CURRICULUM

FOR

TWO-YEAR ASSOCIATE DEGREE/

BS (4-YEAR) IN CHEMISTRY

UNDER UG-POLICY 2023

DEPARTMENT OF CHEMISTRY

UNIVERSITY OF MALAKAND

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Contents

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Academic)
University of Malakand
05-Dec-2023

Introduction

The curriculum of BS (4-year) in Chemistry was drafted under HEC UG-Policy 2023 in the 7th meeting of Board of Studies Department of Chemistry, University of Malakand.

The final meeting of the Board of Studies was held at Department of Chemistry, University of Malakand on Sept 12, 2023, to review and finalized the draft curriculum of associate degree/BS (4-Year) Program (120-144 CH, WITH SINGLE MAJOR) In CHEMISTRY and to make recommendations for the promotion and development of the discipline.

The Framework for Associate Degree/BS (4-Year) Program (120-144 CH, WITH SINGLE MAJOR) In CHEMISTRY (Annex-I) and the details of the courses (Annex-II) is given below.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

SCHEME OF STUDIE FOR 2-YEAR ASSOCIATE DEGREE / BS (4-YEAR) IN CHEMISTRY

Semester-I			
Category	**Code**	**Title**	**Cr. Hrs.**
Gen-Ed-2	**BOT 112/ ZOOL 101**	**Plant Sciences/ Introductory Zoology**	3(2+1)
Gen-Ed-3	**ECON 111/ SOC 113**	**Fundamentals of Economics/ Introduction to Sociology**	2
Gen-Ed-4	**ENG 101**	**Functional English**	3
Gen-Ed-7	**ISL 112/ETH 118**	**Islamic Studies/Ethics (for Non-Muslims)**	2
Gen-Ed-9	**CS 110**	**Introduction to Information and Communication Technologies**	3(2+1)
Major	**CHEM 118**	**Physical Chemistry-I**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**16**
Semester-II			
Category	**Code**	**Title**	**Cr. Hrs.**
Gen-Ed-1	**ISL 113**	**Seerah and its Contemporary Application** سیرت رسول ﷺ اور اس کی عصری معنویت **/Any course can be selected from Arts and Humanities in General Category (For Non-Muslims)**	2
Gen-Ed-5	**ENG 102**	**Introduction to Expository Writing**	3
Gen-Ed-6	**QR 101**	**Quantitative Reasoning-I (Mathematics)**	3
Gen-Ed-8	**PSC 111**	**Ideology and Constitution of Pakistan**	2
Gen-Ed-11	**SOC 114**	**Civic and Community Engagements**	2
Major	**CHEM 127**	**Organic Chemistry-I**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**15**
Semester-III			
Category	**Code**	**Title**	**Cr. Hrs.**
Gen-Ed-6	**QR 102**	**Quantitative Reasoning-II (Statistics)**	3
Gen-Ed-10	**MGT 215**	**Entrepreneurship**	2
Major	**CHEM 235**	**Inorganic Chemistry-I**	3
Major	**CHEM 231**	**Analytical Chemistry-I**	3
Major	**CHEM 232**	**Applied Chemistry-I**	3
Major	**CHEM 233**	**Biochemistry-I**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**17**
Semester-IV			

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Category	Code	Title	Cr. Hrs.
Major	**CHEM 245**	**Inorganic Chemistry-II**	3
Major	**CHEM 246**	**Organic Chemistry-II**	3
Major	**CHEM 247**	**Physical Chemistry-II**	3
Major	**CHEM 241**	**Analytical Chemistry-II**	3
Major	**CHEM 244**	**Fuel Chemistry-I**	3(2+1)
Major	**CHEM 243**	**Biochemistry-II**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**18**
Semester-V			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 355**	**Inorganic Chemistry-III**	3 (2+1)
Major	**CHEM 356**	**Organic Chemistry-III**	3 (2+1)
Major	**CHEM 352**	**Applied Chemistry-II**	3 (2+1)
Major	**CHEM 350**	**Nuclear Chemistry**	3
Inter-Disp-1	**PHYS 101**	**Physics-I (Mechanics)**	3
Inter-Disp-2	**BOT 352**	**Environmental Biology-I**	3(2+1)
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**18**
Semester-VI			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 367**	**Physical Chemistry-III**	3+1
Major	**CHEM 361**	**Analytical Chemistry-III**	3 (2+1)
Major	**CHEM 362**	**Occupational Safety and Environmental Health**	3
Inter-Disp-3	**PHYS 102**	**Physics-II (Rotational Motion and Thermodynamics)**	3
Inter-Disp-4	**BOT 481**	**Environmental Biology-II**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**16**
Semester-VII			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 471**	**Specialization Paper-I**	3
Major	**CHEM 472**	**Specialization Paper-II**	3
Major	**CHEM 473**	**Specialization Paper-III**	3
Major	**CHEM 474**	**Environmental Chemistry-I**	3
Major	**CHEM 475**	**Field Experience/Internship:**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**15**
Semester-VIII			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 481**	**Specialization Paper-IV**	3

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major	**CHEM 482**	**Specialization Paper-V**	3
Major	**CHEM 483**	**Specialization Paper-VI**	3
Major	**CHEM 484**	**Environmental Chemistry-II**	3
Major	**CHEM 500**	**Capstone Project/Thesis**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**15**
Total Credit Hours of the program:			**130**

Note: General education course = 12, Cr. Hr. =30

Interdisciplinary courses = 4, Cr. Hr. =12

Major Courses = 29, Cr. Hr. = 88

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

DETAIL OF COURSES

BS 1st Year

Semester-I

Semester-I			
Category	**Code**	**Title**	**Cr. Hrs.**
Gen-Ed-2	**BOT 112/ ZOOL 101**	**Plant Sciences/ Introductory Zoology**	3(2+1)
Gen-Ed-3	**ECON 111/ SOC 113**	**Fundamentals of Economics/ Introduction to Sociology**	2
Gen-Ed-4	**ENG 101**	**Functional English**	3
Gen-Ed-7	**ISL 112/ETH 118**	**Islamic Studies/Ethics (for Non-Muslims)**	2
Gen-Ed-9	**CS 110**	**Introduction to Information and Communication Technologies**	3(2+1)
Major	**CHEM 118**	**Physical Chemistry-I**	3
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Total Credit Hours: Minimum 15-18			**16**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 1st Year
Semester-I
Course Title: PHYSICAL CHEMISTRY-I
Course Code: CHEM 118
Credit Hours: 3; Marks:100

Course Objectives:

Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibria and to investigate the physical properties of ideal/non-ideal binary solutions. Students will also be able to study the rates of reactions and perform related calculations.

Chemical Thermodynamics: Equation of states, ideal and real gases, the virial equation and the van der Waals equation for real gases, critical phenomena and critical constants, four laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes, spontaneous and non-spontaneous processes, relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity.

Chemical Equilibrium: General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, Van't Hoff equation, Le-Chatelier's principle.

Solution Chemistry: Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and non-ideal solutions, Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions and Henry's law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Chemical Kinetics: The rates of reactions, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, experimental techniques for rate determination and methods for determination of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

Recommended Books:

1. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach,1st ed., University Science Books (1997).
2. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed. (2005).
5. Glasstone, S., Textbook of Physical Chemistry, Macmillan London (1960). 6. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York, (1974).
6. Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana, Lahore, 2013).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

BS 1st Year

Semester-II

Semester-II			
Category	**Code**	**Title**	**Cr. Hrs.**
Gen-Ed-1	**ISL 113**	**Seerah and its Contemporary Application** **سیرت رسول ﷺ اور اس کی عصری معنویت** **/Any course can be selected from Arts and Humanities in General Category (For Non-Muslims)**	2
Gen-Ed-5	**ENG 102**	**Introduction to Expository Writing**	3
Gen-Ed-6	**QR 101**	**Quantitative Reasoning-I (Mathematics)**	3
Gen-Ed-8	**PSC 111**	**Ideology and Constitution of Pakistan**	2
Gen-Ed-11	**SOC 114**	**Civic and Community Engagements**	2
Major	**CHEM 127**	**Organic Chemistry-I**	3
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Total Credit Hours: Minimum 15-18			**15**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 1st Year
Semester-II
Course Title: ORGANIC CHEMISTRY-I
Course Code: CHEM 127
Credit Hours: 3; Marks:100

Course Objectives:

Students will acquire knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reactions. Such information will be useful for qualitative analysis and synthesis of organic compounds.

Course Content:

Basic Concepts of Organic Chemistry: Bonding and hybridization, localized and delocalized bonding, structure- aromaticity, inductive effect, dipole moment, resonance and its rules, hyperconjugation, classification and nomenclature of organic compounds including IUPAC system, types of organic reactions (an overview).

Chemistry of Hydrocarbons: Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and electrophilic substitution reactions.

Chemistry of Functional Groups: Hydroxyl, ether and amino groups, preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications, carbonyl compounds, preparations and reaction mechanism of aldehydes and ketones and their applications, carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydrides.

Recommended Books:

1. Brown, W. and Poon, T., Introduction to Organic Chemistry, 3rd ed., John- Wiley & Sons, Inc., (2005).
2. John, E. M. Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).
4. Younus, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

BS 2nd Year

Semester-III

Semester-III			
Category	**Code**	**Title**	**Cr. Hrs.**
Gen-Ed-6	**QR 102**	**Quantitative Reasoning-II (Statistics)**	3
Gen-Ed-10	**MGT 215**	**Entrepreneurship**	2
Major	**CHEM 235**	**Inorganic Chemistry-I**	3
Major	**CHEM 231**	**Analytical Chemistry-I**	3
Major	**CHEM 232**	**Applied Chemistry-I**	3
Major	**CHEM 233**	**Biochemistry-I**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**17**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics) University of Malakand 05-Dec-2023

Major

BS 2nd Year
Semester-III
Course Title: INORGANIC CHEMISTRY-I
Course Code: CHEM 235
Credit Hours: 3; Marks:100

Course Objectives:

Students will acquire knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of p-block elements as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

Course Content:

Chemical Bonding: Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion (VSEPR) model, molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding.

Acids and Bases: Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB), concept of relative strength of acids and bases, significance of pH, pK_a, pK_b and buffer solutions, theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

p-Block Elements: Physical and chemical properties of p-block elements with emphasis on some representative compounds, inter-halogens, pseudo-halogens and polyhalides.

Recommended Books:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics) 05-Dec-2023
University of Malakand

5. Lee, J. D., Concise Inorganic Chemistry, 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 3rd ed., Pearson Education, India, (2008).
7. Huheey, J. E., Kieter E. A., Keiter L. R., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., Inorganic chemistry, 3rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, Inorganic Chemistry, 3rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., Descriptive Inorganic Chemistry, 2nd ed., Brooks Cole, (2010).
12. Wulfsberg G., Principles of Descriptive Inorganic Chemistry, 1st ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., Laboratory Safety for Chemistry Students, John-Wiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., Vogel's Textbook of Quantitative Chemical Analysis, 6th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., Vogel's Qualitative Inorganic Analysis, 7th ed., (7th imp.), Pearson Education, Ltd., (2009).

Major

BS 2nd Year
Semester-III
Course Title: ANALYTICAL CHEMISTRY-I
Course Code: CHEM 231
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about sampling, sample handling and preparation and results calculation and data reporting. In addition, they will learn and develop understanding about the classical techniques of analytical chemistry and quality control and quality assurance

Course Contents:

Chemometrics:

Sampling, significant figures, stoichiometric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard deviation/relative standard deviation, confidence limits, Gaussian distribution, least square method, tests for significance, outliers

Quality Control and Quality Assurance:

Definitions, seven tools for quality control, the concept of quality assurance, quality assurance techniques, validations based on design qualification (DQ), installation qualification (IQ), operational qualification (OQ) and performance qualification (PQ), calibrations, monitoring and quality reviews, periodical trainings, six sigma concepts, ISO standards.

Classical Analytical Methods:

Acid-base, complexometric and redox titrations, gravimetric analysis.

Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Brooks Cole Publishing Company, (2013).
2. Christian, G. D., Analytical Chemistry. 6th ed., John-Wiley & Sons, New York, (2006).
3. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, USA, (2011).
4. Kealey, D. and Haines, P. J, Instant Notes., Analytical Chemistry, Bios Scientific Publishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, CHEMOMETRICS-Statistics and Computed applications in

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Analytical Chemistry, 2nd ed., Wiley-VCH, Germany, (2007).

6. Mitra A., Fundamentals of Quality Control and Improvement, 3rd ed., John-Wiley & Sons, (2008).
7. Miller, J. and Miller, J., Statistics and Chemometrics for Analytical Chemistry, 5th ed., Prentice Hall, (2005).

Major

BS 2nd Year

Semester-III

Course Title: APPLIED CHEMISTRY-I

Course Code: CHEM 232

Credit Hours: 3

Course Objectives:

The objectives of the course are to educate the students about the fundamentals of chemical industry, raw materials, manufacturing and industrial processes.

Course Contents:

Fundamentals of Chemical Industry:

Basic principles and parameters for industrial plant unit operations and unit processes.

Chemical Industries:

Raw materials, flow sheet diagrams and unit operations and unit processes of sulphuric acid, nitric acid, hydrochloric acid, oxalic acid, formic acid, caustic soda and washing soda, cement industry, petroleum, textile, polymer and fuel industries, applications of these industries.

Recommended Books:

1. Kent, J. A.,_Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/ Plenum Publishers, (2003).
2. Vermani, O. P. and Narula, A. K., Applied Chemistry; Theory and Practice, New Age International Pvt. Ltd. Publishers, (2008).
3. Hede, P. D., Bier. S.P., Inorganic and Applied Chemistry, Ventus publishing app., (2007).
4. Sharma, J., Ndi., Applied Industrial Chemistry, Arise publishers & Distributors, (2012).
5. Heaton, A., An introduction to Industrial Chemistry, 3rd ed., Chapman & Hall, (1996).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 2nd Year
Semester-III
Course Title: BIOCHEMISTRY-I
Course Code: CHEM 233
Credit Hours: 3

Course Objectives:

Students will gain knowledge about fundamental concepts of biochemistry as well as be able to learn about the structures, properties and functions of amino acids, proteins, carbohydrates, lipids and nucleic acids.

Course Contents:

Introduction to Biochemistry: Brief introduction to the scope and history of Biochemistry, molecular logic of the living organism, cell structures and their functions, origin and nature of biomolecules.

Carbohydrates, Lipids and Proteins: Definition and classification, chemistry, physical and chemical properties of various classes of carbohydrates, biological functions of starch, glycogen, cellulose, and cell wall polysaccharides, acid mucopolysaccharides and proteoglycans.

Definition and classification of lipids, chemistry and biological importance of fatty acids, waxes, glycerides, phospholipids, sphingolipids, glycolipids, sterols and prostaglandins.

Significance of lipids in biological membranes and transport mechanism.

Chemistry and classification of amino acids, physical and chemical properties of amino acids, biological significance of amino acids, peptides, proteins, their classification, properties and biological significance, primary, secondary tertiary and quatenary structure of proteins, denaturation of proteins.

Nucleic Acids: Chemical composition of nucleic acids, structure and biological significance of nucleic acids, chemical synthesis of oligonucleotides, nucleic acids hydrolysis, isolation and separation of nucleic acids, introduction to recombinant DNA technology.

Recommended Books:

1. R. C. Alkire, D. M. Kolb, J. Lipkowski, Biselectro chemistry, volume 13,
2. 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
3. Nelson, D.L., Lehninger's Principles of Biochemistry, 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

4. Voet, D. and Voet, J.D., Biochemistry, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
5. Murray, R.M. and Harper, H.A., Harper's Biochemistry, 25th ed., Publisher: Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
6. Zubay, G. L., Biochemistry, 4th ed., illustrated, Publisher W. M. C. Brown Publishers, (1998), Digitized (2008). ISBN: 0697219003, 9780697219008.
7. Guyton, A. C. & Hall, J. E., Guyton & Hall Textbook of Medical Physiology,
8. 12th ed., Publishers: Saunders Elsevier, (2011). ISBN: 978-1-4160-4574-8.
9. Harvey, R. A., Ferrier, DR, Karandish S., Lippincott's illustrated Reviews: Biochemistry, 5th ed., and Biochemistry Map (Med maps) Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

BS 2nd Year

Semester-IV

Semester-IV			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 245**	**Inorganic Chemistry-II**	3
Major	**CHEM 246**	**Organic Chemistry-II**	3
Major	**CHEM 247**	**Physical Chemistry-II**	3
Major	**CHEM 241**	**Analytical Chemistry-II**	3
Major	**CHEM 244**	**Fuel Chemistry-I**	3(2+1)
Major	**CHEM 243**	**Biochemistry-II**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**18**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Major

BS 2nd Year
Semester-IV
Course Title: INORGANIC CHEMISTRY-II
Course Code: CHEM 245
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about the physical and chemical properties of d- & f-block elements on the basis of their electronic configurations and will be able to work out structures of coordination compounds through development of understanding of VBT, CFT and MOT.

Course Contents:

Chemistry of d-block elements and coordination complexes:

Background of coordination chemistry, nomenclature and structure of coordination complexes with coordination number 2-6, chelates and chelate effect, theories of coordination complexes, Werner's theory, valence bond theory (VBT), crystal field theory (CFT) and molecular orbital theory (MOT), Jahn-Teller theorem, magnetic properties, spectral properties, isomerism, stereochemistry, and stability constants of coordination complexes.

Chemistry of f-block elements:

i. Lanthanides: General characteristics, occurrence, extraction and general principles of separation, electronic structure and position in the periodic table, lanthanides contraction, oxidation states, spectral and magnetic properties and uses.

ii. Actinides: General characteristics, electronic structure, oxidation state and position in the periodic table, half-life and decay law.

Recommended Books:

1. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).
2. Housecraft, C. and Sharpe, A. G., Inorganic Chemistry, 4th ed., Prentice Hall, (2012).
3. Miessler, G. L. and Tarr, D.A., Inorganic Chemistry, 4th ed., Pearson- Prentice Hall International, (2010).
4. Douglas, B., McDanial, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons, New York, (1994).
5. Shriver, D. and Atkins, P., Inorganic Chemistry, 5th ed., W. H. Freeman &

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

Company, (2010).

6. Lee, J. D., Concise Inorganic Chemistry, 5th ed., Blackwell Science Ltd., (1996).
7. Atkins, P. and Jones, L., Chemicals Principles, 5th ed., W. H. Freeman & Company, (2010).
8. Svehla, G., Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, 5th ed., Longman Group Limited, (1979).
9. Huheey, J. E., Kieter, E. A. and Kieter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
10. Pass, G., Sutcliffe, H., Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods, 2nd ed., Chapman and Hall (1974).
11. Müller, U., Inorganic Structural Chemistry, 2nd ed., John-Wiley & Sons, Ltd., (2006).
12. Marusak R. A., Doan K., Cummings S. D., Integrated Approach to Coordination Chemistry, 1st ed., John-Wiley & Sons, (2007).
13. Chaudhary, S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2013).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 2nd Year
Semester-IV
Course Title: ORGANIC CHEMISTRY-II
Course Code: CHEM 246
Credit Hours: 3

Course Objectives:

Students will gain knowledge about the stereochemical behavior of organic molecules and acquire an ability to propose mechanism of simple reactions.

Course Contents:

Stereochemistry:

Types of stereoisomers, RS and EZ notation, optical activity, stereoselectivity and stereospecificity, conformational analysis.

Organic Reactions and Mechanism:

Detailed mechanism of aliphatic reactions including addition, substitution (SN1, SN2, SNi, and SN2′), and elimination (E1, E2 and E1cB) reactions, concept of energy profile, transition state and intermediate.

Recommended Books:

1. Robert, T. M., and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).
2. John, E. M., Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Younas, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2006).
4. Morris, D. G., Stereochemistry (Basic Concepts in Chemistry), Wiley-RSC, (2002).
5. Mislow, K., Introduction to Stereochemistry, Dover Publications Inc., (2003).
6. David M., Stereochemistry (Tutorial Chemistry Texts), Royal Society of Chemistry, (2002).
7. Furniss, B. S, Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th ed., Longman, UK, (1989).
8. Mohan J., Organic Analytical Chemistry, Theory and Practice, 1st ed. Alpha Science International, Ltd. (2003).
9. Seiler, J. P., Good Laboratory Practice: The Why and the How, 2nd ed., Springer, (2005).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

10. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed., Brooks/ Cole Cengage Learning, (2012).
11. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons, Inc., (2011).
12. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/ Cole Cengage Learning, (2013).
13. Eames, J. and Peach, J. M., Stereochemistry at a Glance, Blackwell Science, Ltd., (2003).
14. Eliel, E. L., Wilen, S. H. and Doyle, M. P., Basic Organic Chemistry, John-Wiley & Sons, Inc., (2001).
15. Eliel, E. L. and Wilen, S. H., Stereochemistry of Organic Compounds, John-Wiley & Sons, Inc., (1994).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

Major

BS 2nd Year
Semester-IV
Course Title: PHYSICAL CHEMISTRY-II
Course Code: CHEM 247
Credit Hours: 3

Course Objectives:

Students will be able to understand and acquire knowledge about the principles and theoretical background of quantum chemistry, kinetics theory of gases and phase equilibrium. The knowledge gained thus can be applied to study various aspects of quantum mechanics, gas kinetic behavior and thermodynamics and phase equilibrium.

Course Contents:

Quantum Chemistry: Black body radiation, photoelectric effect, line spectra of elements, Bohr atomic model, wave and particle nature of matter, de Broglie's equation, Young's double slit experiment, Heisenberg's uncertainty principle, wavefunctions and Born interpretation of wavefunctions, probability density, eigenfunctions and eigenvalues, Hamiltonian operator, Schrödinger wave equation, wavefunctions for hydrogen-like atomic orbitals, radial distribution functions, shielding and penetration, effective nuclear charge, orbital energies, periodic trends in the properties of the elements in the periodic table.

Kinetic Theory of Gases: Equation of states, ideal and real gases, the virial equation and the van der Waals equation for real gases, critical phenomena and critical constants, probability density for molecular speeds of gas molecules, Maxwell distribution of molecular speeds, average speeds, pressure of an ideal gas, calculation of molecular speeds, binary collisions, effusion and mean free paths, Maxwell Boltzmann's law of energy distribution, method for the determination of the Avogadro's number (NA), statistical probability and entropy.

Phase Equilibrium: Gibbs phase rule, Phase diagrams of one component and two component systems, Gibbs energy and the phase diagram of a substance, location of phase boundaries, Clausius-Clapeyron equation, vapor-liquid equilibrium of binary liquid mixtures, binary phase diagrams and lever rule.

Recommended Books:

1. Silbey, R. J., Alberty, R. A., and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley & Sons, (2005).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

2. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1st ed., University Science Books, (1997).
3. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010). 4. Moore. W. J., Physical Chemistry, 4th ed., Longman Publisher (1972).
4. Coulson C. A., Vanlence, Oxford University Press (1980).
5. Keeler. J. and Wothers, P., Chemical Structure and Reactivity: An Integrated Approach, 1st ed., Oxford University Press, (2008).
6. Helpern, A. M., Experimental Physical Chemistry: A Laboratory Textbook 2nd ed., Prentice Hall, (1997).
7. Garland, C. W., Nibler, J. W. and Shoemaker, D., P., Experiments in Physical Chemistry, 8th ed., McGraw-Hill, (2003).
8. Born, Max., Atomic Physics, 8th ed., Blackie & Son Ltd., (1969).
9. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
10. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York, (1974).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Major

BS 2nd Year
Semester-IV
Course Title: ANALYTICAL CHEMISTRY
Course Code: CHEM 241
Credit Hours: 3

Course Objectives:

The main objectives of this course are to introduce the students to the basic principles, instrumental aspects and applications of thermal analysis, electrode phenomena and basic electroanalytical techniques

Course Contents:

Thermal Analysis

Basic principles, instrumentation and applications of Thermogravimetry (TGA) and Differential Thermal Analysis (DTA).

Electrode Phenomena

The electrochemical cell, Oxidation and reduction potentiometric methods, various types of electrodes and their use, over potentials, membrane potentials, some well-known Redox reactions of analytical importance, ion-selective electrodes

Electroanalytical techniques

Basic principles, instrumentation and application of potentiometry, voltammetry, polarography, conductometry, electrogravimetry, amperometry and coulometry

Recommended Books:

1. Analytical Chemistry by Gary D. Christian; 6th ed. 2004; John Wiley & Sons, Inc.
2. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, "Fundamentals of Analytical Chemistry" 8th ed. 2003; Saunders College Publishing, Philadelphia.
3. Instrumental Methods of Analysis by Hobert H. Willard D.L. Merrit & J.R.J.A. Dean, Frank A. Settle; 7th Sub edition 1988; Wadsworth Publishing Company.
4. Laboratory Manual of Analytical Chemistry by C. Reilly; Allyn and Bacon, London.
5. Quantitative Analysis by W. J. Blaedal and V. W. Medloche; Harper & Row, N.Y.
6. J.G. Dick, Analytical Chemistry, McGraw-Hill, Tokyo.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 2nd Year
Semester-IV
Course Title: FUEL CHEMISTRY-I
Course Code: CHEM 244
Credit Hours: 3(2+1)

Course Objectives

After completing the course, the students will acquire knowledge about the chemistry of fossil fuels like coal, petroleum and natural gas and their conversion processes to get useful chemical products

Course Contents

Introduction and classification of fuels. Origin of coal, petroleum and natural gas. Constituents of coal, petroleum and natural gas. Varieties of crude oils. Coal ranks. Distillation of crude petroleum into marketable products. Uses and properties of naphtha, gasoline, kerosene, diesel, gas oil and furnace oil. Lubricants from petroleum. Producer and water gas from coal. Petrochemicals from natural gas.

CHEM 244-L

Determination of moisture contents of coal mined in different parts of Pakistan. Determination of Ash contents of coal mined in different parts of Pakistan.

Determination of Volatile matter of coal. Determination of fixed carbon contents of coal.

Determination of hydrogen and nitrogen contents of the coal. Determination of chlorine and oxygen in coal.

Determination of various forms of sulfur in coal.

Recommended Books:

1. Gyngell, E.S. “Applied Chemistry for Engineers”. Edward Arnold Publisher, Ltd. London. (1989).
2. Harker, J.H. and Backurst, J.R. “Fuel and Energy” Academic Press, London and New York (1988).

Major

BS 2nd Year
Semester-IV
Course Title: BIOCHEMISTRY-II
Course Code: CHEM 243
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about the fundamental concepts of the mechanisms of major macromolecules (amino acids, proteins, carbohydrates, nucleic acids and lipids), and the metabolism and regulation and inhibition of the metabolic pathways.

Course Contents:

Metabolism of Carbohydrates: Digestion, Absorption and Transport of sugars into cell, Glycolysis, Citric Acid Cycle, HMP pathway and its significance, Uronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Photosynthesis.

Metabolism of Lipids: Digestion of Lipids, absorption and transport of lipids and fatty Acids, Oxidation saturated and unsaturated, odd chain and branched chain fatty acids, Biosynthesis of fatty acids and eicosanoids, Biosynthesis of triglycerides, phosphides, steroid and Bitter acids, Biosynthesis and utilization of Ketone bodies.

Metabolism of Proteins: Digestion of proteins, absorption and transport of amino acids to the cell, Biochemical reaction of amino acids: decarboxylation, deamination, transamination and transmethylation etc., metabolism of essential amino acids, metabolic disorders, urea cycle, Creatine and uric acid synthesis, inter-relationship between carbohydrate, lipid and protein metabolism.

Metabolism of Nucleic Acids: Biosynthesis and catabolism of purines and pyrimidines and their regulation, synthesis, catabolism of nucleosides, DNA polymerases and other enzymes involves in metabolism

Recommended Books:

1. Voet, D. and Voet, J. D., Biochemistry, 4th ed., illustrated. Publisher: John- Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
2. Nelson, D. L. and Cox, M. M., Lehninger's Principles of Biochemistry, 6th ed., Freeman, (2012).
3. Murray, R., Bender, D., Botham, K.M., Kennely, P. J., Rodwall, V. and Weil, P.A., Harper's Biochemistry, 29th ed., (2012).
4. Zubay, G. L., Biochemistry, 4th ed., illustrated. Publisher: WMC. Brown Publishers, (1998), digitized, (2008). ISBN: 0697219003. 9780697219008.
5. Guyton, A. C. & Hall, J. E., Guyton & Hall Textbook of Medical Physiology, 12th ed., Publishers: Saunders Elsevier, (2011).
6. Plummer, D.T., An Introduction to Practical Biochemistry, 3rd ed., TATA MCGraw-Hill Publishing Company LTD, (2010).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics) University of Malakand 05-Dec-2023

7. Sawhney, S. K. and Sing, R., Introductory Practical Biochemistry, 2nd ed., Narosa Publishing House, New Delhi, (2005).
8. Robert A. Copeland, Enzymes: A Practical Introduction to Structure, Mechanism, and Data analysis, 2nd ed., Publishers: John-Wiley & Sons, (2000) ISBN: 0-471-35929-7
9. R. C. Alkire, D. M. Kolb, J. Lipkowski, Biselectro chemistry, volume 13, 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
10. Nelson, D.L., Lehninger's Principles of Biochemistry, 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
11. Voet, D. and Voet, J.D., Biochemistry, 4th ed., illustrated. Publisher: John- Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
12. Murray, R.M. and Harper, H.A., Harper's Biochemistry, 25th ed., Publisher: Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
13. Harvey, R. A., Ferrier, DR, Karandish S., Lippincott's illustrated Reviews: Biochemistry, 5th ed., and Biochemistry Map (Med maps) Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

BS 3rd Year

Semester-V

Semester-V			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 355**	**Inorganic Chemistry-III**	3 (2+1)
Major	**CHEM 356**	**Organic Chemistry-III**	3 (2+1)
Major	**CHEM 352**	**Applied Chemistry-II**	3 (2+1)
Major	**CHEM 350**	**Nuclear Chemistry**	3
Inter-Disp-1	**PHYS 101**	**Physics-I (Mechanics)**	3
Inter-Disp-2	**BOT 352**	**Environmental Biology-I**	3(2+1)
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**18**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

Major

BS 3rd Year

Semester-V

Course Title: INORGANIC CHEMISTRY-III

Course Code: CHEM 355

Credit Hours: 3(2+1)

Course Objectives:

Students will acquire knowledge about various types of inorganic materials, their structure, synthesis, characterization and applications in various fields

Course Contents:

Introduction to inorganic materials, crystalline and amorphous states, bonding in solids, non-stoichiometric compounds, binary solid solutions, mechanical, electrical, magnetic, dielectric, optical, and chemical (corrosion) properties of advanced materials, synthesis (e.g., sol-gel, hydrothermal techniques, etc.) and design of inorganic materials and characterization, doping and purification of silicone, chemical vapor deposition and sputtering, introduction to nano materials.

CHEM 366 Lab

1. Estimation of anions in mixtures:

Chloride-phosphate, chloride-nitrate, oxalate-chloride, sulphate- phosphate, bromide-nitrate, borate-acetate, iodide-nitrate.

2. Iodometric titration with potassium iodate.
3. Gravimetric estimation of oxalate.
4. Precipitation Titrations.

a) Determination of strength of NaCl given solution by AgNO3 using Fluorescein as indicator.

b) Determination of % age purity of KBr using Fluorescein as indicator.

c) Determination of % composition of mixture of KI & KNO3 using Eoscein as indicator.

5. Spectrophotometric determination of cerium.
6. Separation of heavy metals using solvent extraction technique.

Recommended Books:

1. Xu, R., Pang, W., Huo, Q., Modern Inorganic Synthetic Chemistry, 1st ed., Elsevier, (2011).
2. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., Vogel's Quantitative Chemical Analysis, 6th ed., Prentice Hall, (2000).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).
4. Huheey, J. E., Keiter, E. A. and Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
5. Housecraft, C. and Sharpe, A. G., Inorganic Chemistry, 4th ed., Prentice Hall, (2012).
6. Rodgers G. E., Descriptive Inorganic, Coordination, and Solid-State Chemistry,

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics) University of Malakand 05-Dec-2023

3rd ed., Brooks- Cole, (2012).
7. Smart L. E., Moore E. A., Solid State Chemistry: An Introduction, 4th ed., CRC Press, (2012).
8. Müller, U., Inorganic Structural Chemistry, 2nd ed., John-Wiley & Sons, (2006).
9. Schwarzenbach D., Crystallography, 1st ed., John-Wiley & Sons, (1996).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Major

BS 3rd Year
Semester-V
Course Title: ORGANIC CHEMISTRY-III
Course Code: CHEM 356
Credit Hours: 3(2+1)

Course Objectives:

Students will acquire knowledge and understanding about aromatic substitution reactions and oxidation and reduction as well as pericyclic reactions.

Course Contents:

Aromatic Substitution Reactions:

Mechanisms of aromatic reactions including electrophilic and nucleophilic substitutions, effect of substituents on orientation and reactivity.

Oxidation-reductions Reactions:

Common oxidizing and reducing reagents, reactions involving elimination of H, cleavage of C-C bond, replacement of hydrogen by oxygen, and addition of oxygen to substrates, reaction involving replacement of oxygen by hydrogen, removal of oxygen from the substrates and reduction with cleavage.

Pericyclic Reactions:

Introduction to pericyclic reactions, frontier orbital theory, mechanisms of electrocyclic, cycloaddition and sigmatropic reactions.

CHEM 367 Lab.

Experiments involving aromatic substitution, oxidation/reduction reactions and pericyclic reactions, nitration of nitrobenzene to meta-dinitrobenzene, reduction of meta- dinitrobenzene to meta-nitroaniline, sulphonation of aniline, oxidation of benzaldehyde, oxidation of cyclohexanol to cyclohexanone. Preparation of benzoic acid and benzyl alcohol from benzaldehyde using Cannizzaro's reaction.

Recommended Books:

1. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).
2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th edition, Longman, UK, (1989).
3. Mohan, J., Organic Analytical Chemistry: Theory and Practice,1st ed. Alpha Science Int. Ltd.New Delhi, India, (2003).
4. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).
5. Tse-Lok, H., Symmetry: A Basis for Synthesis Design, John-Willey & Sons, Inc., New York, (1995).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

6. Pine, S. H., Organic Chemistry, 5th ed., Tata McGraw-Hill, India, (1987).
7. Sykes, P., A Guidebook to Mechanism in Organic Chemistry, 6th ed., Pearson Education, (1986).
8. Mayo, D. W., Pike, R. M. and Forbes, D. C., Microscale Organic Laboratory with Multistep and Multiscale Syntheses, 5th ed., John-Wiley & Sons, Inc., (2011).
9. Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale and Microscale Approach, 5th ed., Brooks/ Cole Cengage Learning, (2010).
10. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons, Inc., (2011).
11. Carey, F. A. and Giuliano, R. M., Organic Chemistry, 9th ed., McGraw-Hill Education, (2013).
12. Bruice, P. Y., Organic Chemistry, 7th ed., Perason Education, Ltd., (2013).
13. Smith, M. B., March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th ed., John-Wiley & Sons, Inc., (2013).
14. Ansari, F. L., Qureshi, R. and Qureshi, M. L., Electrocyclic Reactions: From Fundamentals to Research, Wiley-VCH, Germany, (1999).
15. Kürti, L. and Czakó. B., Strategic Applications of Named Reactions in Organic Synthesis: Background and Detailed Mechanisms, Elsevier Inc., (2005).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Major

BS 3rd Year
Semester-V
Course Title: APPLIED CHEMISTRY-II
Code: CHEM 352
Credit Hours: 3(2+1)

Course Objectives:

Students will gain understanding about the importance of water and its quality requirements for industrial uses in addition to learning about water treatment techniques. They will also learn about composite materials.

Course Contents:

Water Treatment, Steam Production and Scale Removal: Sources of water hardness, water treatment and conditioning for municipal and industrial purposes, steam production and its utilization for power and energy generation, boiler water treatment, chemistry involved in the formation of scale and its prevention.

Distillation: Vapor liquid equilibrium, methods of getting equilibrium data for binary systems, construction of equilibrium diagram, designing of distillation column, reflux ratio and its importance.

Composite Materials: Introduction to composite material, classification of composite on the basis of reinforcement (Particle–Reinforced composite, Fibre–Reinforced composite, structural composites) and classification of composites on the basis of matrix phase (Polymer–Matrix composite, Metal–Matrix composite, Ceramics–Matrix composite, Carbon-carbon composite, Hybrid-composite, Laminar composite, Sandwich panels), synthesis, properties and applications of composite materials.

CHEM 352 Lab

Extraction of clove oil from cloves.

Preparation of liquid detergents.

Study of the kinetics of dissolution of Magnesium metal in dilute HCl.

Estimation of Manganese in Steel.

Estimation of Ferric Iron in Cement.

Recommended Books:

1. Erwin D. L., Industrial Chemical Process Design, McGraw-Hill, (2002).
2. Chawla, K. K., Composite Materials: Science and Engineering, 3rd ed., Springer, (2012).

3. Methews, F. L., Rawlings, R. D., Composite Materials: Engineering and Sciences, CRC Press, (2003).
4. Deborah, D. L., Composite Materials: Science and Applications, 2nd ed., Springer, (2010).
5. Gay, D. and Hoa, S. V., Composite Materials: Design and Applications, 2nd ed., CRC Press, LLC, (2007).
6. Kister, H., Distillation Operation, 1st ed., McGraw-Hill Professional, (1990).
7. Kister, H., Distillation Design, 1st ed., McGraw-Hill Professional, (1992).
8. Tchobanoglous, G., Burton, F. L. and Stensel, H. D., Wastewater Engineering: Treatment and Reuse, 4th ed., McGraw-Hill, (2003).
9. Callister, W. D. Jr., Materials Science and Engineering: An Introduction, 7th ed., John-Wiley & Sons, Inc., (2007).
10. Roussak, O. V. and Gesser, H. D., Applied Chemistry: A Textbook for Engineers and Technologists, 2nd ed., Springer, (2013).
11. Mizrahi, J., Developing an Industrial Chemical Process: An Integrated Approach, CRC Press, (2002).
12. Vermani, O. P., Applied Chemistry: Theory and Practice, 2nd ed., New Age International, (2006).

Major

BS 3rd Year
Semester-V
Course Title: NUCLEAR CHEMISTRY
Code: CHEM 350
Credit Hours: 3

Course Objectives:

The course will focus on the basics of nuclear chemistry, its principles, and applications.

The atomic nucleus

The atom, Units used in nuclear chemistry, The nucleus and the outer sphere, Classification of nuclides, nuclear stability, atomic energy.

Radioactivity

Discovery, Radioactive elements, General characteristics of radioactive decay, Decay kinetics, Parent-daughter decay-growth relationships, Alpha decay, Beta decay, Nuclear deexcitation: gamma emission, Artificial radioactivity

Nuclear reactors

The fission energy, the natural uranium reactor, the classification of reactors, Reactor power, Critical size of a thermal reactor, Excess reactivity and control, the breeder reactor, Reprocessing of spent fuels: Recovery of uranium and plutonium, Nature's nuclear reactor.

Applications of radioactivity

Probing by isotopes, Typical reactions involved in the preparation of radioisotopes, The Szilard-Ohalmers' reaction, Use of charged plates in the collection of radioisotopes, Radiochemical principles in the use of tracers, Typical applications of radioisotopes as tracers, Uses of nuclear radiations, Radioisotopes as a source of electricity.

Elements of radiation chemistry

Radiation chemistry, Interaction of radiation with matter, Passage of neutrons through matter, Interaction of gamma radiation with matter, Units for measuring radiation absorption, Radiation dosimetry, Radiolysis of water: The hydrated electron, Free radicals in water radiolysis.

Recommended Books:

1. H.J. Arnikar, Essentials of nuclear *Chemistry* (2nd ed.) Wiley Eastern Limited (1987)
2. Choppin, Gregory, Jan-Olov Liljenzin, and Jan Rydberg. Radiochemistry and nuclear chemistry. Butterworth-Heinemann, 2002.
3. Loveland, Walter D., David J. Morrissey, and Glenn T. Seaborg. Modern nuclear chemistry. John Wiley & Sons, 2017.
3. Vertis, Attila, and Istvan Kiss. “Nuclear Chemistry” (1987).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

BS 2nd Year
Semester-V
Course Title: Physics-I (Mechanics)
Course Code: PHYS 101
Credit Hours: 3

Course Objectives:

This course is based on basic concepts of physics that will enable students to understand the fundamentals of mechanics. After studying this course students will be able to solve problems related to physics/mechanics.

Course Outline:

Motion along a straight line (position, displacement, velocity, acceleration and graphical analysis of motion). Vectors and their components (vectors, unit vectors, vectors addition by components, multiplication of vectors). Motion in two and three dimensions (position, velocity etc. projectile motion, uniform circular motion, relative motion in one and two dimensions). Force and Motion-I (Newton's laws, applying Newton's laws, some particular forces). Force and Motion-II (Friction, Drag force and terminal speed, Uniform circular motion). Kinetic Energy and Work (work done and Kinetic energy, work done by gravitational force, Work done by a spring and variable force, Power). Potential Energy and Conservation of Energy (Potential energy, conservation of mechanical energy, potential energy curve, Work done on a system by external force). Center of mass and linear momentum(center of mass, Newton's second law for a system of particles, linear momentum, Collision and impulse, Conservation of linear momentum, Momentum and kinetic energy in collision, elastic collision in one and two dimensions, systems with varying mass

Textbook:

Fundamentals of Physics by Halliday, Resnick and Walker: 8th Edition (Textbook).

Holiday, Resnik, Krane

Serway Jewett, Physics for Scientists and Engineers with Modern Physics. (2010)

Recommended Book:

University Physics with Modern Physics 13th Ed. Pearson Education Inc. USA

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics) University of Malakand 05-Dec-2023

BS 3rd Year
Semester-V
Course Title: Environmental Biology-I
Course Code: BOT 352
Credit Hours: 3(2+1); Marks: 100

Theory:

Introduction: Definitions, History, Environmental systems and factors: Atmosphere and its Layers, Lithosphere and its zones, hydrosphere and its classification and Biosphere and limits of life.

Ecosystem: Structure (Biotic and Abiotic factors) and Functions (Materials and Energy Flow) of ecosystem

Environmental sustainability: Ecosystem evolution (Hydroseres and Xeroseres)

Pollution: Definition, types (Material and non-material), sources, causes, effects.

- Air Pollution and its consequences (Global warming, Greenhouse effect, Acid rain, Ozone Layer depletion).
- Water Pollution: Sources and effects of water pollution on living organisms
- Soil Pollution: Sources and effects of Soil pollution on living organisms

Resources: Renewable and Non-Renewable resources (Land, Agriculture, Fisheries, Forests and Energy resources)

Practical:

Testing water for different pollutants (Coliform bacteria, Chloride, Carbonate ions and Nitrate ions). Design for material recycling and reuse. Test for Ozone. Algae as Biofuel Wind, Solar and Hydal energy. Design to observe the Effect of Pollutant on Plant Growth Primary, Secondary and Tertiary treatment of water.

Recommended Books:

1. Botkin, D. and Keller, E. Environmental Sciences; Earth as a Living Planet. 8th ed. John Wiley and Sons, Inc. (2000).
2. Cunningham, W.P, & Saigo, B.W. Environmental Sciences 6th ed. McGraw-Hill (2001).
3. Enger, E.D. and Smith, B.F. Environmental Science: A study of Interrelationship. McGraw-Hill, (1997).
4. Kupchella, C.E. and Hyland. M.C. Environmental Science; Living within the System of Nature. Prentice Hall, (1986).
5. Nebel, B.J. & Wright, R.T. Environmental Sciences, 6th ed. Prentice Hall. New Jersey, (1999).
6. Zia-ul-Haq, Calculas and Analytic Geometry, 1998. The Caravan Book House, Lahore.

BS 3rd Year

Semester-VI

Semester-VI			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 367**	**Physical Chemistry-III**	3+1
Major	**CHEM 361**	**Analytical Chemistry-III**	3 (2+1)
Major	**CHEM 362**	**Occupational Safety and Environmental Health**	3
Inter-Disp-3	**PHYS 102**	**Physics-II (Rotational Motion and Thermodynamics)**	3
Inter-Disp-4	**BOT 481**	**Environmental Biology-II**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**16**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

Major

BS 3rd Year
Semester-VI
Course Title: PHYSICAL CHEMISTRY-III
Course Code: CHEM 367
Credit Hours: 3+1

Course Objectives:

Students will acquire knowledge and understanding about the theoretical and instrumental as well as application related aspects of conductometric, and electrochemical techniques and surface chemistry. They will also acquire information regarding nuclear binding energy, nuclear instabilities and decay mechanisms as well as the fission and fusion processes.

Course Contents:

Conductometry: Ions in solution, measurement of conductance and Kohlrausch's law, mobility of ions and transport number, conductometric titrations, Debye-Hückel theory and activity coefficient, determination of activities, application of conductance measurement.

Electrochemistry: Redox reactions, spontaneous reactions, electrochemical cells, standard electrode potentials, liquid junction potential, electrochemical series, Nernst's equation, thermodynamic of redox reactions, measurement of pH and pKa, dynamic electrochemistry, Latimer Diagram, Frost Diagram, electrolytic cells, potentiometry, reference and indicator electrodes, voltammetry, fuel cells, corrosion and its prevention, fuel cell and hydrogen economy.

Surface Chemistry: Adsorption and absorption, adsorption isotherms, Freundlich and Langmuir adsorption isotherms, Gibbs adsorption isotherm, application of adsorption, characteristics of catalyst, type of catalysis, theories of catalysis, industrial applications of catalysis.

Nuclear Chemistry: Atomic nucleus, nuclides, nuclear stability, modes of decay, nuclear energetics, nuclear models (shell + liquid drop model), fusion and fission, nonspontaneous nuclear processes, nuclear reactors, beta decay systematic.

CHEM 368 Lab.

Spectroscopic determination of Cu percentage in the given sample.
Conductometric determination of Cu (II)- EDTA mole ratio in the complex.
To determine the effectiveness of an extraction of I_2 solution by using Solvent Extraction method.
Determination of molecular weight of a polymer by viscosity method.
Determination of percentage composition of $KMnO_4$/ $K_2Cr_2O_7$ in a given solution by spectrophotometry.
Evaluation of pKa value of an indicator by spectrometric method.
Conductometric determination of hydrolysis constant (K_h) of conjugate base of a weak acid.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Recommended Books:

1. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley & Sons, (2005).
2. Ball D. W., Physical Chemistry, Brooks/Cole Co. Inc., (2003).
3. Vertes, A., Nagy, S. and Klencsar, Z., Handbook of Nuclear Chemistry. Volume 1: Basics of Nuclear Science, 1st ed., Springer, (2003).
4. Choppin, G., Liljenzin, J-. O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth- Heinemann, (2002).
5. Loveland, W., Morrisey, D. J. and Seaborg, G. T., Modern Nuclear Chemistry, John-Wiley & Sons, Inc., (2006).
6. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010). 7. Somorjai, G. A. and Li, Y., Introduction to Surface Chemistry and Catalysis, 2nd ed., John-Wiley & Sons, Inc., (2010).
7. Laidler. K. J., "Chemical Kinetics" 3rd ed., Prentice Hall, (1987).
8. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

Major

BS 3rd Year
Semester-VI
Course Title: ANALYTICAL CHEMISTRY-III
Course Code: CHEM 361
Credit Hours: 3(2+1) Marks:75+25

Course objectives

Students will learn about basic differences between separation techniques and thermal analysis approaches

Course Contents:

Separation Techniques

Introduction and Classification of Separation Techniques

1. Masking, 2. Precipitation, 3. Filtration, 4. Distillation, 5. Volatilization, 6. Solvent Extraction, 7. Chromatography, 8. Electrophoresis

Thermal Analysis

Basic principles, instrumentation and applications of Thermogravimetry (TGA) and Differential Thermal Analysis (DTA).

CHEM 361-L

Experiments based on theory topics as per facilities available.

Recommended Books:

1. Analytical Chemistry by Gary D. Christian; 6th ed. 2004; John Wiley & Sons, Inc.
2. G. D. Christian and J.E. Reilly; "Instrumental analysis" Allyn and Bacon, Inc.
3. Douglas A. Skoog, and D.M. West, "Principle of Instrumental analysis" einholt, New York.
4. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, "Fundamentals of Analytical Chemistry" 8th ed. 2003; Saunders College Publishing, Philadelphia.
5. Instrumental Methods of Analysis by Hobert H. Willard D.L. Merrit & J.R.J.A. Dean, Frank A. Settle; 7th Sub edition 1988; Wadsworth Publishing Company.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 3rd Year
Semester-VI
Course Title: Occupational Safety & Environmental Health
Course Code: CHEM 362
Credit Hours: 3

Course Objectives:
The course will make the students able to understand basic concepts of physics related to thermodynamics and the theory of gases.

Course Contents:
History and Importance of Safety and health in Laboratory

- Introduction to Occupational safety and environmental health (OSEH)
- Different Types of Hazards and risk in Chemical Laboratory
- Moral, Legal and Financial Reasons
- Importance of Safety and Security, Responsibility and Accounting for Safety

Housekeeping and Good Laboratory Practice (GLP) in Chemical Safety: Use of Appropriate Personal Protection Equipments (PPEs)

- Potential Health Hazards from Cleaning Chemicals
- Choosing Environmentally safer Cleaning Chemicals
- Personal Protection Equipments; Aprons, Gloves Face, Eye and Foot Protection, Respiratory Protection
- Contaminated Work Environment
- Preventing Ergonomic Injuries
- Worker Training and Employer Responsibilities

Hazard Identification, Management and Control

- Introduction to Hazard Recognition and Evaluation
- Unrecognized hazards and their Consequences; Slips, Trips & Falls Hazards
- Understanding the safety Data Sheet (SDS) and Pictogram Communications
- Hazard Warning Signs, Labeling & Tagging System
- Hazard Communication Standard (HCS) and Globally Harmonized System (GHS)
- Ways of Protection and Control to Reduce Hazards Toxic Effects
- Examples of Hazards at the Workplace

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

- Hazards Reporting Procedures

Waste Management and Disposal

- Waste Management System for Laboratories
- Identification, Classification and Segregation of Laboratory Waste
- Storage of Laboratory Waste
- Recovery, Recycling and Reuse of Laboratory Chemicals
- Disposal of Chemicals in the Sanitary Sewer System
- Procedures for Laboratory Destruction of Chemical Waste
- Transportation of Hazardous Chemicals
- Incineration of Hazardous Chemicals
- Disposal of Hazardous Chemicals
- Disposal of Hazardous Chemicals in Landfill
- Disposal of Chemically Contaminated Waste from Life-Science Laboratories

Managing Chemicals

- Introduction
- Green Chemistry for Every Laboratory
- Purchasing Chemicals
- Inventory and Tracking of Chemicals
- Storage of Chemicals
- Transfer, Transport and Shipment of Chemicals

Recommended Books:

1. Fanning, Fred E. (2003). Basic Safety Administration: A Handbook for the New Safety Specialist, Chicago: American Society of Safety Engineers
2. Stephen K. Hall “Chemical Safety in the Laboratory” CRC Press
3. Anthony Fuscaldo, “Laboratory Safety Theory and Practice” Elsevier Science
4. Jay A. Young, “Improving Safety in the Chemical Laboratory: A Practical Guide”, Wiley, 1991
5. Brinton Marshall Miller, “Laboratory safety: principles and practices”, American Society for Microbiology, 1986
6. Stephen R. Rayburn The Foundations of Laboratory Safety: A Guide for the Biomedical Laboratory, Springer 1991

BS 3rd Year
Semester-VI
Course Title: Physics-II (Rotational Motion and Thermodynamics)
Course Code: PHYS 102
Credit Hours: 3; Marks 100

Course Objectives:

This course is based on basic concepts of physics that will enable students to understand fundamentals of rotational mechanics and thermodynamics. After studying this course students will be able to solve related problems.

Course Outline:

Rotation with Constant Angular Acceleration, Relating the Linear and Angular Variables, Kinetic Energy of Rotation, Calculating the Rotational Inertia, Torque, Newton's Second Law for Rotation, Work and Rotational Kinetic Energy, Rolling as Translation and Rotation Combined, The Kinetic Energy of Rolling, The Forces of Rolling, Angular Momentum, Newton's Second Law in Angular Form, The Angular Momentum of a System of Particles, The Angular Momentum of a Rigid Body Rotating About a Fixed Axis, Conservation of Angular Momentum, Newton's Law of Gravitation, Gravitation and the Principle of Superposition, Gravitation Near Earth's Surface, Gravitation Inside Earth, Gravitational Potential Energy, Planets and Satellites, Kepler's Laws, Satellites: Orbits and Energy, Einstein and Gravitation, A Closer Look at Heat and Work, The First Law of Thermodynamics, Some Special Cases of the First Law of Thermodynamics, Heat Transfer Mechanisms, Avogadro's Number, Ideal Gases, Pressure, Temperature, and RMS Speed, Translational Kinetic Energy, Mean Free Path, The Distribution of Molecular Speeds, The Molar Specific Heats of an Ideal Gas, Degrees of Freedom and Molar Specific Heats, A Hint of Quantum Theory, The Adiabatic Expansion of an Ideal Gas, Irreversible Processes and Entropy, Change in Entropy, The Second Law of Thermodynamics, Entropy in the Real World: Engines, Entropy in the Real World: Refrigerators, The Efficiencies of Real Engines, A Statistical View of Entropy

Textbook: Physics by Hallidy, Resnick and Walker: 8th Edition

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

BS 3rd Year
Semester-VI
Course Title: Environmental Biology-II
Course Code: BOT 481
Credit Hours: 3 Marks: 100

Theory:

1. Environment: Introduction, scope, pressure
2. Pollution: definition, classification and impact on habitats
   i. Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, and remediation. Photochemical Smog. Acid rain: 1. Theory of acid rain, 2. adverse effect of acid rains Chlorofluorocarbons and its effects.
   ii. Water pollution: Major sources of water pollution and its impact on vegetation. Prevention, control remediation, eutrophication, thermal pollution.
   iii. Sediments pollution: fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control remediation and Heavy metal pollution. Tanneries and Hospital waste. Treatments of sewage, sludge, and polluted waters.
   iv. Noise pollution
   v. Radiation pollution (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal
3. Forest: importance, deforestation, desertification and conservation
4. Ozone layer:
   i. Formation
   ii. Mechanism of depletion
   iii. Effects of ozone depletion
5. Greenhouse effect: causes, impacts.
6. Human population explosion: impact on environment.
7. Impact assessment: Industrial urban, civil developments.
8. National conservation strategy: Brief review of major problems of Pakistan and their solutions.
9. Sustainable Environmental management
10. Wetlands and sanctuaries protection: The pressures, problems and solutions.
11. Range management: Types of rangelands, potential threats, sustainable management.

Practical:

1. Examination of industrial wastewater and Municipal sewage and sludge for

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

i) Total dissolved solids.
ii) pH and EC.
iii) BOD/COD.
iv) Chlorides, Carbonate, and Nitrates.

2. Examination of water samples forms different sites for the presence and diversity of organisms.

3. Effect of air pollutants on plants.

4. Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

1. Bazzaz, F.A. 1996. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
2. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
3. Eugene, E.D. and Smith, B.F. 2000. Environmental Science: A study of interrelationships. McGraw Hill. USA.

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

BS 4th Year

Semester-VII

Semester-VII			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 471**	**Specialization Paper-I**	3
Major	**CHEM 472**	**Specialization Paper-II**	3
Major	**CHEM 473**	**Specialization Paper-III**	3
Major	**CHEM 474**	**Environmental Chemistry-I**	3
Major	**CHEM 475**	**Field Experience/Internship:**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**15**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 4th Year
Semester-VII (ANALYTICAL CHEMISTRY)
Specialization Paper-I
Course Title: ATOMIC SPECTROSCOPY
Course Code: CHEM 471
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about theoretical aspects and instrumentation of different atomic spectroscopic methods as well as learn about the applications of these techniques in the field of chemical sciences.

Course Contents:
Flame Photometry: Origin and classification of atomic spectroscopic methods, origin of atomic spectrum, position of the signal, intensity of the signal, spectral line width, principle of flame photometry, fate of the sample in the flame, flame and its characteristics, instrumentation for flame photometry, merits and limitations.
Atomic Fluorescence Spectrometry: Origin of atomic fluorescence, atomic fluorescence spectrum, types of atomic fluorescence transitions, principle of atomic fluorescence spectrometry, fluorescence intensity and analyte concentration, instrumentation for atomic fluorescence spectrometry, applications of atomic fluorescence spectrometry, interferences, merits and limitations.
Atomic Absorption Spectrophotometry: Principle of atomic absorption spectrophotometry, concentration dependence of absorption, quantitative methodology, instrumentation for atomic absorption spectrophotometry, radiation sources, atomizers, flames, graphite furnaces and electrochemical atomizers, monochromators, detectors, handling background absorption, interferences in atomic absorption spectrophotometry, sample handling in atomic absorption spectrophotometry, preparation of the sample, use of organic solvents, microwave, digestion, sample introduction methods, applications of atomic absorption spectrophotometry.
Atomic Emission Spectrophotometry: Introduction, principle of atomic emission spectrometry, atomic emission spectrometry using plasma sources, plasma and its characteristics, inductively coupled plasma, direct current plasma, microwave induced plasma, choice of argon as plasma gas, instrumentation for ICP-MS.

Recommended Books:

1. Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, (2011).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Academics)
University of Malakand
05-Dec-2023

3. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry*, Bios Scientific Publishers Limited, Oxford, UK, (2002).
4. Sharma, B. K., *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Skoog, D. A. and West., D. M., *Fundamentals of Analytical Chemistry*, 8th ed., Hot Reinehart Inc., London, (2008).
6. Ebdon, L., Evaus, E.H, Fischer, A., and Hill, S.J., *An Introduction to Analytical Atomic Spectrometry*, John Wiley & Sons, England. (1998).
7. Bernhard Welz, Michael Sperling, *Atomic Absorption Spectrometry*, 3rd ed., Wiley-VCH, Germany, (1998).
8. Farrukh, M. A., *Atomic Absorption Spectroscopy*, In Tech, (2012).
9. Kellner, R., Mermet, J. M, Otto, M., Valcarcel, M., Widmer, H.M., *Analytical Chemistry: A Modern Approach to Analytical Science*, Wiley-VCH, (2004)

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (ANALYTICAL CHEMISTRY)
Specialization Paper-II
Course Title: ELECTROANALYTICAL TECHNIQUES
Course Code: CHEM 472
Credit Hours: 3

Course Objectives:
Students will acquire sound knowledge regarding the theoretical, instrumental as well as application related aspects of different electroanalytical techniques

Course Contents:
Potentiometry: Electrode potential, Nernst equation and its use for measuring half-cell potential, different kinds of electrodes including glass and calomel electrodes, working of potentiometer and its applications including pH measurements, Ion selective electrode systems, Ion exchange membrane electrode, solid state membrane electrodes, and bio-membrane electrodes, Potentiometric titrations.
Coulometry and Electrogravimetry: Basic electrochemistry, principle, instrumentation of coulometry, principle, instrumentation of electrogravimetry, consequences of electrogravimetry, Ohmic drop, activation over potential, concentration and gas polarization, basic difference and merits/demerits of coulometry and electrogravimetry.
Voltammetry and Polarography: Basic principle, voltammogram, polarizable and non-polarizable electrodes, solid electrodes, their scope and limitations, cyclic voltammetry, anodic stripping voltammetry. voltammetric equation, basic concept of polarography and interpretation of various polarographic curves, measurement of decomposition potential, diffusion and limiting currents, derivation of Ilkovic equation, logarithmic analysis of polarographic wave, advantages and limitation of dropping mercury electrode.

Recommended Books:

1. Christian, G. D., Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., Quantitative Chemical Analysis 8th ed., W.H. Freeman and Company, New York, (2009).
3. Kealey, D. and Haines, P. J., BIOS Instant Notes in Analytical Chemistry,
4. Bios Scientific Publishers Limited, Oxford, UK, (2002).
5. Sharma, B. K., Instrumental Methods of Chemical Analysis, 24th ed., Goel Publishing House, Meerut, India, (2005).
6. Skoog, D. A. and West, D. M., Fundamentals of Analytical Chemistry, 8th ed., Hot Reinehart Inc., London, (2008).
7. Fritz, Schulz, Electroanalytical Methods: Guide to Experiments and Applications. 2nd revised, Springer-Verlag Berlin, Germany, (2010).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (ANALYTICAL CHEMISTRY)
Specialization Paper-III
Course Title: ADVANCED SEPARATION TECNIQUES
Course Code: CHEM 473
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about the principles and instrumentation of advanced chromatographic techniques namely GLC, HPLC and capillary electrophoresis along with their applications in different fields such as food, pharmaceuticals, petroleum, environmental and other industrial sectors.

Course Contents:
Introduction: Classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency.
Gas Liquid Chromatography: General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.
HPLC: General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.
Capillary electrophoresis: Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning, (2013).
2. Christian, G. D., Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).
3. Kealey, D. and Haines, P. J., BIOS Instant Notes in Analytical Chemistry,
4. 1st ed., Taylor & Francis, (2002).
5. Sharma, B.K. Instrumental Methods of Chemical Analysis, 24th ed., Goel Publishing House, Meerut, India, (2005).
6. Grob, R. L., Eugene, F. Barry, Modern Practice of Gas Chromatography,
7. 4th ed., John-Wiley & Sons, USA, (2004).
8. Kellner, R., Mermet, J-. M., Otto, M., Valcarcel, M. and Widmer, H. M., Analytical Chemistry: A Modern Approach to Analytical Science, Wiley-VCH, (2004).
9. Meyer, V. R., Practical High-Performance Liquid Chromatography, 5th ed., John-Wiley & Sons, Ltd., (2010).
10. Lindsay, S., High Performance Liquid Chromatography, 2nd ed., John- Wiley & Sons, Ltd., (1992).
11. Braitwaite, A. and Smith, F. J., Chromatographic Methods, 5th ed., Kluwer Academic Publishers, (1999).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (APPLIED CHEMISTRY)
Specialization Paper-I
Course Title: COMMON INDUSTRIES-I
Course Code: CHEM 471
Credit Hours: 3

Course Objectives:

Students will acquire knowledge and technical know-how about sugar manufacturing industry, starch production industry and leather tanneries.

Course Content

Sugar Industry: Scope of sugar industry, Manufacture of raw sugar from cane and beet, refining of raw sugar, Methods of clarification of cane juice and chemistry involved in the clarification processes, Defecation Remelt Carbonation (DRC), Defecation Remelt Sulphitation (DRS), Defecation Remelt Phosphitation (DRP) and Double Carbonation Double Sulphitation (DCDS), Utilization of by-products of sugar industry.

Starch Industry: Scope of starch industry, Raw materials for starch production, Manufacture of starch from various raw materials such as corn, rice, wheat, potatoes, Industrial applications of starch, Chemistry involved in the conversion of starch, Synthesis of d-glucose and dextrin from starch.

Leather Industry: Leather, gelatin and adhesives, Preparation of hides, Methods of tanning, vegetable and chrome tanning processing of leather, Production of glue and gelatin.

Recommended Books:

1. Rao, G. P., Mogarey, R. C., Solomn, S., Rewal, S. S. and Li, Y-., Sugar Cane: Production Managemnet and Agro-Industrial Imperatives, Ibdc Publisher, (2005).
2. Covington, A. D., Tanning Chemistry: The Science of Leather, Royal Society of Chemistry, (2009).
3. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/ Plenum Publishers, (2003).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (APPLIED CHEMISTRY)
Specialization Paper-II
Course Title: AGRO BASED INDUSTRIES AND POLLUTION CONTROL
Course Code: CHEM 472
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about various fertilizers, pesticides and herbicides used in agriculture sector as well as know about the environmental pollution and its protection.

Course Contents:
Fertilizers: Importance of chemical fertilizers, classification of chemical fertilizers, manufacture and chemistry involved in the production of various fertilizers i.e., Urea, Single Super phosphate (SSP), Triple superphosphate (TSP), Nitrophos (NP), Diammonium phosphate (DAP), Calcium ammonium nitrate (CAN), Ammonium nitrate (AN), Ammonium sulphate (AS), Zinc sulphate (ZS) and Complex fertilizers.
Agrochemicals: Classification of pesticides, formulation and toxicity of pesticides, future trends of pest control, control of weeds, household agrochemicals, plant growth regulators and background chemistry, hazards associated with the use of agrochemicals and environmental aspects.
Industrial Pollution and Its Abatement: Sources of air, water and soil pollution, Industrial waste control for the protection of environment, modern trends of waste management.

Recommended Books:

1. Afonso, C. A. M. Crespo, J. P. G. and Anastas, P. T., Green Separation Process: Fundamentals and Applications, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, (2005).
2. Manahan, S. E., Fundamentals of Environmental Chemistry, 2nd ed., CRC Press, (2001).
3. Lister, J. and Ennis, B., The Science and Engineering of Granulation Processes, Kluwer Academic Publishers, (2004).
4. Park, M., The Fertilizer Industry, Woodhead Publishing Limited, (2001).
5. Anastas, P. T. and Warmer, J. C., Green Chemistry: Theory and Practice, Oxford University Press, (2000).
6. Kumar, A., Industrial Pollution: Problems and Solution, Daya Publishing House, India, (2006).
7. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/ Plenum Publishers, (2003).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester- VII (APPLIED CHEMISTRY)
Specialization Paper-III
Course Title: COMMON INDUSTRIES-II
Course Code: CHEM 473
Credit Hours: 3

Course Objectives:

Students will acquire knowledge for extraction, production and processing oil, fats and waxes. They will also gain knowledge about soap and detergent industries as well as surface coating industries.

Oils and Fats: Oils, Fats and Waxes, extraction of oils such as soya bean and cotton seed oils, purification and refining of oils, chemistry involved in the production of vegetable ghee, selective hydrogenation of oil and fats during the manufacture of vegetable ghee, inter-esterification of crude fats.

Soaps and Detergents: Raw materials for the manufacture of soap and detergents, chemistry involved in the production of soap and detergents, action of builders, additives brighteners and surfactants, cleansing action of soaps, effect of acidic species and hard water on soap, Production of transparent soap.

Paints: Raw materials for paints and pigments, classification and properties of surface-coating constituents, classification and manufacture of pigments, production of paints, varnishes, distempers, enamels and lacquers, chemistry involved in the drying phenomena of paints, drying oils for paint and classification of drying oils.

Recommended Books:

1. Vermani, O. P, Narula, A.K, Applied Chemistry, Theory and Practice, 2nd ed., New Age International. Publisher, India, (1995).
2. Balasaraf, V. M, Applied Chemistry, I. K. International House Pvt. Ltd, India, (2009).
3. P. K. Chattopadyay, Modern Technology of Soaps, Detergents and Toilries: with formulae and project profile, 2nd ed., National Institute of Industrial Research, India, (2003).
4. Bockisch M., Fats and Oils Handbook, American oil Chemists and Society, (1998).
5. Gunstone F., Oils and Fats in Food Industry, Wiley Black Well, (2008).
6. Gunstone F., Vegetable Oil in Food Technology: Composition, Properties and Uses, John-Wiley & Sons, (2011).
7. Lambourme, R., Strivens, T.A., Paint and Surface Coatings: Theory and Practice, 2nd ed., Woodhead Publishing Limited, (1999).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

8. Board. B, Paint, Pigment, Solvent, Coating, Emulsion, Paint additives and formulations, Engineers India Research Incorporation, (2008).
9. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/Plenum Publishers, (2003).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VII (INORGANIC CHEMISTRY)
Specialization Paper-I
Course Title: INORGANIC REACTION MECHANISM
Course Code: CHEM 471
Credit Hours: 3

Course Objective:

Students will acquire know-how and understanding about different mechanisms of inorganic reactions and their applications towards understanding different types of complexes.

Course Contents:

Classification of reaction mechanisms; rate laws; steady state approximation; inert and labile complexes; substitution reactions in octahedral complexes and square planar complexes, acid hydrolysis, base hydrolysis, steric effects of inert ligands, nucleophilic reactivity, trans-effect, *cis*-effect, racemization reactions. Mechanism of electron transfer reactions, oxidation reduction reactions of metal ions, outer and inner sphere mechanisms, factors affecting rate of electron transfer reactions, two electrons transfer reactions, complementary or non-complementary electron transfer reactions, oxidative addition, addition of oxygen, hydrogen, HX, organic halides and bimetallic species, Reductive Elimination Reactions.

Recommended Books:

1. Huheey, J. E., Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
2. Shriver, D. F., Atkins, P. W., Inorganic Chemistry, 3rd ed., Oxford University Press, (2001).
3. Wilkins, R. G., Kinetics and Mechanism of Reactions of Transition Metal Complex, 2nd ed., (Rev.), Wiley-VCH, (1991).
4. Jolly, W. L., Modern Inorganic Chemistry, 2nd ed., McGraw-Hill Company, (1991).
5. Jordan, R. B., Reaction Mechanisms of Inorganic and Organometallic Systems, 2nd ed., Oxford University Press, New York, (1998).
6. Atwood, J. D., Inorganic and Organometallic Reaction Mechanisms, 2nd ed., Wiley-VCH, Inc., (1997).
7. Sharma, S. K., Inorganic Reaction Mechanisms, Discovery Publishing House, (2007).

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Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 4th Year
Semester-VII (INORGANIC CHEMISTRY)
Specialization Paper-II
Course Title: π- ACEPTOR LIGANDS AND INORGANIC POLYMERS
Course Code: CHEM 472
Credit Hours: 3

Course Objective:

Student will acquire sound knowledge about π--acceptor ligands and different types of inorganic polymers.

Course Contents:

π-Acceptor Ligands: Introduction to π-acceptor ligands, effective atomic number (EAN) rule and chemistry of metal carbonyls, nitrosyls, and isocyanides, structure elucidation based on spectroscopic evidence, applications and uses of metal carbonyls and their derivatives for catalysis and organic synthesis.

Inorganic Polymers: Introduction to homoatomic and heteroatomic inorganic polymers, chains and cages of boron, silicon, nitrogen, phosphorous and sulphur, synthesis and applications, Polyionic species, Isopoly and heteropoly, anions of transition metals, silicates, borates, condensed phosphates, zeolites.

Recommended Books:

1. Brady, J. E., and Sense, F., Chemistry-The Study of Matter and Its Changes, 5th ed., Wiley Plus, (2009).
2. Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 4th ed., Prentice-Hall International, New Jersey, USA, (2010).
3. Douglas, B., McDanial, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons, New York, (1994).
4. Huheey, J. E., Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
5. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).
6. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).
7. Atkins, P. and Jones, L., Chemicals Principles: The Quest for Insight, 5th ed., W. H. Freeman, (2010).
8. Mandelkern, L., An Introduction to Macromolecules, 2nd ed., Springer Verlag, New York, (1983).
9. Ravve, A., Principles of Polymer Chemistry, 2nd ed., Plenum Publishers, (2000).
10. Crabtree, R. H., The Organometallic Chemistry of the Transition Metals, 5th ed., John-Wiley and Sons, New Jersey, (2011).
11. Yamamoto, A., Organotransition Metal Chemistry, Prentice Hall, (1992).

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Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (INORGANIC CHEMISTRY)
Specialization Paper-III
Course Title: INORGANIC SPECTROSCOPY
Course Code: CHEM 473
Credit Hours: 3

Course Objectives:

Students will acquire understanding about various types of transitions (e. g. d- d transition, charge transfer) occurring in transition metal compounds and to characterize new compounds by application of electronic spectroscopy.

Course Contents:

Electronic States of transition metal complexes, Russel-Sander's coupling scheme, derivation of term symbols for d1-d10 systems, d-d transitions, connecting atomic states and molecular states, correlation diagrams, Tanabe - Sugano diagrams, calculation of 10Dq values, High-spin and low-spin molecules, Jahn-Teller effect, applications of subgroups, selection rules for electronic transitions in molecules, LMCT and MLCT transitions, some examples involving different geometries.

Recommended Books:

1. Yarwood, J., Bazin, P., and Douthwaite, R., Spectroscopic Properties of Inorganic and Organometallic Compounds, Volume 42, The Royal Society of Chemistry, UK, (2011).
2. Lever, A. B. P., Inorganic Electronic Spectroscopy, 2nd ed., Elsevier, UK, (1984).
3. Brisdon, A. K., Inorganic Spectroscopic Methods, Oxford University Press, UK, (1998).
4. Solomon, E.I., Inorganic Electronic Structure and Spectroscopy: Methodology, Volume 2, Wiley, New York, (1999).

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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
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University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (ORGANIC CHEMISTRY)
Specialization Paper-I
Course Title: HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS
Course Code: CHEM 471
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about C-Hetero atom bond with emphasis on how it is formed and how it reacts. The importance and applications of compounds containing hetero atom should also be discussed.

Course Contents:

Aromatic Heterocycles: Structure, classification and nomenclature; aromaticity; basicity and acidity of the nitrogen heterocycles; synthesis and reactions, chemistry of furan, pyrrole and thiophene, pyridine.

Organometallic Compounds: Principles, organomagnesium, organolithium, organocopper, organocadmium, organomercury and organozinc compounds: their structure and reactivity, methods of preparation and synthetic applications.

Chemistry of organic compounds containing sulfur, phosphorus, boron and silicon: synthesis, reactions and application.

Recommended Books:

1. Claydem, J., Greeves, N. and Warren, S., Organic Chemistry, 2nd ed., Oxford University Press, (2012).
2. Coxon, J. M. Norman, R. O. C., Principles of Organic Synthesis, 3rd ed., CRC Press, (1993).
3. Joule, J. A., Mills, K., Heterocyclic Chemistry, 5th ed., John-Wiley & Sons, UK, (2010).
4. Crabtree, R. H., The Organometallic Chemistry of the Transition Metals, 5th ed., John-Wiley & Sons, New Jersey, (2009).

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Assistant Registrar
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05-Dec-2023

Major

BS 4th Year
Semester-VII (ORGANIC CHEMISTRY)
Specialization Paper-II
Course Title: REACTIVE INTERMEDIATES
Course Code: CHEM 472
Credit Hours: 3

Course Objectives:

Students will acquire knowledge regarding the rearrangement reactions and their types including some name reactions, and different intermediates involved in organic reactions. Students are expected to learn the underlying concepts and synthetic applications.

Course Contents:

Reactive Intermediates: Carbocations, carbanions, free radicals, carbenes, nitrenes, and arynes, their generation, stability, reactions and synthetic applications. Chemistry of Enolates and Enols: Acidity of carbonyl compounds, enolization of carbonyl compounds, α-halogenation of carbonyl compounds; aldol-addition and aldol-condensation, condensation reactions involving ester enolate ions, alkylation of ester enolate ions.

Rearrangement Reactions: Types of rearrangements, general mechanisms of nucleophilic, free radical and electrophilic rearrangements, hydrogen and/or carbon migration to electron-deficient carbon, nitrogen and oxygen, carbon migration to electron- rich carbon, aromatic rearrangements, inter- and intra-molecular carbon migration from oxygen to carbon.

Recommended Books:

1. Clayden, J., Greeves, N. and Warren, S., Organic Chemistry, 2nd ed., Oxford University Press, (2012).
2. Coxon, J. M. and Norman, R.O.C., Principles of Organic Synthesis, 3rd ed., Chapman and Hall, UK, (1993).
3. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed., Brooks/Cole Learning, (2012).
4. John, E. M., Organic Chemistry, 8th ed., Brooks/Cole Publishing Co., USA, (2012).
5. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).

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University of Malakand

Assistant Registrar
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05-Dec-2023

Major

BS 4th Year
Semester-VII (ORGANIC CHEMISTRY)
Specialization Paper-III
Course Title: ORGANIC SPECTROSCOPY
Course Code: CHEM 473
Credit Hours: 3

Course Objectives:

Students will acquire an adequate knowledge about fundamental and instrumental aspects of different spectroscopic techniques and will be able to perform structural elucidation of organic compounds using spectral data.

Course Contents:

UV-Visible: Basic concepts, electronic transitions, Lambert-Beer's law, factors influencing the lambda max (λ_{max}) values, Woodward rules for calculation of wavelength values.

IR spectroscopy: Basic concepts, absorption mechanisms, functional group determination and factors affecting the absorption frequencies.

^{1}H-NMR and ^{13}C-NMR: Chemical shift, factors affecting chemical shift, spin relaxation, spin-spin coupling, coupling constants, nuclear overhauser effect, 2-D NMR, COSY and HETCOR.

Mass Spectrometry: Basic concepts; mass spectrometers, ionization techniques, different fragmentation patterns and structure elucidation, combined usage of IR, UV, NMR and Mass spectrometric data for structure elucidation of organic compounds having medium complexity.

Recommended Books:

1. Mohan, J., Organic Analytical Chemistry: Theory and Practice, 1st ed., Alpha Science Int. Ltd., (2003).
2. Kalsi, P. S., Spectroscopy of Organic Compounds, 6th ed., New Age International, New Delhi, India, (2007).
3. Yadav, L. D. S., Organic Spectroscopy, Springer, UK, (2005).
4. Kemp, W., Organic Spectroscopy, 3rd ed., W. H. Freeman & Company, New York, USA, (1991).
5. Younas, M., Organic Spectroscopy, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).
6. Hollas, J. M., Modern Spectroscopy, 4th ed., John-Wiley & Sons, Inc., (2004).
7. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., Introduction to Spectroscopy, 4th ed., Brooks/ Cole Cengage Learning, (2009).
8. Silverstein, R. M., Webster, F. X. and Kiemle, D., Spectrometric Identification of Organic Compounds, 7th ed., John-Wiley & Sons, Inc., (2005).
9. Williams, D. H. and Flemming, I., Spectroscopic Methods in Organic Chemistry, 6th ed., McGraw-Hill Higher Education, (2008).

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University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (PHYSICAL CHEMISTRY)
Specialization Paper-I
Course Title: ELECTROCHEMISTRY & STATISTICAL THERMODYNAMICS
Course Code: CHEM 471
Credit Hours: 3

Course Objectives:

Students will develop understanding of the electrochemical processes, thermodynamic principles and mechanisms involved in aqueous salt solutions as well as colloidal solutions. In the second part of the course, students will acquire knowledge about the molecular level treatment of the thermodynamic functions/properties using partition functions and Boltzmann statistics.

Electrochemistry: Electrical double layer, interface, Outer Helmholttz Plane and Inner Helmholttz Plane , contact adsorption, Gibbs Surface Excess, potential differences across metal solution interfaces, outer and surface potential differences, galvanic potential difference, electrochemical potential difference, interfacial tension, electro-capillary thermodynamics, Lippmann's equation, Helmholtz-perrin model, Gouy Chapmann model, Stern model of electrical double layer, differential capacitance, the Capacitance hump. Electrochemical devices, charge transfer processes in the absence and presence of electrical field, the over potential, the symmetry factor, high field and low field approximation, cyclic voltammetry and its applications,

Statistical Thermodynamics: Description of various systems, Concepts of states, accessible states and distribution, Probability concepts, Maxwell-Boltzmann's statistics for the systems of independent particles, Partition functions, The relationship of partition function to the various thermodynamic functions, Transitional, vibrational and rotational partitional functions and equilibrium constant, Statistical thermodynamics, Applications to equilibrium and chemical kinetics, Bose-Einstein's and Fermi-Dirac's statistics.

Recommended Books:

1. Gasser, R. P. H., Entropy and Energy Level, Rev. ed., Oxford University Press, New York, (1986).
2. Wayatt, P. A. H., The Molecular Basis of Entropy and Chemical Equilibrium, Royal Institute of Chemistry London, UK, (1971).
3. Bockris J. O. M., and Reddy, A. K. N., Modern Electrochemistry: Ionics, Vol. I, 2nd ed., Plenum Press, London, (1998).
4. Seddon, J. M. and Gale, J. D., Thermodynamics and Statistical Mechanics, Royal Society of Chemistry, (2001).
5. Engel, T., Reid, P., Thermodynamics, Statistical Thermodynamics, and Kinetics, 3rd ed., Prentice Hall, (2012).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

6. Bard, A. J. and Faulkner, L. R., Electrochemical Method: Fundamentals and Applications 2nd ed., John-Wiley & Sons, New York, (2001).
7. Kondepudi D., Introduction to Modern Thermodynamics, John-Wiley & Sons, (2008).
8. Hamann, C. H., Hamnett, A. and Veilstich, W., Electrochemistry, 2nd ed., Wiley-VCH Verla Gnb H and Co. KGaA, (2007).
9. Braun R. D. and Walters F., Application of Chemical Analysis, MCGraw-Hill, (1982)
10. McQuarrie, D. A., Statistical Mechanics, Viva Books Private Ltd. (2008).

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University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VII (PHYSICAL CHEMISTY)
Specialization Paper-II
Course Title: POLYMER CHEMISTRY
Course Code: CHEM 472
Credit Hours: 3

Course Objectives:

Students will learn the fundamental principles of polymerization, synthesis methods and reaction mechanisms, thermodynamic and kinetic aspects of the polymerization, and physical and mechanical properties of polymers. Students will also know about the polymer characterization techniques and various applications of polymers.

Polymer Chemistry: Introduction to Polymers, Application of polymers in Chemical Industries, Properties of polymers. Classification of polymers-classification based on sources (Natural and inorganic), classification based on the structure, classification based on mode of polymerization (Addition or chain reaction, condensation or step growth polymerization), Classification based on molecular forces (elastomers, fibers, thermoplastic and thermosetting polymers), Kinetics of polymer chain growth. Co-polymerization and its types-Alternating, Random, Block and periodic co-polymers, form of copolymers.

Introduction to surfactants-Classification and its uses, Manufacture, micelle and its formation. Emulsion polymerization-ingredients, stages of emulsion polymerization, Applications.

Physical aspects of polymers-molecular weight of polymers and methods of determination by viscosity, optical rotation method. Chain isomerism, stereochemistry, configurations, conformation, amorphous state of polymers, dynamics in the amorphous state, mechanical models of polymer behavior, polymer rheology.

Chairman
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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Recommended Books:

1. Sperling, L. H. Introduction to Physical Polymer Science, 4th ed., Wiley-Interscience, New York, USA, (2006).
2. Boyd, R. H. and Phillips, P. J., The Science of Polymer Molecules, Cambridge, UK, (1993).
3. Odian, G., Principles of Polymerization, 4th ed., Wiley Interscience, (2004).
4. Carraher Jr, C. E., Carraher's, Polymer Chemistry, 8th ed., CRC Press, Inc., (2010).
5. Ravve, A., Principles of Polymer Chemistry, 3rd ed., Springer, (2012).
6. Stevens, M. P., Polymer Chemistry: An Introduction, 3rd ed., Oxford University Press, (1998).
7. Allcock, H., Lampe, F. and Mark, J., Contemporary Polymer Chemistry, 3rd ed., Prentidl Hall, (2003).

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University of Malakand

Assistant Registrar
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University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VII (PHYSICAL CHEMISTRY)
Specialization Paper-III
Course Title: QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY
Course Code: CHEM 473
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about quantum chemistry including Schrödinger wave equation and its applications to define the behavior and properties of different systems. In addition, they will learn about different molecular spectroscopic techniques.

Course Contents:

Quantum Chemistry: Operators and their properties, Schrödinger wave equation, particle in a box and a ring, quantum mechanical tunneling, angular momentum, postulates of quantum mechanics, central field problem, approximate methods, perturbation methods and variation principle, many electron systems, treatment of simple harmonic oscillator, diatomic rigid rotor, valence bond and molecular orbital theories, Hũckel method for pi-electron approximation in aromatic compounds.

Molecular Spectroscopy: Interaction of electromagnetic radiation with matter, symmetry properties of molecules, microwave and infrared spectroscopy, rotational, vibrational and rotational-vibrational spectra of diatomic and polyatomic molecules, electronic spectra of simple molecules, nuclear magnetic resonance spectroscopy.

Recommended Books:

1. Fayer, M. D., Elements of Quantum Mechanics, Oxford University Press, London, UK, (2001).
2. Becker, E. D., High Resolution NMR; Theory & Chemical Application, 3rd ed., Academic Press, New York, USA, (2000).
3. Graybeal, J. D., Molecular Spectroscopy, 1st ed., McGraw-Hill, New York, (1988).
4. Hayward, D. O., Quantum Mechanics for Chemists, Royal Society of Chemistry, (2002).
5. House, J. E., Fundamentals of Quantum Mechanics 2nded., Elsevier Academic Press, New York, USA, (2004).
6. Kirsten, H. J. W. M., Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral 1st ed., World Scientific Publishing Co. Pvt. Ltd., (2006).
7. Barrow, G. M., Physical Chemistry, 6th ed., McGraw-Hill Book Company, (1996).
8. Straughan, B. P., and Walker, S., Spectroscopy, Vol. 1 and 2., Chapman and Hall Ltd., (1976).

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Department of Chemistry
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Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations)
University of Malakand
05-Dec-2023

Major

BS 4th YEAR
SEMESTER-VII
COURSE TITLE: ENVIRONMENTAL CHEMISTRY-I
COURSE CODE: CHEM 474
CREDIT HOURS: 3

Course Objectives:

This course will enable the students to understand various types of energy sources and the types of air pollution. They will also understand the soil and mineral resources.

Course Contents:

1. Fossil Fuels and Energy Sources:

Origin and development of coals: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, environmental problems associated with petroleum, nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conversion of free energy, the energy balance of the earth.

2. The Atmosphere and Air Pollution:

Structure and properties of the atmosphere, temperature inversion and air pollution, atmospheric photochemistry, possible depletion of stratospheric ozone, natural Vs. polluted air, particulate matter, analysis and control of particulates, Sulphur oxides, effects of Sulphur oxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen, photochemical smog, airborne lead, control of automobile emissions.

3. Soil and Mineral Resources:

Estimating reserves of mineral resources of earth. Extraction of metal-general principles, iron, steel, aluminum, copper and other metals, Sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Recommended Books:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. J.W. Moore & E.A. Moore, Environmental Chemistry, Academic Press, New York.
3. S.K. Banerji, Environmental Chemistry, Prentice Hall, Delhi.
4. S.K. Banerji, Environmental Chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental Chemistry, Brooks, California.

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Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

BS 4th Year

Semester-VIII

Semester-VIII			
Category	**Code**	**Title**	**Cr. Hrs.**
Major	**CHEM 481**	**Specialization Paper-IV**	3
Major	**CHEM 482**	**Specialization Paper-V**	3
Major	**CHEM 483**	**Specialization Paper-VI**	3
Major	**CHEM 484**	**Environmental Chemistry-II**	3
Major	**CHEM 500**	**Capstone Project/Thesis**	3
	The Teaching of Holy Quran with Translation		Non-Credit
Total Credit Hours: Minimum 15-18			**15**

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VIII (ANALYTICAL CHEMISTRY)
Specialization Paper-IV
Course Title: LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS
Course Code: CHEM 481
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about the theoretical and instrumental aspects of luminescence spectroscopy and thermal techniques of analysis in addition to learning about their applications.

Course Contents:

Luminescence Spectrophotometry: Introduction, origin of fluorescence and phosphorescence spectra, Jablonski diagram, activation, deactivation, fluorescence spectrum, fluorescent and phosphorescent species; photoluminescence and structure, factors affecting fluorescence and phosphorescence, fluorescence quenching, quantum yield, instrumentation for fluorescence measurement, sources, wavelength selectors, sampling, detectors, read out devices, instrumentation for phosphorescence measurement, sampling, recording procedure, applications of fluorescence and phosphorescence.

Thermal Methods of Analysis: Introduction, instrumentation, sources of errors, interpretation of data, Factors affecting curve, applications of TGA, DTA and DSC.

Recommended Books:

1. Christian, G. D., Analytical Chemistry. 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Braun, R. D., Introduction to Chemical Analysis, International Student Edition, (1985).
4. Haines, P. J., Whitby, On Canada Mcgraw Hill Ltd., Thermal Methods of Analysis Principles, Applications and Problems, 1st ed., Springer, (1995).
5. Lakowicz, J. R., Principles of Fluorescence Spectroscopy, 3rd ed., Springer (2006).
6. Gabbot, P., Principles & Applications of Thermal Analysis, Wiley-Blackwell, (2007).
7. Brown, M. E., Introduction to Thermal Analysis: Techniques and Applications, 2nd ed., Kluwer Academic Publishers, (2001).
8. Skoog, D. A., West, D. M. and Holler, F. J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 8th ed., (Int.), Cengage Learning, (2004).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VIII (ANALYTICAL CHEMISTRY)
Specialization Paper-V
Course Title: NUCLEAR ANALYTICAL TECHNIQUES
Course Code: CHEM 482
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about different nuclear analytical techniques with special emphasis on the theoretical, instrumental and applications

Course Contents:

Radiotracer techniques, choice of radiotracers, factors affecting choice of radiotracers, isotope dilution analysis (IDA), principle and equation, instrumentation, applications, advantages and limitations, sub-stoichiometric isotope dilution analysis (SIDA), activation analysis (AA), principle of NAA, neutron sources, interferences, sensitivity and detection limits, classification, instrumentation, applications, advantages and limitations, comparison of NAA and IDA with other methods, radiometric titrations (RT), procedure, advantages and limitations, radio chromatography and radioimmunoassay.

Recommended Books:

1. Friedlander, G., Kennedy, J. W., Macias, E. S. and Miller. M. J., Nuclear and Radiochemistry, 3rd ed., Wiley, New York, (1981).
2. Arnikan, H. J., Essentials of Nuclear Chemistry, 4th ed., New Age International Pvt. Ltd. (1995)
3. Harvey, B. G., Nuclear Physics and Chemistry, 2nd ed., Prentice Hall Inc., (1969).
4. Naqvi, I. I., Farrukh, M. A Radiotracers in Chemical Applications: Radiochemistry, VDM Verlog Dr. Muller, (2010).

Chairman
Department of Chemistry
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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 4th Year
Semester-VIII (ANALYTICAL CHEMISTRY)
Specialization Paper-VI
Course Title: FOOD AND DRUG ANALYSIS
Course Code: CHEM 483
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about sample preparation, derivations and analysis of different types of foods, pharmaceuticals and forensics.

Course Contents:

Food Products: Introduction to food analysis, sampling of food, general methods of analysis. Analysis of milk, butter, wheat flour, meat, beverages, tea, coca, honey and soft drinks.

Pharmaceuticals: Classification of drugs, tests for analysis of different pharmaceuticals, introduction to US and British pharmacopeia.

Forensics: History and scope of Forensic Science, Forensic Ethics, Forensic Toxicology. Classification and analysis of narcotics & dangerous drugs, examination of crime scene evidence, fingerprinting, skeletal material to provide scientific opinion for legal.

Recommended Books:

1. Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry, 7th ed., Saunders College Publishing, (1995).
2. Christian, G. D., Analytical Chemistry, John-Wiley & Sons, Inc., 6th ed., (2004).
3. Eckert, W. G., Introduction to Forensic Science, 2nd ed., CRC Press, (1997).
4. Nielsen, S. S., Food Analysis, 4th ed., Springer, (2010).
5. Thomas, G., Medicinal Chemistry: An Introduction, 2nd ed., John-Wiley & Sons, (2007).
6. Kobilinsky, L. F., Forensic Chemistry Handbook, 1st ed., John-Wiley & Sons, USA, (2012).
7. Watson, D. G., Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists, Elsevier, (2012).
8. Stuart H. Barbara, "Forensic Analytical Techniques", 1st ed., John-Wiley & Sons, (2013).
9. Jackson, A. R. W. and Jackson, J. M., Forensic Science, 2nd ed., Pearson Education, (2008).

Chairman
Department of Chemistry
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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BSc 4th Year
Semester-VIII (APPLIED CHEMISTRY)
Specialization Paper-IV
Course Title: ORGANIC BASED INDUSTRIES
Course Code: CHEM 481
Credit Hours: 3

Course Objectives:

Students will acquire knowledge to understand the structure, mechanism, properties and synthesis of various polymers. The course will also provide technical know- how about perfumes and cosmetics and surface coating industries.

Course Contents:

Paper and Pulp: Raw materials for pulp and paper industries, classification of paper products, chemistry involved in the processing of Kraft pulp, sulphite pulp and semi-chemical pulp, manufacture of paper and regeneration of spent liquor.

Polymers: General classification and characterization of polymers, mechanism and chemistry of polymerization, thermoplastic and thermosetting polymerization, A brief outline for the production and applications of polymers i.e., polyethylene, polystyrene, polyurethanes, polyesters and urea phenol formaldehyde resins, and production of drug delivery polymers.

Cosmetics and Perfumes: Chemistry and production of hair products and shampoos, chemistry involved in hair curling and styling products, hair tonics and depilatory products, production of cold cream, vanishing cream, bleach cream and shaving creams, toothpaste and face powders, production of nail polish, lipsticks and mascaras.

Recommended Books:

1. Odian, G., Principles of Polymerization, 4th ed., John-Wiley & Sons, Inc., (2004).
2. Carraher, C. E. Jr., Polymer Chemistry, 6th ed., Marcel Dekker Incorporation, New York, (2003).
3. Roussak, D. V., Gesser, H. D., Applied Chemistry; A Textbook of Engineers and Technologists, 2nd ed., Springer, (2013).
4. Bajpai, P., Environmentally Friendly Production of Pulp and Paper, John- Wiley & Sons, Inc., (2010).
5. Schueller, R. and Romanowski, P., Beginning Cosmetic Chemistry: Practical Knowledge for the Cosmetic Industry, 3rd ed., Allured Publishing Corporation, (2009).
6. Barel, A. O., Paye, M. and Maibach, H. I., Handbook of Cosmetic Science and Technology, 3rd ed., Informa Healthcare, (2009).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Academics)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VIII (APPLIED CHEMISTRY)
Specialization Paper-V
Course Title: INDUSTRIAL PROCESSES
Course Code: CHEM 482
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about pharmaceutical industries and nuclear industries as well as about oil refinery and production of various petrochemicals.

Course Contents:
Pharmaceuticals: Classification of pharmaceutical products and pharmaceutical processing, manufacture of paracetamol and aspirin, chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.
Petroleum and Petrochemicals: Origin of petroleum, constituents and classification of petroleum, cracking and distillation of various fractions in distillation towers, control of distillation tower in refinery, manufacture of monomers such as acetylene, ethylene, propylene, separation and purification of benzene, toluene and xylene.

Recommended Books:

1. Austin, G. T., Nelson, W. L., Petroleum Refinery Engineering, 4th ed., Aukland. Mcgraw Hill, (1985).
2. Shreve, R. M., George, T. A., Shreve's Chemical Process Industries, 5th ed., McGraw-Hill Book Company Inc., New York, (1984).
3. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10h ed., Kluwer Academic/Plenum publishers, (2003).
4. Vermani, O. P., Narula. A. K, Applied Chemistry, Theory and Practice, 2nd ed., New Age International Publisher, India, (1995).
5. D. G. Watson, Pharmaceutical Chemistry, Churchill Living Stone, (2007).
6. Cairms, D., Essentials of Pharmaceutical Chemistry, Pharmaceutical Press, (2003).
7. Loveland, W. D., Morrisey, D. J, Modern Nuclear Chemistry, Wiley Interscience, (2005).
8. Speight, J. G., The Chemistry and Technology of Petroleum, 3rd ed., Taylor & Francis, (2013).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 4th Year
Semester-VIII (APPLIED CHEMISTRY)
Specialization Paper-VI
Course Title: METALLURGY AND EXPLOSIVES
Course Code: CHEM 483
Credit Hours: 3

Course Objectives:

The course is designed to give sufficient knowledge about iron, steel and its alloys. The course also provides the knowledge about corrosion and its preventions. The course will also give the knowledge about organic Dyes industries, different lubricants used in industrial processes.

Course Contents:

Iron, Steel and Alloys: Iron ores, constituents and their classification, manufacture of iron and steel, types of iron and steel, metal extractions and production of Alloys.

Explosives and Propellants: Raw materials, manufacture of industrial explosives and propellants, types of explosives and their safety measures, chemistry involved in production of military explosives.

Nuclear Materials: Extraction of uranium from rocks, importance of nuclear technology, nuclear energy and its peaceful applications, production of nuclear energy and control of nuclear reactors, chemistry of fission and fusion reactions, reprocessing of nuclear spent fuel, industrial application of nuclear radiations.

Recommended Books:

1. Akhawan, J., The Chemistry of Explosives, 2nd ed., Royal Chemical Society, (2004).
2. Campball, F. C., Elements of Metallurgy and Engineering Alloys, ASM. International, (2008).
3. Davis, T. L., The Chemistry of Powder and Explosives, Angriff Press, (2012).
4. Reddy, L. K., Principles of Engineering Metallurgy, 2nd ed., New Age Publishers, (2009).
5. Loveland, W., Morrissey, D. J. and Seaborg, G. T., Modern Nuclear Chemistry, John-Wiley & Sons, Inc., (2006).
6. Choppin, G., Liijenzin, J-O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann, (2002).
7. Vermani, O. P, Narula, A. K, Applied Chemistry, Theory and Practice, 2nd ed., New Age Publishing House, India, (1995).
8. Balsaral, V. M, Applied Chemistry, I.K. International House Pvt. Ltd., India, (2009).

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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VIII (INORGANIC CHEMISTRY)
Specialization Paper-IV
Course Title: ORGANOMETALLICS
Course Code: CHEM 481
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about chemistry of organometallics especially with reference to their types and bonding, and reactivity of organometallic compounds in homogeneous catalysis.

Course Contents:

Fundamentals of organometallic compounds, types of bonding in organometallics, single, double and triple bonds to carbon (compound types, acyls, alkylidene complexes and alkylidyne complexes), delocalized hydrocarbon systems (alkenes, olefins, allyl and butadienes), alkyne complexes, cyclic π-complexes (five and six membered rings). Homogeneous catalytic hydrogenation, dimerization, oligomerization, polymerization, hydroformylation of olefins, catalytic polymerization of acetylenes. Insertion reactions and uses of organometallic compounds in organic synthesis.

Recommended Books:

1. Powell, P., Principles of Organometallics Chemistry, 2nd ed., Springer, (1998).
2. Yamamoto A., Organotransition Metal Chemistry: Fundamental Concepts and Applications, 1st ed., John-Wiley & Sons, Inc., (1986).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann M., Advanced Inorganic Chemistry, 6th ed., Wiley-Intersceince, New York, (1999).
4. Miessler, G. L., Fisher, P. J. and Tar, D, A., Inorganic Chemistry, 5th ed., Prentice Hall, (2013).
5. Douglas, B., McDaniel, D. and Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons, Inc., (1994).
6. Haiduc, I. and Zuckerman, J. J., Basic Organometallic Chemistry, Walter De Gruyter Inc., (1985).
7. Jolly, W. L., Modern Inorganic Chemistry, 2nd ed., McGraw-Hill Company, (1991).
8. Porterfield, W. W., Inorganic Chemistry: A Unified Approach, 2nd ed., Academic Press, (1993).
9. Vincet, A., Molecular Symmetry and Group Theory: 2nd ed., John-Wiley & Sons, Ltd., (2001).
10. Malik, W. U., Tuli, G. D., Madan, R. D., Selected Topics in Inorganic Chemistry, S. Chand and Co. Ltd., (2010).

Chairman
Department of Chemistry
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Faculty of Sciences
University of Malakand

Assistant Registrar
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VIII (INORGANIC CHEMISTRY)
Specialization Paper-V
Course Title: SYMMETRY AND MAGNETOCHEMSITRY
Course Code: CHEM 482
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about magnetic properties from chemistry point of view and group theory.

Course Contents:
Symmetry and Group Theory: Symmetry and group theory, point groups, multiplication tables, group representation and development of character tables. Introduction to the interpretation of spectra and structure elucidation.
Magnetochemistry: Theory of magnetism, diamagnetism, paramagnetism, ferro, ferri and antiferromagnetism, magnetic susceptibility, magnetic moments, Faraday's & Gouy's methods, effect of temperature on magnetic properties of complexes. Electron spin resonance spectroscopy, Magnetic moment of lanthanides.

Recommended Books:

1. Douglas, B., McDaniel, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons Inc., (1997).
2. Huheey, J. E, Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity", 4th ed., Prentice Hall, (1997).
3. Mackay, K. M., Mackay, R. A. and Henderson, W., Introduction to Modern Inorganic Chemistry, 6th ed., CRC Press, (2002).
4. Miessler, G. L., Fisher, P. J. and Tar, D, A., Inorganic Chemistry, 5th ed., Prentice Hall, (2013).
5. Purcell, K. F., Kotz, J. C., An Introduction to Inorganic Chemistry, W. B. Saunders, Company Holt-Saunders, International ed., (1980).
6. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Intersceince, New York, (1999).
7. Jolly, W. L., Modern Inorganic Chemistry, 2nd ed., McGraw-Hill Company, (1991).
8. Carter, R. L., Molecular Symmetry and Group Theory, 1st ed., John-Wiley & Sons, Inc., New York, (1997).
9. Orchin, M., Jaffe, H. H., Symmetry, Orbitals, and Spectra, John-Wiley & Sons, Inc., New York, (1971).
10. McWeeny, R., Symmetry: An Introduction to Group Theory and its Applications, Dover Publications, Inc., (2002).
11. Vincet, A., Molecular Symmetry and Group Theory, 2nd ed., John Wiley & sons Ltd, (2001).

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Department of Chemistry
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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VIII (INORGANIC CHEMISTRY)
Specialization Paper-VI
Course Title: RADIO AND NUCLEAR CHEMISTRY
Course Code: CHEM 483
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about radio and nuclear chemistry and nuclear reactions.

Course Contents:
Fundamentals and applied aspects of radioactivity and nuclear chemistry. types and characteristics of nuclear radiation, structure of nucleus, half-life, nuclear binding energy, and artificial radioactivity, fission and fusion reactions, acceleration of charged particles and applications of radioisotopes.

Recommended Books:

1. Friedlander, G., Kennedy, J. W., Miller, J. M. and Maciuas, E. S., Nuclear and Radiochemistry, 3rd ed., John-Wiley & Sons, Inc., (1981).
2. Choppin, G. R., Rydberg, J., Liljenzin, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann Ltd., (2002).
3. Arnikar, H. J., Essentials of Nuclear Chemistry, 4th ed., New Age International Pvt. Ltd. Publishers, (1996).
4. Naqvi, I. I. and Farrukh, M. A., Radiotracers in Chemical Applications VDM Verlag Dr. Müller, Germany, (2010).
5. Loveland, W., Morrissey, D. J. and Seaborg, J. T., Modern Nuclear Chemistry, John Wiley and Sons, Inc., (2006).

Chairman
Department of Chemistry
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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations) University of Malakand 05-Dec-2023

Major

BS 4th Year
Semester-VIII (ORGANIC CHEMISTRY)
Specialization Paper-IV
Course Title: NATURAL PRODUCTS
Course Code: CHEM 481
Credit Hours: 3

Course Objectives:
Students will acquire knowledge about different types of natural products with emphasis on their structure, synthesis and applications.

Course Contents:
Alkaloids: Introduction, classification, isolation methods, structure elucidation and discussion with particular reference to structure and synthesis and biosynthesis of typical alkaloids such as ephedrine, nicotine, atropine, quinine, papaverine and morphine.
Terpenoids: Introduction, classification, isolation techniques and discussion with particular reference to structure and synthesis and biosynthesis of typical terpenoids such as citral, α-terpineol, α-pinene, camphor and α-cadinene.
Steroids: Study of cholesterol and steroidal hormones with emphasis on their structure and biosynthesis.
Flavonoids: Introduction and classification of flavonoids, general biosynthetic pathway, synthesis of flavone, flavonol and cyanidin.

Recommended Books:

1. Dewick, P. M., Medicinal Natural Products: A Biosynthetic Approach, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd., (2009).
2. Sell, C. S., A Fragrant Introduction to Terpenoid Chemistry, The Royal Society of Chemistry, UK, (2003).
3. De la Rosa, L. A., Parrilla, E. A. and Aguitar, G. A. G., Fruit and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability, Wiley-Blackwell, (2009).
4. Shahidi, F. and Naczk M., Phenolics in Food and Nutraceuticals, CRC Press, (2004).
5. Oyvind, M. A., and Kenneth, R. M., Flavonoids: Chemistry, Biochemistry and Applications, CRC, Taylor & Francis, New York, (2010).
6. Finar, I. L., Organic Chemistry, Vol. 2, Stereochemistry and the Chemistry of Natural Products, 5th ed., Pearson Education Ltd., Delhi, (2008).
7. Hesse, M., Alkaloid Chemistry, John-Wiley & Sons, New York, (1981).
8. Bhat, S. V., Nagasampagi, B. A. and Sivakumar, M., Chemistry of Natural Products, Narosa Publishing House, (2005)

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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VIII (ORGANIC CHEMISTRY)
Specialization Paper-V
Course Title: ORGANIC SYNTHESIS
Course Code: CHEM 482
Credit Hours: 3

Course Objectives:
Students will acquire knowledge and understanding to design protocols for synthesis of small to medium sized organic compounds and be able to carry out retrosynthetic analysis and propose alternative reactions to synthesize a compound.

Course Contents:
Principles and importance of organic synthesis: Introduction to reterosynthesis and disconnection approach, synthesis of aromatic compounds; one and two group carbon C-X disconnections, donor and acceptor synthons, C-C disconnections and 1,2-, 1,3-, 1,4-, 1,5- and 1,6- difunctionalized compounds, synthesis of cyclic compounds (3-6 membered), chemo-, regio- and stereoselectivity.
Synthetic strategies: Functional group protection: hydroxyl, amino, carbonyl, carboxylic, sulfanyl, C=C, solid phase synthesis, phase-transfer catalysis and metal catalyzing reactions.

Recommended Books:

1. Warren, S. and Wyatt, P., Workbook for Organic Synthesis: The Disconnection Approach, 2nd ed., John-Wiley & Sons, Inc., (2010).
2. Fox, M. A. and Whitsell, J. K., Organic Chemistry, 3rd ed., Jones & Bartlett Publishers (1997).
3. Clayden, J., Greeves, N., and Warren, S., Organic Chemistry, 2nd ed., Oxford University Press, New York, (2012).
4. Loudon, M., Organic Chemistry, 5th ed., Roberts Company Publishers, (2009).
5. Smith, J. G., Organic Chemistry, 3rd ed., McGraw-Hill, (2010).
6. Norman, R. O. C. and Coxon, J. M., Principles of Organic Synthesis, 3rd ed., CRC Press, (1993).

Chairman
Department of Chemistry
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Dean
Faculty of Sciences
University of Malakand

Assistant Registrar (Examinations)
University of Malakand
05-Dec-2023

Major

BS 4th Year
Semester-VIII (ORGANIC CHEMISTRY)
Specialization Paper-VI
Course Title: MEDICINAL CHEMISTRY
Course Code: CHEM 483
Credit Hours: 3

Course Objectives:

Students will acquire knowledge and learn about the nature, types and properties of drugs and medicines, and the role of an organic chemist in drug designing and drug discovery.

Course Contents:

Chemistry of biomolecules; introduction to drugs and drug discovery, sources of therapeutic agents, structure activity relationship (SAR), drug-receptor interaction, drug formulation and its methods, different types of drugs; chemistry and modes of action of some common drugs.

Recommended Books:

1. Paul, M. D., Medicinal Natural Products: A Biosynthetic Approach, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd, (2009).
2. Wolff, M. E., Burger's Medicinal Chemistry, 4th ed., Part III, John-Wiley & Sons, New York, (2006).
3. Williams, D. A. and Lemke, T. L., Foye's Principles of Medicinal Chemistry, 6th ed., Lippincott Williams & Wilkins, New York, (2008).
4. D. Sriram, P. Vogeeswari, Medicinal Chemistry, 2nd ed., BITS Pilani, Pearson, Publisher: Darling Kindernley, India, (2010).
5. Carins D., Essential of Pharmaceutical Chemistry, 3rd ed., Pharmaceutical Press, London, (2008).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VIII (PHYSICAL CHEMISTRY)
Specialization Paper-IV
Course Title: REACTION DYNAMICS
Course Code: CHEM 481
Credit Hours: 3

Course Objectives:

Students will acquire knowledge and learning about reaction dynamics and kinetic theories. They will also know about the factors which can influence the rates of reactions under different reaction conditions.

Course Contents:

Reaction Dynamics: Correlation between physical properties and concentration, Kinetics of the complex reactions, reversible, parallel, consecutive bimolecular reactions, Theory of absolute reaction rate, Lindemann's theory of unimolecular reactions, bimolecular collision theory, transition state theory, comparison of collision and absolute reaction theories, Potential energy surfaces, Thermodynamic formulation of reaction rates, Calculation of entropy and enthalpy changes, Thermal decomposition of nitrogen pentaoxide.

Reactions in solutions: Influence of ionic strength on the reaction rate, effect of dielectric constant of the medium on the rate of the reaction, single sphere activated complex model, double sphere activated complex model, complex reactions, chain reactions, single chain carrier with second order breaking, one chain carrier with first order breaking, two chain carriers with second order breaking, experimental techniques for fast reactions.

Recommended Books:

1. Espenson, J. H., Chemical Kinetics and Reaction Mechanism 2nd ed., McGraw-Hill, London (2002).
2. Connors, K. A., Chemical Kinetics: The Study of Reaction Rates in Solution, VCH Publishers, Inc., (1990).
3. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley& Sons, (2005).
4. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VIII (PHYSICAL CHEMISTRY)
Course Title: RADIATION AND PHOTOCHEMISTRY
Specialization Paper-V
Course Code: CHEM 482
Credit Hours: 3

Course Objectives:

Students will learn about the mechanisms of radiation induced chemical changes in molecules, radiation dosimetery and applications of the radiation chemistry. They will also learn about radioactive decays, and how radioisotopes are produced and applied in Mössbauer spectroscopy. Students will be able to understand the principles of fluorescence, phosphorescence and other photochemical processes, and their applications.

Course Contents:

Radiation Chemistry: Development and advancement in radiation chemistry, radiation dosimetry, Fricke dosimeter, dosimetry in pulse radiolysis, energy states in radiation chemistry, excited states, fragmentation, pre-dissociation, photochemical decay, ions and electrons, radiolysis of gases, liquids, solids, frozen liquids and ions in radiation chemistry, recent application of radiation chemistry.

Photochemistry: Principles of photochemistry, laws of photochemistry, Einstein's law of photochemical equivalence, rates of intramolecular processes, chemical reactions and quantum yields with examples, energy transfer in photochemical reaction, quantum yield of emission process radiation and nonradiation process, kinetics and quantum yields of radiative and nonradiative process (fluorescence, phosphorescence, inter-system crossing, internal conversion, quenching) and Stern-Volmer reactions, photosensitized reactions.

Recommended Books:

1. Spinks, J. W. T. and Woods, R. J., An introduction to Radiation Chemistry, 3rd ed., Wiley Inter Si. Pub., USA, (1990).
2. Aziz, F. and Rodgers, M. A. J., Radiation Chemistry Principles and Applications, 1sted., VCH Publishers, Inc., (1987).
3. Choppin, G., Liljenzin, J-O., Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann, (2002).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023

4. Mostafavi, M., Douki, T., Radiation Chemistry: From Basic to Applications in Material and Life Sciences, EDP Science, (2008).
5. Dunkin, I., Photochemistry, Vol. 36, RSC Publishing, (2007).

Major

BS 4th Year
Semester-VIII (PHYSICAL CHEMISTRY)
Specialization Paper-VI
Course Title: COLLOID AND SURFACE CHEMISTRY
Course Code: CHEM 483
Credit Hours: 3

Course Objectives:

Students will acquire knowledge about the important colloidal system and Nano Size materials with applications. The solid surface will be characterized and will be used for the process of surface phenomenon. The Thermodynamic study of the solid-liquid interfaces will also be explored.

Course Contents:

Colloidal solutions: Introduction, Classification of colloidal system, Structural characteristics, Preparation of colloidal system. Optical Properties: Optical and electron microscopy, Light scattering. Composition and structure of solid surfaces. Colloid with special reference to surfactants and emulsions.

Introduction to Nano sized materials: Classification of NSM, Synthesis of NSM, properties of NSM. Case studies of NSM. Charged films and Langmuir-Blodgett layers, Applications.

Characterization of Colloidal and Nano sized materials: Experimental probes techniques for the surface chemistry of adsorbent: scanning probe techniques (SEM/TEM, low energy electron diffraction (LEED), other surface analysis techniques like EDS, Zeta Potential, FTIR, TGA/DTA).

Adsorption on the surface: Solid–liquid interfaces: Adsorption equilibration, Adsorption kinetics, adsorption isotherms, factors affecting the process of adsorption, adsorption mechanism and thermodynamics of adsorption. Usefulness of surface chemistry to colloidal solution and NSM surfaces.

Recommended Books:

1. Hunter, R. J., Introduction to Modern Colloid Science, Oxford University Press, Oxford, (1994).
2. Poole, C. P. and Owens, F. J., Introduction to Nanotechnology, 1st ed., Wiley-Interscience, (2003).
3. Klabunde, K. J., Nanoscale Materials in Chemistry, John-Wiley & Sons, Inc., (2003).
6. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 8th ed., Oxford University Press, (2006).

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
05-Dec-2023

Major

BS 4th Year
Semester-VIII
Course Title: Elective Course-II (Environmental Chemistry)
Course Code: CHEM 484
Credit Hours: 3

Course Objectives:

This course will enable the students to understand the basic concepts of water pollution and water treatment and the green revolution

Course Contents:

Water and Water Treatment:

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophication, detergents and phosphates, importance of microorganisms in water purification, primary and secondary treatment of water, advanced wastewater treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The Green Revolution:

Pest control, pesticides, toxicity of pesticides, pest management.

Recommended Books:

1. Anil Kumar, Environmental Chemistry, Wiley Eastern, New Delhi.
2. J.W. Moore & E.A. Moore, Environmental Chemistry, Academic Press, New York.
3. S.K. Banerji, Environmental Chemistry, Prentice Hall, Delhi.
4. S.K. Banerji, Environmental Chemistry, Tata Publisher, Delhi.
5. Stanley E. Manahan, Environmental Chemistry, Brooks, California.

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website. For any query the office of the Registrar Academics may be approached for clarification/guidance.

THE END

Chairman
Department of Chemistry
University of Malakand

Dean
Faculty of Sciences
University of Malakand

Assistant Registrar
(Examinations)
University of Malakand
05-Dec-2023