. Electroanalytical methods including potentiometry, voltammetry and coulometry.

Main Text Books:

1. Principles of Instrumental Analysis, 9th edition, skoog, 2014.
- 2-Analytical Electrochemistry by Joseph Wong, 4rd Edition,2012

Subsidiary Books:

- 1-Electrochemical Sensors, Biosensors and Their Biomedical Applications Xueji Zhang, Huangxian J. and Joseph Wang first edition 2008
- 2-Bard, A. J., and Faulkner, L. R., *Electrochemical Methods*, second edition, Wiley, New York, 2001.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5182	Chromatography and separation techniques	3	-	3	

Course Objectives:

The course is intended to:

- 1- Concrete knowledge of chromatographic and separation techniques (Gas chromatography, high-performance liquid chromatography and the combined chromatography and mass spectrometry techniques
2. Interpretation of mass spectra based on understanding the fragmentation of ions formed by different ionization methods.
- 3- Ability to associate the knowledge gained in lectures to new developments in analytical chemistry research and their applications in different fields.

Course Description:

This course aims to provide a systematic study and an advanced knowledge of the modern chromatographic and separation techniques focusing on the recent development of gas chromatography, liquid chromatography and electrophoretic separation techniques. It includes mass spectrometry and the coupling of mass spectrometry to chromatographic separation methods (GC/MS, LC/MS, CE/MS and SFC/MS). The course offers a good understanding and Interpretation of mass spectra. Emphasis will be placed on the theory, principles, instrumentations and applications of the analytical chromatographic and separation techniques in different fields of analytical science.

Main Text Books:

- 1- Chromatography: Concepts and Contrasts, by James. M miller, Wiley-Interscience;, 2009.
- 2- Principles of Instrumental Analysis, 9th edition, skoog, 2014.

Subsidiary Books:

- 1- Principles and Practice of Chromatography, by Raymond P. W. Scott Library4 Science Publisher 2003.
- 2- Quantitative Chromatographic Analysis, by Raymond P. W. Scott, Library4Science Publisher, 2007.



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5183	Automated and miniaturized analytical techniques	3	-	3	

Course Objectives:

- 1- To provide students with a sound background on the automation of analytical methods and the new trends toward miniaturization technology.
- 2- Student will have introduced to the essential theories and applications of automated methods of analysis in process analysis, and research in addition to the fast growing miniaturized analytical systems and their applications.
- 3- To overview the development of these techniques and most recent trends in the area.

Course Description:

Automated and miniaturized analytical techniques have become one of the distinctive modern trends in analytical science. This course will be devoted to introducing students to this field. The course aims primarily at providing students with the theoretical foundations of automated analysis methods and their applications in the field of quality control, in addition to the most significant modern trends in the field of the advancement of miniature technologies and their applied fields. Part of the course will be devoted to reviewing the development of these technologies and the most recent trends and applications in recent years

Main Text Books:

1-. Special Issue: Special Issue on Automated Flow Injection Techniques , Analytical Letters , 46(11), 2013

2- Spas D. Kolev•Ian and Donald McKelvie, Advances in Flow Injection Analysis and Related Techniques, Elsevier, 2008. .

2. Angel Rios, Alberto Escarpa, Bartolome Simonet, Miniaturization of Analytical Systems: Principles, Designs and Applications, John Wiley & Sons, Inc., 2009.

Subsidiary Books:

1. Miguel de la Guardia, Salvador Garrigues (edit.) Handbook of Green Analytical Chemistry, John Wiley & Sons, Ltd, 2012.
2. Angel Ríos, Alberto Escarpa, Bartolomé Simonet, Miniaturization of analytical systems. Principles, designs and applications, Analytical and Bioanalytical Chemistry , 2010, 396 (7), pp 2375-2376
3. Keith E. Herold and Avraham Rasooly (Edit), Lab on a Chip Technology: Volume 1: Fabrication and Microfluidics, Caester academic press, 2009.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5184	Bioanalytical chemistry	3	-	3	

Course Objectives:

- 1-To provide students with principles, terminology and core technologies (include modern techniques and equipment).
- 2- To analyze wide variety of compounds (from small molecules to large biopolymers) of biological importance in diagnostic, industrial and bioresearch settings.

Course Description:

This course is optional for students of the Master's degree in Chemistry and covers bio-analysis techniques and related topics in the field of biochemistry. The course will provide the student with a background on biochemical compounds and their types of separation and detection methods as well as the associated quantitative measurement methods and techniques for examining a wide range of biochemical compounds in various fluids and biological media. The content of the course should include some advanced topics and special projects in the field of biochemistry, such as micro-size analysis technology, enzymatic sensors and other advanced and modern biometrics techniques.

Main Text Books:

1-Understanding Bioanalytical Chemistry: Principles and Applications by Victor Gault, Neville McClenaghan, 2009

2-Bioanalytical chemistry by Andreas Manz, Nicole Pamme & Dimitri Iossifidis. Imperial College Press May 2004

Subsidiary Books:

- 1- Biosensors and Modern Biospecific Analytical Techniques by L. Gorton Elsevier Science 2005
- 2- Metabolomics - The Frontier of Systems Biology by M Tomita and T Nishioka Springer 2005
- 3- Regulatory Aspects from Global Perspectives by Michael Zhou . Wiley 2011.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5185	Chemometrics	3	-	3	

Course Objectives:

- 1-Define accuracy and precision and calculate combinations of errors and confidence limits.
- 2- Differentiate between the application of parametric and non-parametric tests.
- 3-Understand the concept of significance testing, undertake simple significance tests and interpret significance probabilities.
- 4-Know how to construct appropriate calibration curves and extract quantitative information. A further important objective is to illustrate how such statistical information and calculations are obtained from common PC software. The examples class will be hands-on use of Excel.

Course Description:

The course of Chemometrics is an elective course that covers the analysis and statistical tools needed by the chemist to examine the results of chemical analysis methods and the quality of the analysis, the work of a statistical study of the quality of the methods of analysis and differentiation between them and the work of statistical studies to adopt the results of analysis, and statistical studies to compare the results of innovative analysis methods with the methods adopted previously. In addition to introducing the student to the various statistical studies required for chemistry and statistical analysis appropriate for each analysis or development takes place within the laboratory of chemical analysis.

Main Text Book:

- 1- James N. Miller and Jane C. Miller, Statistics and Chemometrics for Analytical Chemistry, Fifth Edition (2005)

Subsidiary Books:

- 1-Mullins, E., Statistics for the Quality Control Laboratory, (RSC, 2003).



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5186	Selected topics in analytical chemistry	3	-	3	

Course Objectives:

Determined by the professor course by topics.

Course Description:

This course is optional and is intended for a Master's degree student who intends to specialize in the field of analytical chemistry. This course aims to provide the student with a more in-depth knowledge in advanced analytical fields and techniques related to any of the following topics: thermal analysis, water analysis, pharmaceutical analysis, traditional or folk medicine analysis, forensic analysis, biological analysis, industrial material analysis, food analysis, technology Biochemistry, Medical Chemical Analyzes, Nanotechnology in Analytical Chemistry, Sensors and Biosensors, Quality Control in Analytical Laboratories, On-chip Laboratory Technology, Corrosion Analysis as well as any developments and applications in the fields of chromatography A, different methods of separation, electrolysis and analysis using spectroscopy devices.

Main Text Book:

Will be announced after selecting the topic(s).

Subsidiary Books:

Will be announced after selecting the topic(s).



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5191	Bioinorganic Chemistry	3	-	3	-

Course Objectives:

- 1-The course aims at giving students the basic principles in biological molecules.
- 2-How metal ions interact with biological environments.
- 3- How these interaction influences the properties of metal centers.

Course Description:

Building blocks of biological ligands – Biological functions of metal ions in biological system – Metal ion – bioligands interactions and factors favouring them. – Toxic metals and detoxification by chemotherapy. - Design of anticancer agents and reactions with DNA constituents and study structural parameters to favour such interactions- Ways to minimise the side effect.

Main Textbook:

- Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life 2nd Ed, By: W. Kaim and B. Schwederski, Wiley, 2013.
- Dieter Rehder, “Bioinorganic Chemistry”, 1st ed., Oxford University Press, 2014

Subsidiary books:

1. Bioinorganic Chemistry: A short course, 3rd Edition, By: R.M. Roat-Malone, John wiley & Sons, 2020.
2. Chemistry of metallo-proteins: problems and solutions in bioinorganic chemistry, by Joseph J. Stephanos, Anthony W. Addison, Wiley, 2014.



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5192	Inorganic reaction mechanism	3	0	3	-

Course objective:

1. This course aims to discuss the thermodynamics of complex formation.
2. Substitution reaction of ligands in octahedral, tetrahedral and square planar complexes.
3. The course includes the concept of trans-effect and application in synthesis of isomers.

Course Description:

Stabilities of complexes in solutions- Thermodynamic parameters and stability constants - Labile and inert complexes - Ligand displacement reactions in octahedral, tetrahedral and square planar complexes - Activation parameters and reaction mechanism - Trans-effect and application in synthesis of isomers.

Main Textbook:

- Chemical structure and reactivity: An integrated approach, By: J. Keeler and P. Wothers, Oxford, 2014

Subsidiary books:

1. Inorganic Chemistry: Reactions, Structure and Mechanism (1st ed.) Harold H. Trimm, Apple Academic Press (2011).



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5193	Organometallic chemistry	3	0	3	-

Course Objectives:

- 1-This course aims to discuss the synthesis and reactivity of organometallic compounds.
- 2- The role of them in industry for the catalysis is investigated.
- 3- The toxic effect of some organometallic compounds and their use in chemotherapy is studied.

Course Description:

The synthesis, structure, bonding, reactivity and catalytic applications of main group and transition metal organometallic compounds. The primary emphasis will be on the fundamental reaction types of organometallic compounds, their mechanism and application in catalysis. The marine environmental pollution caused by some organometallic compounds is investigated. The use of some organometallic compounds in chemotherapy is studied.

Main Textbook:

- 1-Basic Organometallic Chemistry, By: B.D. Gupta, Publisher: Orient Black Swan, 2011.
- 2-Organometallic Chemistry: Volume 43, Editors: Nathan J Patmore, Paul I P Elliott, RSC 2021

Subsidiary books:

Organo-transition metal chemistry: A mechanistic Approach, By: R. Heck, Academic Press, 2012.



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5194	Inorganic catalysis	3	-	3	-

Course objective:

The course aims at giving students the basic principles of Transition metal chemistry of macrocycles, and its application for coupling reaction.

Course description:

Molecular metals, Inorganic Rings, transition metal chemistry of macrocycles, Binap synthesis, Homogenous and Heterogeneous Catalysis, Palladium Mediated cross-coupling reactions: Heck Reaction, Suzuki Coupling, Hiyama Coupling, Kumada Coupling, Negishi coupling, Stille Coupling, The Sonogashira Reaction, Liebeskind-Srogl reaction, Pd-Carbene Catalytic Systems.

Main Textbook:

- Metal-Catalyzed Cross-Coupling Reactions and More by Armin de Meijere, Stefan Bräse and Martin Oestreich, Wiley, 2013
- Catalysis: An Integrated Textbook for Students, Lefferts, Leonardus Hanefeld, Ulf, Wiley, 2018

Subsidiary books:

Transition Metal Catalyzed Oxidative Cross-Coupling Reactions by Aiwen Lei, Springer, 2019



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5195	Industrial inorganic chemistry	3	-	3	-

Course objective:

- 1- Knowing the importance of industrial inorganic chemistry and its role in development
- 2- Learn about many industries such as glass, porcelain, fertilizer, plastic and iron industries

Course description:

Identify the glass and porcelaine industries and its different types and chemical reactions - Iron industry with all their characteristics and chemical reactions in manufacturing furnaces - Fertilizer industry such as nitrogen fertilizer - ammonia industry and nitrogen fixation and nitrogen liquifaction and its uses.

Main Textbook:

Industrial Inorganic Chemistry, By: Mark A. Benvenuto, De Gruyter, 2015.
Chemical Technology (2nd ed), A. Jess, P. Wasserscheid, Wiley-VCH, 2019.

Subsidiary books:

Chemistry of Actinides and Transactinide elements, by Joseph J. Katz, Morss, Norman M., Jean Fuger, 2007



Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5196	Selected topics in inorganic chemistry	3	-	3	-

Course objective:

Understanding in-depth knowledge of a specific topic from advanced techniques and topics in

inorganic chemistry are among the following:

- 1- Thermodynamic measurements of complexes.
- 2- Study of drug interaction with mineral ions in biological systems .
- 3- Study of marine environment pollution with metallic organic materials.
- 4- Study of complexes in nanoscale

Course description:

This course is optional and is intended for a Master's degree student who intends to specialize in the field of inorganic chemistry. This course aims to provide the student with more in-depth knowledge in the fields of inorganic chemistry or advanced techniques related to any of the following topics: thermal analysis of complexes, study of drug complexes, environmental chemistry, and chemistry of complexes in the nanoscale.

Main Textbook:

1. They will be announced after selecting the topic (s)
2. Inorganic Coordination Chemistry (Landskron).

Subsidiary books:

They will be announced after selecting the topic (s)



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Course No.	Course Title	No. of Units			Pre-requisites
		Th.	Pr.	Credit	
CHEM 5291	Thesis	--	10	10	-

Course Objectives:

Performing concentrated research and gaining the necessary research skills related to a special scientific topic in chemistry.

Course Description:

Thesis topic will include experimental work about a specific research problem related to the different chemistry research fields. The subject of the thesis is determined by an academic supervisor/s committee from the department according to the available research facilities in the department of chemistry.

Main Text Book:

- Based on the thesis topic and determined by the academic supervisor/s committee

Subsidiary Books:

- Based on the thesis topic and determined by the academic supervisor/s committee