WOMEN UNIVERSITY MARDAN
DEPARTMENT OF CHEMISTRY

CURRICULUM OF CHEMISTRY

(Bachelor Studies in Chemistry)

BS Program

(4-Year, 8-Semester)

HEC NEW UNDERGRADUATE POLICY
(FALL-2023)

Department of Chemistry
Women University Mardan

WOMEN UNIVERSITY MARDAN
DEPARTMENT OF CHEMISTRY

SCHEME OF STUDIES
(Session 2023 onward)

WOMEN UNIVERSITY MARDAN
DEPARTMENT OF CHEMISTRY

Undergraduate Scheme of Studies (New Policy-2023)
BS Chemistry

Semester-I				
Course Code	**Course Name**	**Credit Hours**	**General Education Course /Major/Interdisciplinary**	**Marks**
BBA-322	Entrepreneurship	02	General Education Course*	100
PSY-301	Social Sciences Introduction to Psychology	02	General Education Course* (List attached)	100
ENG-301	Functional English	03	General Education Course	100
ISL-301	Islamic Studies	02	General Education Course	100
PSC-301	Civic and Community Engagement	02	General Education Course	100
CHEM-311	Inorganic Chemistry-I	03 (2+1)	Major Disciplinary Specific	100
BIO-301	Molecular Biology	03	Interdisciplinary	100
Semester Credit Hours		**17**		
Semester-II				
CHEM-321	Natural Sciences Extraction Fraction and Purification of Macromolecules	3(2+1)	General Education Course* (List attached)	100
ENG-302	Expository Writing	03	General Education Course	100
ISL-302	Arts & Humanities approved Course History of Islamic civilization	02	General Education Course	100
PSC-302	Ideology and Constitution of Pakistan	02	General Education Course	100
MTH-433	Quantitative Reasoning-I Exploring Quantitative Skills	03	General Education Course	100
CHEM-322	Organic Chemistry-I	03 (2+1)	Major Disciplinary Specific	100
Semester Credit Hours		**16**		
Semester-III				
MTH-444	Quantitative Reasoning-II Tools for Quantitative Reasoning	03	General Education Course*	100
CS-301	Application of Information and Communication Technology	3 (2+1)	General Education Course	100
STAT-301	Introduction to Statistics	03	Interdisciplinary	100
MTH-302	Pre-Calculus-II	03	Interdisciplinary	100
CHEM-431	Physical Chemistry-I	03 (2+1)	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-IV				
BCH-311	Biochemistry	03	Interdisciplinary	100
CHEM-441	Environmental Chemistry	03	Major Disciplinary Specific	100
CHEM-442	Industrial Chemistry	03	Major Disciplinary Specific	100

CHEM-443	Fuel Chemistry	03	Major Disciplinary Specific	100
CHEM-444	Analytical Chemistry-I	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-V				
CHEM-551	Analytical Chemistry-II	04 (3+1)	Major Disciplinary Specific	100
CHEM-552	Inorganic Chemistry-II	04 (3+1)	Major Disciplinary Specific	100
CHEM-553	Organic Chemistry-II	04 (3+1)	Major Disciplinary Specific	100
CHEM-554	Physical Chemistry-II	04 (3+1)	Major Disciplinary Specific	100
Semester Credit Hours		**16**		
Semester-VI				
CHEM-561	Analytical Chemistry-III	04 (3+1)	Major Disciplinary Specific	100
CHEM-562	Inorganic Chemistry-III	04 (3+1)	Major Disciplinary Specific	100
CHEM-563	Organic Chemistry-III	04 (3+1)	Major Disciplinary Specific	100
CHEM-564	Physical Chemistry-III	04 (3+1)	Major Disciplinary Specific	100
Semester Credit Hours		**16**		
Semester-VII (Specialization in Analytical Chemistry)				
CHEM-671	Atomic Spectroscopy	03	Major Disciplinary Specific	100
CHEM-672	Electroanalytical Techniques	03	Major Disciplinary Specific	100
CHEM-673	Advanced Separation Techniques	03	Major Disciplinary Specific	100
CHEM-674	Luminescence Spectroscopy and Thermal Analysis	03	Major Disciplinary Specific	100
CHEM-679	Field Experience/Internship /Advanced Lab in Analytical Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VIII (Specialization in Analytical Chemistry)				
CHEM-681	Nuclear Analytical Techniques	03	Major Disciplinary Specific	100
CHEM-682	Food and Drug Analysis	03	Major Disciplinary Specific	100
CHEM-683	Molecular Spectroscopy	03	Major Disciplinary Specific	100
CHEM-684	Mass Spectrometery	03	Major Disciplinary Specific	100
CHEM-689	Capstone Project/Advanced Lab in Analytical Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VII (Specialization in Inorganic Chemistry)				
CHEM-671	Atomic Spectroscopy	03	Major Disciplinary Specific	100
CHEM-672	Nuclear Chemistry	03	Major Disciplinary Specific	100
CHEM-673	Bioinorganic Chemistry	03	Major Disciplinary Specific	100
CHEM-674	Coordination Chemistry	03	Major Disciplinary Specific	100
CHEM-679	Field Experience/Internship /Advanced Lab in Inorganic Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VIII (Specialization in Inorganic Chemistry)				
CHEM-681	Inorganic reaction mechanisms	03	Major Disciplinary Specific	100
CHEM-682	Inorganic Polymers	03	Major Disciplinary Specific	100
CHEM-683	Organometallic Chemistry	03	Major Disciplinary Specific	100
CHEM-684	Elementary Group Theory	03	Major Disciplinary Specific	100

CHEM-689	Capstone Project/Advanced Lab in Inorganic Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VII (Specialization in Organic Chemistry)				
CHEM-671	Spectroscopic methods in Organic Chemistry-I	03	Major Disciplinary Specific	100
CHEM-672	Chemistry of Heterocycles	03	Major Disciplinary Specific	100
CHEM-673	Organic Synthesis	03	Major Disciplinary Specific	100
CHEM-674	Stereochemistry	03	Major Disciplinary Specific	100
CHEM-679	Field Experience/Internship /Advanced Lab in Organic Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VIII (Specialization in Organic Chemistry)				
CHEM-681	Spectroscopic methods in Organic Chemistry-II	03	Major Disciplinary Specific	100
CHEM-682	Natural Products Chemistry	03	Major Disciplinary Specific	100
CHEM-683	Named Organic Reactions	03	Major Disciplinary Specific	100
CHEM-684	Retrosynthesis	03	Major Disciplinary Specific	100
CHEM-689	Capstone Project/Advanced Lab in Physical Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VII (Specialization in Physical Chemistry)				
CHEM-671	Chemical Kinetics	03	Major Disciplinary Specific	100
CHEM-672	Photochemistry	03	Major Disciplinary Specific	100
CHEM-673	Thermodynamics	03	Major Disciplinary Specific	100
CHEM-674	Polymer Chemistry	03	Major Disciplinary Specific	100
CHEM-679	Field Experience/Internship /Advanced Lab in Physical Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Semester-VIII (Specialization in Physical Chemistry)				
CHEM-681	Quantum Chemistry	03	Major Disciplinary Specific	100
CHEM-682	Molecular Spectroscopy	03	Major Disciplinary Specific	100
CHEM-683	Nuclear Chemistry	03	Major Disciplinary Specific	100
CHEM-684	Surface Chemistry	03	Major Disciplinary Specific	100
CHEM-689	Capstone Project/Advanced Lab in Physical Chemistry	03	Major Disciplinary Specific	100
Semester Credit Hours		**15**		
Total Credit Hours		**125**		

Summarized Scheme of Studies for the Degree of Bachelor of Science (BS) in Chemistry.

S#	Courses Category	HEC Recommended Range	Adopted by Chemistry Dept. WUM
		Credit Hours	**Credit Hours**
1	General Education	30	30
2	Major Disciplinary Specific	Minimum 72	77
3	Interdisciplinary/Allied	Flexible	12
4	Field Experience	Min. 03	03
5	Capstone Project	03	03
Total		**123-144**	**125**

Details of Theory/Practical Courses for BS (4-Years) Chemistry

1st Semester

BBA-322 **Entrepreneurship** **Credit Hours: 02**

Course Objectives:

With more than half of the new jobs being created in the world economy by small businesses, the particular problems and experiences encountered in starting and developing new enterprises are clearly worth studying. This course of Entrepreneurship has been designed to provide the participants with an overall understanding of the concept of entrepreneurship and small business management. Participants will be prepared to start, survive, and succeed in their own businesses.

Course Content:

Entrepreneurship: an evolving concept, Entrepreneurship – a perspective, The Role of Entrepreneurship, Kinds of Entrepreneurs, Role and Functions of Entrepreneurs

Understanding strategic issues in business plan development, Pitfalls in selecting new ventures, Innovation: the creative pursuit of ideas, Opportunity identification: the search for new ideas, Reason for failures of new ventures, Legal challenges for entrepreneurial ventures, Sources of capital for entrepreneurial ventures

Assessment of entrepreneurial plan, Marketing challenges for entrepreneurial ventures, Developing an effective business plan, Strategic entrepreneurial growth Problems Faced by Newly Established Company, Post and Field Problems Faced by a New Enterprise, Franchising and the Entrepreneur

Recommended Books:

1. Small Business Management:Entrepreneurship and Beyond, Timothy S. Hatten.South-Western, Cengage Learning
2. Norman M. Scarborough., Essentials of Entrepreneurship and Small Business Management.Pearson Education
3. Donald F. Koratko , Entrepreneurship –Theory Process Practice (10th Edition), South Western -Cengage Learning.
4. David L. Kurtz& Louis E. Boone, Contemporary Business (latest edition).
5. Philip Kotler &Gary Armstrong, Principles of marketing (latest edition).
6. Any Other Resources such as: Internet and Resource Notes and Modules
7. Local and international newspapers and financial journals

PSY-301 **Introduction to Psychology** **Credit Hours: 02**

Course Objectives:

To ensure that the students are aware of the nature, origin, history and scope of Psychology as a modern discipline and its relationship with other sciences and to have a working knowledge of the application and the practice of psychology in real life.

Course Outline:

Introduction to Psychology:

- Nature and Application of Psychology with special reference to Pakistan.
- Historical Background and Schools of Psychology (A Brief Survey)

Methods of Psychology:

- Observation
- Case History Method
- Experimental Method
- Survey Method
- Interviewing Techniques

Biological Basis of Behavior:

- Neuron: Structure and Functions
- Central Nervous System and Peripheral Nervous System
- Endocrine Glands

Sensation, Perception, and Attention

Sensation:

- Characteristics and Major Functions of Different Sensations
- Vision: Structure and functions of the Eye.
- Audition: Structure and functions of the Ear

Perception:

- Nature of Perception
- Factors of Perception: Subjective, Objective and Social
- Kinds of Perception
- Spatial Perception (Perception of Depth and Distance)
- Temporal Perception
- Auditory Perception

Attention:

- Factors
- Subjective
- Objective
- Span of Attention
- Fluctuation of Attention
- Distraction of Attention (Causes and Control)

Recommended Books:

1. Atkinson R. C., & Smith E. E. (2000). *Introduction to psychology* (13th ed.). Harcourt Brace College Publishers.
2. Fernald, L. D., & Fernald, P. S. (2005). *Introduction to psychology*. USA: WMC Brown Publishers.
3. Glassman, W. E. (2000). *Approaches to psychology*. Open University Press.
4. Hayes, N. (2000). *Foundation of psychology* (3rd ed.). Thomson Learning.

5. Lahey, B. B. (2004). *Psychology: An introduction* (8th ed.). McGraw-Hill Companies, Inc.
6. Leahey, T. H. (1992). *A history of psychology: Main currents in psychologicalthought*. New Jersey: Prentice-Hall International, Inc.
7. Myers, D. G. (1992). *Psychology* (3rd ed.). New York: Wadsworth Publishers.
8. Ormord, J. E. (1995). *Educational psychology*: *Developing learners*. PrenticeHall, Inc

ENG-301 Functional English-I Credit hours: 03

Course Description:

This course introduces the students with the basic grammatical / structural rules of English Language. It will help the students in improving their basic Language Skills to an optimum level so as to enable them to communicate effectively in English language through proper usage of vocabulary & knowledge of English grammar.

Course Outcomes:

Students will be familiarized with the technical methods of reading / comprehension. They will be exposed to different reading materials, which will help them in improving their vocabulary, grammar and sentence structure etc. The experience of this course will also help them to overcome those problems due to which they are unable to express themselves properly Parts of Speech.

Course Contents:

- Vocabulary (Frequently confused / misused words,
- Phrases,
- synonyms,
- antonyms,
- idioms & General vocabulary),
- Practical Use of Grammar (Nouns, Pronouns, Verbs, Adjectives, Adverbs, Prepositions, Conjunctions, Articles, Interjections & Tenses)
- Sentences (Types of sentences, Parts of sentences),
- Direct and Indirect Speech,
- Active & Passive Voice & Conditional Sentences),

Recommended Books:

1. High School English Grammar & Composition by Wren and Martin.
2. Practical English Grammar by A.J. Thomson &A.V. Martinet. Exercises 1 & 2. 3rdedition. Oxford University Press.
3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand& Francoise Grellet. Oxford Supplementary Skills. 4thImpression 1993.4.Reading. Upper Intermediate. Brian Tomilson& Rod Ellis. Oxford Supplementary Skills. 3rdImpression 1992.
4. Précis writing by R. Dhillon.

5. Systems Student Companion English for lower secondary schools by Magdalene Chew &Surinder Kaur.

ISL-301 Islamic Studies Credit Hours: 02

Course Objectives:

The course is aimed;

- To learn about Islam and its application in day to day life.
- To provide basic information about Islamic studies.
- To improve students skill to perform prayers and other worships.
- To enhance the skills of the students for understanding of issues related to faith and religious life.

Course Outline:

- Holy Quran
- Sunnah
- Fundamentals Doctrine of Islam
- Life of Holy Prophet
- Islamic Economic system
- Islam and science
- Political system of Islam
- Social System of Islam
- Introduction to Islamic law and jurisprudence
- Islamic culture and civilization

Recommended Books:

1. Hafiz Ahmed Yar, Madhamin.e.Quran
2. Prof. Arif Naseem, Islamiat for degree classes.
3. Hameed Ullah Muhammad, Introduction of Islam.
4. Islamiat, Compulsory for degree classes Published by Allama Iqbal University.
5. Syed Suleman Nadvi, Nabi Rehmat (P.B.U.H).

PSC-301 Civic and Community Engagement Credit Hours: 02

Course Objectives:

Understand, critically think about, and reflect upon the history of democracy and civic engagement in the Pakistan.Identify and utilize - civic/community engagement skills such as: (advocacy, organizing, communications) and knowledge- (working in groups and teams, leadership, diversity, how systems work). Create civic sense and establish importance of civic and community engagement. Identify and explain the values and ethics for community engagement. Carry out a civic engagement activity incorporating

some of their new knowledge and skills of civic engagement and reflect on their learning about the community, the issue addressed, and about themselves.

Course Contents:

Divided into categories for in-depth comprehension-

Category A: General

1. The historical background of civic and community engagement
2. Conceptual understanding of Human Rights and Minority Rights
3. Dimensions of Citizens engagement in Community: Political, Social, Economic
4. Rights and duties of Citizens in Community
5. Organizations (National & International) and Groups
6. Role of non-governmental organizations and their contributions
7. NGOs: Nature and Scope
8. International Commission for Red Cross (ICRC)
9. Amnesty International
10. Asia Watch

Category B: Pakistan's context

1. Role of Citizens in Governance of Pakistan
2. Democratic Accountability and Civic Engagement
3. Enhancement of leadership skills among women and youth of Pakistan through civic community engagement programs

Recommended Books:

1. Hoefer, R. (2012). Advocacy
2. for Practice. 3rd Edition. Chicago, IL: Lyceum Books, Inc. (ISBN-13: 978-1935871828)
3. Putnam, R. and Feldstein, L (2003). Better Together. New York, NY: Simon and Schuster. (ISBN-13: 978-0743235471)
4. Civic Engagement—What Is It and Why Is It Important? Kerry J. Kennedy
5. Universal Human Rights in Theory and Practice by Jack Donnelly
6. Adamantia Pollis and Peter Schwab, Human Rights Cultural and Ideological Perspectives. Preager Publishers, Preager Publishers, London, 1980.
7. Promoting and Protecting Minority Rights- A Guide for Advocates by United Nations.
8. Human Rights in International Law, Council of Europe press, 1992.
9. United Nations, Human Rights Status of International Instruments, United Nations, Baltimore, New York, 1987.

CHEM-311 Inorganic Chemistry-I Credit Hours: 03(2+1)

Aims and Objectives:

The course is designed to enable the students; to acquire knowledge about the key introductory concepts of chemical bonding and 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 outline:

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, Soft and hard acids and bases (SHAB), Concept of relative strength of acids and bases, Significance of pH, pKa, pKb and buffer solutions, Theory of indicators, Solubility and solubility product, Common ion effect and its 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.

Practical:

1. Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD).
2. Disposal of chemical waste and first-aid practices.
3. Qualitative analysis of salt mixtures.
4. Quantitative analysis.
5. Acid- base titrations.
6. Preparation and standardization of acid and alkali solutions
7. Redox titrations.
8. Preparation and standardization of potassium permanganate solution and its
9. Use for the determination of purity of commercial potassium oxalate or oxalic acid.
10. Preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample.
11. Gravimetric analysis.
12. Determination of barium in a given sample, determination of chloride in a given solution.

Recommended Books:

1. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley & Sons, New York, (2007).
2. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3rd ed., Harper International SI Edition, (2006).
3. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).

4. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).
5. Catherine E. House crdft, Alan G. Sharpe, Inorganic Chemistry, 3rd ed., Prentice Hall, (2008).
6. Kathleen A. H., James E. H., Descriptive Inorganic Chemistry, 2nd ed., Brooks Cole, (2010).

BIO-301 **Molecular Biology** **Credit Hours: 03**

Aims and Objectives:

To learn about the genetic materials of living organisms.
To learn about the mutation.

Course outline:

- **DNA**
- The primary genetic material.
- Structure
- Replication in prokaryotes and comparison with eukaryotes.
- DNA sequencing.
- Chemical synthesis of polynucleotides.
- DNA repair and recombination.
- **Different types of RNA and their role in protein synthesis.**
- Transcription and its regulation.
- Genetic code.
- Post transcriptional processing.
- Structure of transfer RNA.
- Protein synthesis inhibitors.
- Control of translation .
- Post translational modification.
- **T-Plasmids and bacteriophage.**
- **In vitro mutagenesis.**
- Deletion, Insertion and Substitution.
- **Recombinant DNA and genetic diseases.**

Recommended Books:

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, Molecular Biology of the Gene 2004, Pearson Education, Inc.
2. Watson, J.D. Tooze, J and Kurtz, D.T. Recombinant DNA Scientific American Books. Freeman
3. Lewin B. Gene VII. Oxford University Press

4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter Molecular Biology of the Cell 5th Edition Taylor &Francis
5. T. A. Brown. Genomes 3rd Edition Taylor &Francis.

2nd Semester

CHEM-321 Extraction, Fraction and purification of macromolecules Credit Hours:03

Aims and Objectives:

The course is aimed:

- To help the students to understand the essentials of homogenizes and lopholization.
- To understand the principles of techniques.

Course Outline:

- **Homogenization, Solubilization and Concentration including ultrasonication, lyphilization and ultradecantation, Purification based on**
    - Differential solubility techniques
    - Ion-Exchange chromatography
    - Gel chromatography
    - Affinity chromatography
    - Paper & Thin layer chromatography and HPLC.
    - Electrophoresis Paper and Gel electrophoresis.
    - Two-dimensional electrophoresis.
    - Capillary electrophoresis.
    - Elecrofocusing Preparative and Analytical electrofocusing.
    - Centrifugation Principle.
    - Preparative centrifugation.
- **Application of density gradient and differential centrifugation.**
    - Ultracentrifugation.
    - Sedimentation equilibrium and sedimentation velocity methods.
    - Application of analytical centrifugation.
- **Tracer techniques Detection and measurement of radioactivity.**
- **Application of radioisotopes in biological system.**
- **U.V. and Visible Spectroscopy Basic principles.**
- **Instrumentation and applications.**
- **ELISA Techniques**

Recommended Books:

1. The tools of Biochemistry by Cooper (2008)
2. Principles and techniques of practical Biochemistry by William Edward and Arnold (2001)

3. Qualitative problems in Biochemistry by Dawas (2000)
4. A biologist's Physical chemistry by J.Gareth Morris (2007)
5. Protein purification, principle and practice by Robert.K.Scope (2000)

ENG-302 Expository Writing Credit Hour: 03

Course Description:

This course will introduce students to the basic principles of effective / skillful writing and will develop the understanding of the students on academic and technical writing skills. Students will understand and know how to follow the stages of writing process and will apply these to technical and workplace writing tasks. Students will learn how to incorporate clarity and utility in their writing, learn stylistic methods for effective writing and to be aware of ethical issues in technical writing. Also, Students will read, analyze, and interpret material from technical fields, and will practice research and writing skills appropriate for technical topics.

Course Outcomes:

1. Students will be familiarized with basic sources and methods of research and documentation on topics including on-line research.
2. They will be able to synthesize and integrate material from primary and secondary sources wedded to their own ideas in research papers.

Course Contents:

- Topic sentence
- Paragraph writing:
- Essay writing:
- Introduction and Practice: Essay types: descriptive, narrative, discursive, argumentative.
- CV and job application
- Letter and memo writing
- Minutes of meetings
- Summary and précis writing
- Comprehension

Recommended Books:

1. Boutin, M.,& Brinand,S.,& Grellet, F. (1993). Oxford Supplementary Skills. Fourth Impression. Pages 45-53.
2. Nolasco, R. (1992). Oxford Supplementary Skills (3rd ed.). Fourth Impression.
3. Langan, J. (2004). College Writing Skills. Mc-Graw-Hill Higher Education.

ISL-302 History of Islamic Civilization Credit Hours: 02

Course Objectives:

1. Definition of Islamic Culture & Civilization
2. Analysis of the Rise and Fall of Islamic Culture in various parts of the World
3. A Critical Study of the Effect and benefits of Islamic Civilization on other Cultures

Course Description:

Introduction of Civilization, Foundation of Civilization, Elements of Civilization
Important Civilization in the Pre-Islamic Era, Greek Civilization, Roman Civilization
Important Civilization in the Pre-Islamic Era, Egypt Civilization, Hindu Civilization
Principles of Islamic Civilization, Pillars of Culture & Civilization, Foundations of Islamic Civilization in the Era of the Prophet (SAW) and the Caliphates, Reasons for the evolution of Islamic Civilization in the Era of the Prophet (SAW), Islamic Civilization in the Era of the Caliphates, Elements of Islamic Civilization in the era of Caliphates,
Islamic Civilization in the era of Banu Ummayads- 1, Introduction of Banu Ummayads
Intellectual development among the Banu Ummayads, Educational Centers for the Banu Ummayads
Islamic Civilization in the era of Banu Ummayads- 2, Social developments of the Banu Ummayads, Causes of the civilization development of the Banu Ummayads, Results of the civilization development of the Banu Ummayads
Islamic Civilization in the era of Banu Ummayads- 3, Religious Movements in the era of Ummayads, Internal Disputes in Ummayads era, Reasons for the decline of the Ummayads
Islamic Civilization in the era of Abbasids- 1, Beginning of Abbasid civilization
Educational movements of the Abbasid period, Islamic Civilization in the era of Abbasids-2, Cultural development in the Abbasid period, Social development in the Abbasid period
A, Comparative study of the Islamic Culture of Abbasids with other Civilization
Islamic Civilization in the era of Abbasids- 3, Battles of Crusades, Battlers of Tartarians
The Causes of the Fall of the Abbasids and its Effects on Islamic Civilization,
Islamic Civilization in Spain, Causes of the spread of Islamic civilization in Spain
Manifestations of Islamic civilization in Spain, Influence of Islamic civilization in Spain on European civilization, Islamic Culture and civilization in the Sub-continent, Islamic civilization achievements in the Sub-continent, Reasons for the spread of Islamic cultural in Sub-continent, The effects of publication of Islamic civilization in the sub-content on other civilization

Recommended Books:

1. Muslim History and Civilization by Ehsan ul Karim
2. Islamic Religion History and Civilization, Seyyed Hossein Nasr
3. Tareekh-e-Islam Shah Nadvu Moin-ud-din

4. Islamic History by Dr. Kabeer Ali
5. An Atlas of Islamic History, H.W.Hazard
6. A Short History of Islam, S.F.Mehmood
7. تاریخ تمدن اسلامی، شاہ معین الدین ندوی .
8. تاریخ اسلام، اکبر شاہ نجیب آبادی .

PSC-302 Ideology and Constitutional Development of Pakistan Credit Hours: 02

Learning Objectives:

- To develop critical thinking for understanding Constitutional development in Pakistan;
- To develop understanding of the legal and constitutional structure of the state;
- To develop comprehension of the interconnectivity between the Constitutional provisions and political practice;
- To develop the understanding of students regarding ideological basis of Pakistan as well as role of ideology in building national character.

Course Contents:

Course is divided into two sections to cover the maximum portion of the course.

Section A: Ideological understanding and development of Pakistan

- Basis of Ideology of Pakistan and Two Nations Theory
- Ideology of Pakistan: Vision of Quaide e Azam and Allama Iqbal
- Role of ideology in building national character
- Democratic system of Pakistan (Issues)
- Major causes of the Imposition of martial Law (1958, 1969, 1977&1999).

Section B: Constitutional Development of Pakistan

- Pakistan's Constitutional Development from 1947 onward.
- An Overview of the Constitution of Pakistan (Features of 1973 Constitution).
- Basic Concepts—Federalism and the 1973 Constitution.
- Islam and the Constitution of Pakistan -1973.
- Constitutional Amendments and Reforms- 1973.

Recommended Books:

1. Constitution of Pakistan
2. The Constitutional History of Pakistan—1947-2012, Malik Muhammad Owais Khalid, 2012
3. Constitutional History and Political Development, Hamid Khan, 2005
4. Constitutional Development in Pakistan, G.W. Chaudhary
5. Constitution Making in Pakistan 1947-85, Dr. Baz Muhammad

6. Allen Gledhill, Pakistan: The Development of its Laws and Constitution
7. "Military, State and Society in Pakistan" by Hasan Askari Rizvi, 2000.
8. Kazmi, Raza, Pakistan Studies, Karachi Oxford University Press.
9. Qureshi, I. H., A Short History of Pakistan, University of Karachi Press.
10. Qureshi, I. H., Struggle for Pakistan, University of Karachi Press.
11. Sayeed, K. B., Pakistan Formative Phase, National Book Service
12. Ziring, Lawrance, Pakistan in Twentieth Century: A Political History, London; Oxford University Press
13. Government and politics in Pakistan by Mushtaq Ahmad
14. Ideology and Dynamics of Politics in Pakistan by Muhammad Asif Malik

MTH-433 QR-I---Exploring Quantitative Skills Credit Hours: 03

Course Objectives:

Introduce students to importance of quantitative reasoning skills, history of mathematics and numbers in the real World.

Course Outline:

- Different types of standard numbers and their operations.
- Understanding relationship between parts and whole
- Practical life scenarios involving parts & whole
- Money management (profit, loss, discount, zakat, simple interest, compound interest and taxation)
- Practical life scenarios involving units and rate, percentage, ratio, proportions
- Basic of Geometry (line, angles, circles, polygon etc)
- Golden ratio in sculptures
- Equating two expressions in one variable & using it to solve practical problems
- Sets and their operations, Venn diagrams
- Relations, Functions and their graphs
- Algebraic solution of quadratic equations and inequalities
- System of linear equations and their solutions
- Introduction to logic, prepositions, logical connectives, truth tables etc

Recommended Books:

1. Bennett, J. & Briggs, W. (2015). Using and understanding mathematics (6th Edition). Pearson Education, Limited. http://xn--webducation-dbb.com/wp-content/uploads/2019/09/Jeffrey-Bennett-William-Briggs-Using- Understanding-Mathematics_-A-Quantitative-Reasoning-Approach-Pearson-2015.pdf
2. Blitzer, R. (2014). Precalculus. (5th Edition). Pearson Education, Limited. https://www.ilearnacademy.net/uploads/3/9/2/2/3922443/precalculus edition_5f.pdf

CHEM-322 Organic Chemistry-I Credit Hours: 03(2+1)

Aims and Objectives:

The course is aimed to give student

- Knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reactions.
- Information will be useful for qualitative analysis and synthesis of organic compounds.

Course Outline:

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). Saturated, unsaturated and aromatic hydrocarbons with emphasis on; synthesis and free radical, Electrophilic addition and electrophilic substitution reactions. Chemistry of Functional Groups.

Practical:

- Qualitative analysis of compounds with different functional groups.
- Synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

Recommended Books:

1. John, E. M. *Organic Chemistry,* 8th ed., Brooks/Cole Publishing Co, USA, (2012).
2. Younus, M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).
3. Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry,* 10th ed., John- Wiley & Sons, Inc., (2011).
4. 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).
5. Mayo, D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic to Laboratory with Multistep and Multisacle Syntheses*, 5th ed., John-Wiley & Sons, Inc., (2011).
6. Gilbert, J. C. and Martin, S. F., *Experimental Organic Chemistry: A Miniscale and Microscale Approach*, 5th ed., Brooks/ Cole Cengage Learning, (2010).
7. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry*, 6th ed., Brooks/ Cole Cengage Learning, (2012).

3rd Semester

MTH-444 QR-II----Tools for Quantitative Reasoning Credit Hours: 03

Course Objectives:

Introduce students to variables, sampling data and statistical approach in decision making.

Course Outline:

- Investigating relationships between variables
- Exploring tools to find relationship between variables
- Population and samples,
- Exploring and summarizing data
- Finding a representative value in a data
- Measure and spread of a data, measuring degree of relationship among variables
- Measure of central tendency, dispersion, data interpretation
- Basic probability theory
- Basics of estimation and confidence interval
- Testing hypothesis
- Statistical inferences in decision making
- Survey sampling

Recommended Books:

1. Heumann, Christian, and Schomaker, Michael. Introduction to Statistics and Data Analysis: With Exercises, Solutions and Applications in R. Switzerland, Springer International Publishing, 2023.
2. James, Gareth, et al. An Introduction to Statistical Learning: With Applications in R. Germany, Springer New York, 2013.
3. Reid, Howard M.. Introduction to Statistics: Fundamental Concepts and Procedures of Data Analysis. United States, SAGE Publications, 2013.

CS-301 Applications of Information and Communication Technologies Credit Hours: 3 (2+1)

Course Contents:

- Brief history of Computers.
- Types of computers (Super, Mainframe, Mini and Micro Computer)
- Computer elements: Hardware, software, Storage Devices, Input Devices, Output Devices.
- Software: Operating Systems, Programming and Application Software.
- Introduction to Programming Languages.
- Databases and Information Systems.
- Data Communication and Networks.
- The internet: browsers and search engines.

- Email, collaborative computing, and social networking.
- E-commerce.
- IT Security and other issues.
- Use of Microsoft Office tools (MS Word, MS Powerpoint, MS Excel).

Recommended Books

1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.
3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in Computers & Education." Computers & Education 122 (2018): 136-152.
4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.
5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.
6. Introduction to Computers, Peter, N. McGraw-Hill

STAT-301 Introduction To Statistics Credit Hours:03

Course Objectives:

The main objectives of the course are to enhance students‟ competency in application of statistics. Statistical analysis help to shape important decisions that have local, national, and global impacts. This discipline can offer insight and support in any situation where relevant data can be collected, analyzed, interpreted, and presented to work toward an effective resolution.

Learning Outcomes:

At the conclusion of this course, the student will be:

- Data description and data presentation
- Measures of Central Tendency
- Measure of Relative Dispersion
- Basic probability concepts
- Sample Regression and Correlation

Course Contents:

Introduction

- Definition
- Descriptive Statistics & Inferential Statistics
- Statistics Applications in other fields

Data Condensation and Presentation

- Data and Data Classification
- Tabulation
- Data Array and Frequency Distribution
- Cumulative Frequency Distribution

Data Presentation

- Graphical Representation
- Pie Chart
- Frequency Bar Chart
- Frequency Histogram

Measures of Central Tendency

- Means: (Arithmetic, Geometric, Harmonic)
- The Median
- The Mode

Measures of Dispersion For Grouped And Ungrouped Data

- Range
- Mean absolute deviation
- Variance
- Standard Deviation

Random Experiments

- Sample Space
- Events
- Counting Sample Points

Probability Distribution

- Basic concept
- Types of Probability Distribution.
- Random variables

Sample Regression and Correlation

- Least-Squares estimates in Simple Linear Regression
- Standard Deviation of Regression
- Correlation
- Pearson Product Moment Correlation Coefficient

Recommended Books:

1. David, S Moore et.al, Introduction to the Practice of Statistics, 6th Edition WH. Freeman.
2. Levin I. Richard., Statistics for Management, 4th ed; McGraw Hill.
3. Walpole, R, Introduction to Statistics, Edition 3.
4. Professor Sher M. Chaudhry, Introduction to Statistical Theory Part-1 & 2.

MTH-302 Pre-Calculus II Credit Hours: 03

Course Objectives:

To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

Limits and Continuity: Limit of a function, left- hand and right-hand limits, continuity, continuous functions.

Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books:

1. Anton H, Bevens I, Davis S, Calculus: A New Horizon (8th edition), 2005, John Wiley, New York.
2. Stewart J, Calculus (3rd edition), 1995, Brooks/Cole (suggested text).
3. Swokowski E W, Calculus and Analytic Geometry, 1983, PWS-Kent Company, Boston.
4. Thomas G. B, Finney A. R. Calculus (11th Edition), 2005, Addison-Wesley, Reading, Ma, USA

CHEM-431 Physical Chemistry-I Credit Hours: 03(2+1)

Aims and Objectives:

- Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics
- Students 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.

Course Contents:

Gases: Equation of states, ideal and real gases, virial equation and van der Waals equation for real gases, liquefaction of gases-critical phenomena and critical constants. **Thermodynamics and Thermochemistry:** Basic concepts, four laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible andnon-reversible processes, spontaneous and non-spontaneous processes, relations of Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity. **Chemical Equilibrium:** Reversible reaction, examples, nature of chemical equilibrium, law of mass action, equilibrium constant expressions and its unit, relation between Kp and Kc. **Chemical Kinetics:** Rate of reactions, order of reactions, molecularity, extent of reaction, rate law, rate laws of zero order and first-order reactions and differential and integrated forms, examples, concept

of half-life and mean-life, factors affecting rates (Arrhenius equation).

Practical

1. Determination of viscosity and refractive index of liquids.
2. Determination of percent composition of liquid solutions viscometrically.
3. Determination of refractive index and molar refractivity.
4. Determination of percent composition of liquid solutions by refractive index measurements.
5. Determination of heat of solution by solubility method.
6. Determination of heat of neutralization of an acid with a base.
7. Kinetic study of acid catalyzed hydrolysis of ethyl acetate.

Recommended Books:

1. Atkins,P. and Paula,J.D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).
2. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).
3. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).
4. Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana, Lahore, (2013).
5. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).
6. Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Ptv. Ltd., (2011).
7. Davis, W. M., Dykstra, C. E., Physical Chemistry: A Modern Introduction, 2nd ed., CRC Press, (2011).

4th Semester

BCH-311 Biochemistry Credit Hours: 03(2+1)

Aims and 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. **Acid–Base and Electrolyte Chemistry:** Intracellular and extracellular electrolytes, body fluids as electrolyte solutions, pH, Henderson-Hasselbalch equation and buffers, amino acids, peptides and proteins, buffer capacity, buffers of body fluids, haemoglobin as an acid-base system, renal control of acid- base, balance, acid-base disorders: acidosis,alkalosis. Haemoglobin and omeostasis, variation of Na+, K+, Cl- in acid-base disturbances. **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 muco-polysaccharides 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.

Practical:

- Qualitative and quantitative analysis of carbohydrates, lipids and proteins.
- Determination of pH, Preparation of buffers.
- Enzyme catalysis, Progress curve for enzyme catalyzed reactions,
- Determination of values. To study the effect of different factors on the rate of enzyme catalyzed reactions.

Recommended Books:

1. R. C. Alkire, D. M. Kolb, J. Lipkowski, Biselectro chemistry, volume 13, 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
2. Nelson,D.L., Lehninger's Principles of Biochemistry, 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN:149222638, 9781429222631.
3. Voet, D. and Voet, J.D., Biochemistry, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
4. Murray, R.M. and Harper, H.A., Harper's Biochemistry, 25th ed.,Publisher:Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
5. Zubay, G. L., Biochemistry,4th ed., illustrated, Publisher W. M. C. Brown Publishers, (1998), Digitized (2008). ISBN: 0697219003, 9780697219008.
6. Guyton, A. C. & Hall, J. E., Guyton & Hall Textbook of Medical Physiology, 12th ed., Publishers: Saunders Elsevier, (2011). ISBN: 978-1-4160-4574-8.
7. Harvey, R. A., Ferrier, DR, Karandish S.,Lippincott's illustrated Reviews: Biochemistry, 5th ed., and Biochemistry Map (Med maps) Bundle. Publisher:
8. Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

CHEM-441 Environmental Chemistry Credit Hours: 03

Aims and Objectives:

The aim of course is:

- To enable students to acquire knowledge and develop understanding about the fundamental principles of environmental chemistry and different types of pollutions.
- Information will be useful in studying and solving pollution related issues and experiments in the laboratory.

Course Contents:

The atmosphere, composition, temperature and pressure profile. Role of free radicals in the atmosphere, temperature inversion and photochemical smog. Particulate matter in the atmosphere. Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation. Global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone–the ozone hole. CFCs, ozone protection, biological consequences of ozone depletion. Water Pollution, Land pollution, Green Chemistry.

Recommended Books:

1. Baird, C. and Cann, M., *Environmental Chemistry*, 5th ed., W. H. Freeman & Company, (2012).
2. Dara, S. S. and Mihsra, D. D., *A Text Book of Environmental Chemistry and Pollution Control*, 9th ed., S. Chand & Co. Ltd., (2004).
3. Singhi, R. and Singh, V., *Green Chemistry for Environmental Remediation*, John-Willey & Sons, Inc., (2011).
4. Holloway, A. M. and Wayne, R. P., *Atmospheric Chemistry*, 1st ed., Royal Society of Chemistry, (2010).
5. Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. *Water Treatment Technologies for Removal of High Toxicity Pollutants*, Springerlink, UK, (2010).
6. Manahan, S. E., *Environmental Chemistry*, 9th ed., CRC press, Taylor & Francis group, USA, (2009).

CHEM-442 Industrial Chemistry Credit Hours: 03

Aims and 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, and 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
4. publishing app., (2007).
5. Sharma, J., Ndi., Applied Industrial Chemistry, Arise publishers & Distributors, (2012).
6. Heaton, A., An introduction to Industrial Chemistry,3rd ed., Chapman & Hall, (1996).

CHEM-443 Fuel Chemistry Credit Hours: 03

Aims and Objectives:

Able the students about the chemistry of fossil fuels like coal, petroleum and natural gas and their conversion processes to get useful chemical products. Improve their understanding about alternative fuels to be used in case of non-availability of petroleum based oils.

Course Contents:

Chemistry of fossil fuels: Classification of fossil fuels**,** Origin of coal, petroleum and natural gas**,** Preliminary treatment of crude oil**,** Fractionation of crude oil.**,** Properties of petroleum products i.e. CNG, LPG, gasoline, kerosene, diesel fuels and lubricating oils, Coal storage and cleaning**. Carbonization of coal:** Low temperature and high temperature carbonization**,** Coking and non-coking coals**,** Separation of tar from coke oven gas**,** Hydrogen sulfide removal from coke oven gas**. Introduction to alternate sources of energy:** Biomass as energy resources, Biogas technology**. Alcohols:** Alcohols and its uses as alternative fuel. **Hydrogen:** Hydrogen production, storage, handling and its uses as alternative fuel. Fuel Cells and its application**. Solar Energy:** Solar energy collectors. **Nuclear fuels:** Fission and fusion, nuclear reactors and introduction to Hydel energy.

Recommended Books:

1. Harold, H. S. Chemistry of Fossil Fules Biofuels, Cambridge University Press, New York (2013).
2. Nancy, E. C. Chemistry of Sustainable Energy, CRC Press, Tylor & Francis Group, New York (2014).
3. Clarence, K. J. Analytical Methods for Coal and Coal Products, Academic Press, INC., New York (1978).
4. David, E. B., Brian, F. T., Maohong, F. Coal Gasification and its Applications, Elsevier, UK (2011).

5. Efstathios, E. S. M. Green Energy and Technology; Alternative Sources, Springer, New York (2012).

CHEM-444 Analytical Chemistry-I Credit Hours: 03(2+1)

Aims and Objectives:

Students will acquire knowledge about sampling and their 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:

Introduction to Analytical Chemistry: Chemical analysis, analytical processes, sampling and applications. **Measurements and Chemical Analysis:** Concentration units, stoichiometric calculations. **Data Handling:** Experimental errors, precision, accuracy and limits of detection, evaluation of data, quality of results, quality assurances and calibration methods. **Chemical Equilibria:** Basic approach to chemical equilibria (acid-base, redox, complexation, precipitation), solubility and solubility product, ionic strength and activity coefficient, analysis by acid-based chemistry and titration curves.

Practical:

1. Lab safety and precautions
2. Introduction and calibration of glassware and instruments
3. Determination of Cations and anions (mass measurement)
4. Acid-base titrations
5. Redox titrations
6. Complexation titrations

Recommended Books:

1. Christian, G.D., “Analytical Chemistry”, 6th Ed., John Wiley & Sons, New York, 2003.
2. Harris, D.C., “Quantitative Chemical Analysis”, 8th Ed., Freeman, W.H. and Company, New York, 2011.
3. Skoog D.A., West D.M., and Holler F.J., “Fundamentals of Analytical Chemistry”, 8th Ed., Thomson, 2004.
4. Vogel A.I., “A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis”, Longman Green & Co., 1995.
5. Jaffar M., “Experimental Physical Chemistry”, University Grants Commission, 1989.

5th Semester

CHEM-551 Analytical Chemistry-II Credit Hours: 04(3+1)

Aims and Objectives:

The main objectives of this course are to introduce the students to the basics principles, instrumental aspects and applications of separation and spectrophotometric analytical methods.

Course Contents:

Electroanalytical methods: Classification, electrode processes, working principle, instrumentation and applications of potentiometry, coulometry, conductometry, amperometryand electrogravimetry. voltammetry: Basic principle, types, instrumentation and major applications; qualitative and quantitative aspects of voltammetry and polarography. **Spectroscopy:** Classification, basic principles, UV-visible spectroscopy, Lambert-Beer's lawand its deviations, major applications of UV-visible spectroscopy.

Practical:

1. Calibrationof volumetric apparatus and analytical balance and to investigate errors in delivered quantity.
2. Determination of the concentration of strong acid solutions by conductometric titration.
3. Determination of the individual concentration of the acids in the given binary mixtures of strong/weak acidsby conductometric titration.
4. Evaluation ofsolubility product for lead iodate by conductance method.
5. Determination of solubility product of cadmium iodate titrimetrically.
6. Verification of the constancy of solubility product using solvent extraction.
7. Estimation of Ca^{2+} and Mg^{2+} concentration in drinking water by EDTA complexometric titration method.
8. Determination of the concentration of a strong/weak acid using potentiometric titration method.
9. Determination ofCl^{1-} and I^{1-} by the potentiometric titration method.
10. Establishment of the stoichiometric relation for the precipitation of silver chloride.
11. Preparation of buffer solutions and studying buffering capacity.

Recommended Books:

1. G.D. Christian, *Analytical Chemistry*, 6thed., John Wiley & Sons Ltd.(2003).
2. D. Harvey, *Modern Analytical Chemistry*, McGraw-Hill Companies Inc.(2000).
3. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8thed., Thomson Books/Cole, Belmont, USA (2004)
4. D.A. Skoog,F.J. Holler and S.R. Crouch, *Principles of Instrumental Analysis*,

6th ed., Thomson Brooks/Cole, USA (2007).
5. D.C. Harris, *Quantitative Chemical Analysis*, 5th ed., W.H. Freeman Company, New York (1999).
6. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, *Analytical Chemistry*, 2nd ed., Wiley-VCH Verlag GmbH & Co. (2004).
7. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, *Vogel's Textbook of Quantitative chemical Analysis*, 6th ed., Pearson Education Ltd. (2000).
8. G.D. Christian, *Analytical Chemistry*, 6th ed., John Wiley & Sons Ltd. (2003).
9. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, *Analytical Chemistry*, *A Modern Approach to Analytical Science*, 2nd ed., Wiley-VCH Verlag GmbH & Co. (2004).
10. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, *Vogel's Textbook of Quantitative chemical Analysis*, 6th ed., Pearson Education Ltd. (2000).

CHEM-552 Inorganic Chemistry-II Credit Hours: 04(3+1)

Aims and 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; Back ground 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: 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. **Actinides:** General characteristics, electronic structure, oxidation state and position in the periodic table, half-life and decay law.

Practical:

1. Preparations of following Inorganic Complexes;
2. Tetra ammine copper (II) sulphate.
3. Potassiumtrioxalatochromate (III).
4. Potassiumtrioxalatoaluminate (III).
5. Cis-Potassium dioxalatodiaquachromate (III).
6. Determination of zinc and cadmium by complexometric titration

7. Chromatographic separations of transition metals;
8. Separation of Ni^{2+} & Co^{2+} ions in a mixture by paper chromatography.
9. Separation of Ni^{2+} & Cu^{2+} ions in a mixture by paper chromatography.
10. Separation of Cu^{2+} & Fe^{2+} ions in a mixture by paper chromatography.
11. Spectrophotometric determination of iron, manganese and nickel.

Recommended Books:

1. Cotton, F.A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley- Interscience, (1999).
2. House craft, 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 & 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).

CHEM-553 Organic Chemistry-II Credit Hours: 04(3+1)

Aims and Objectives:

Students will gain knowledge about the stereo-chemical 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, and elimination reactions, concept of energy profile, transition state and intermediate.

Practical:

- Experiments using polarimeter such as to determine optical activity of a sugar solution and to determine sugar concentration by polarimeter, isomerization of maleic acid.
- Experiments involving aliphatic addition, elimination and substitution reactions, e.g., synthesis of cyclohexene from cyclohexanol, addition reaction to cyclohexene etc.
- Synthesis of a chalcone explaining the concept of condensation and dehydration, N- Alkylation of phthalimide, etc.

Recommended Books:

1. John, E. M., Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
2. Younas, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2006).
3. Morris, D. G., Stereochemistry (Basic Concepts in Chemistry), Wiley- RSC, (2002).
4. Mislow, K., Introduction to Stereochemistry, Dover PublicationsInc., (2003). David M., Stereochemistry (Tutorial Chemistry Texts), Royal Society of Chemistry, (2002).
5. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed., Brooks/ Cole Cengage Learning, (2012).
6. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons, Inc., (2011).
7. 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).

CHEM-554 Physical Chemistry-II Credit Hours: 04(3+1)

Aims and Objectives:

Students will be able to understand and acquire knowledge about the principles and theoretical background of solution chemistry, theory of dilute solution, and kinetics theory of gases.

Course Contents:

Solution Chemistry: Concept of solute and solvent, types of solutions, mixture and their importance, solution formation and interactions, concentration units, solubility and factors effecting it, Henry's law. **Theory of Dilute Solution:** Colligative properties; Lowering of vapor pressure, Raoult's Law elevation of boiling point, depression of freezing point, elevation of osmotic pressure and experimental methods for the determination of these

properties, partial molar quantities. **Kinetic Theory of Gases**: Kinetic molecular theory of gases, kinetic gas equation, gas laws in terms of kinetic gas equation, Probability density for molecular speeds of gas molecules, Maxwell distribution of molecular velocities; average velocity, root mean square velocity, most probable velocity, pressure of an ideal gas, calculation of molecular speeds, Collision properties: binary collisions, effusion and mean free paths, Maxwell-Boltzmann's law of energy distribution, method for the determination of the Avogadro's number (NA).

Practical:

1. Equilibrium constant of the $KI + I_2 = KI_3$ reaction.
2. Kinetics of saponification of ethyl acetate.
3. Acid catalyzed hydrolysis of sucrose.
4. Study of the adsorption isotherms of acetic acid-charcoal system.
5. Study of the charge transfer complex formation between iodine and benzene.
6. Determination of activation energy for the acid catalyzed hydrolysis of ethyl acetate.
7. Determination of partial molar volumes.
8. Characterization of the given compound by UV-Vis spectroscopy.

Recommended Books:

1. Silbey, R. J., Alberty, R. A., and Bawendi, M. G., Physical Chemistry, 4th ed., Jojn- Wiley & Sons, (2005).
2. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).
3. Keeler. J. and Wothers, P., Chemical Structure and Reactivity: An
4. Integrated Approach, 1st ed., Oxford University Press, (2008).
5. Garland, C. W., Nibler, J. W. and Shoemaker, D., P., Experiments in Physical Chemistry, 8th ed., McGraw-Hill, (2003).
6. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W.H. Freeman, New York, (2010).
7. J. Burgess, *Ions in Solution: Basic Principles of Chemical Interactions*, Ellis Harwood Ltd. UK (1999).
8. C. Reichardt, *Solvents and Solvent Effects in Organic Chemistry*, 3rd ed., VCH, Weinheim, Germany (2003).

6th Semester

CHEM-561 Analytical Chemistry-III Credit Hours: 04(3+1)

Aims and Objectives:

The students will be able to gain knowledged abount the principles and applications of various separation techniques.

Course Contents:

Separation techniques: basic principle of solvent extraction, distribution coefficient, distribution ratio, counter current distribution, applications of solvent extraction. Theoretical aspects of chromatography: *Van Deemter* equation, column efficiency, band broadening and resolution, classification, various types of planar and column chromatography. Basic principles and applications of: adsorption, partition, ion exchange, size exclusion and affinity chromatography. Gas chromatography and high-performance liquid chromatography: instrumentation, types of column, sample injection system, column loading and detectors, qualitative and quantitative aspects.

Practical:

1. Determination of Cu^{2+} in solution by electrogravimetric method.
2. Separation and quantification of copper in brass using constant-current electrolysis.
3. Verification of Beer's law and evaluation of molar extinction coefficient.
4. Estimationof Ni^{2+} in solution spectrophotometrically.
5. Spectrophotometric determination of ammonia.
6. Spectrophotometric determination of phosphate (PO_4^{3-}) in given sample.
7. Determination of Fe^{2+} by spectrophotometric method using 2,2′-bipyridine/o-phenanthroline.
8. Spectrophotometric determination of Fe^{3+} with potassium thiocyanate.
9. Determination of distribution coefficient of a given solute between and aqueous/non-aqueous system.
10. Separation ofFe^{3+}, Co^{2+}, Ni^{2+} and Cu^{2+} from mixture using paper and thin layer chromatography.
11. Determination of the percentage composition of Na_2CO_3 in commercial soda ash using pH titration method.
12. Estimation of Pb^{2+} ampereometrically through titration with potassium dichromate.
13. Determination of $Ca^{2+}$by the indirect titration with EDTA.
14. Determination of Zn^{2+} by direct titration with EDTA.
15. Analysis of commercial hypochlorite or peroxide by iodometric titration.

Recommended Books:

1. D.A. Skoog,F.J. Holler and S.R. Crouch, *Principles of Instrumental Analysis*, 6thed., Thomson Brooks/Cole, USA (2007).
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 9thed., Thomson Books/Cole, Belmont, USA (2013).

3. D.C. Harris, *Quantitative Chemical Analysis*, 8th ed., W.H. Freeman Company, New York (2010).
4. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, *Instrumental Methods of Analysis*, Wiley, New York(2003).
5. G.D. Christian, *Analytical Chemistry*, 6th ed., John Wiley & Sons Ltd. (2003).
6. D. Harvey, *Modern Analytical Chemistry*, McGraw-Hill Companies Inc.(2000).
7. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, *Analytical Chemistry, A Modern Approach to Analytical Science, 2nd ed., Wiley-VCH Verlag GmbH & Co. (2004).*
8. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th ed., Pearson Education Ltd.(2000).
9. G.D. Christian, *Analytical Chemistry*, 6th ed., John Wiley & Sons Ltd.(2003).
10. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, *Analytical Chemistry:A Modern Approach to Analytical Science*,2nd ed., Wiley-VCH Verlag GmbH & Co.(2004).
11. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th ed., Pearson Education Ltd.(2000).

CHEM-562 Inorganic Chemistry-III Credit Hours: 04(3+1)

Aims and 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 vapour deposition and sputtering, Introduction to nano-materials.

Practical:

1. Estimation of anions in mixtures:
2. Chloride-phosphate, chloride-nitrate, oxalate-chloride, sulphate-phosphate, bromide- nitrate, borate-acetate, iodide-nitrate.
3. Iodometric titration with potassium iodate
4. Gravimetric estimation of oxalate
5. Precipitation Titrations.
    a. Determination of strength of NaCl given solution by AgNO3 using Fluorescein as indicator.
    b. Determination of % age purity of KBr using Fluoresceine as indicator.

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

6. Spectrophotometric determination of cerium
7. 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. Housecraft, C. and Sharpe, A. G.,Inorganic Chemistry,4th ed., Prentice Hall, (2012).
4. Rodgers G. E., Descriptive Inorganic, Coordination, and Solid State Chemistry, 3rd ed., Brooks-Cole, (2012).
5. Smart L. E., Moore E. A., Solid State Chemistry: An Introduction, 4th ed., CRC Press, (2012).
6. Müller, U., Inorganic Structural Chemistry, 2nd ed., John-Wiley & Sons, (2006).

CHEM-563 Organic Chemistry-III Credit Hours: 04(3+1)

Aims and 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.

Practical:

1. 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.
2. 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. Mohan, J., Organic Analytical Chemistry: Theory and Practice, 1st ed. Alpha Science Int. Ltd.New Delhi, India, (2003).
3. Mayo, D. W., Pike, R. M. and Forbes, D. C.,Microscale Organic
4. Laboratory with Multistep and Multiscale Syntheses, 5th ed., John-Wiley & Sons, Inc., (2011).
5. Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale and Microscale Approach, 5th ed., Brooks/ Cole Cengage Learning, (2010).
6. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons, Inc., (2011).
7. Carey, F. A. and Giuliano, R. M., Organic Chemistry, 9th ed., McGraw-Hill Education, (2013).
8. Bruice, P. Y., Organic Chemistry, 7th ed., Perason Education, Ltd., (2013).
9. Smith, M. B., March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th ed., John-Wiley & Sons, Inc., (2013).

CHEM-564 Physical Chemistry-III Credit Hours: 04(3+1)

Aims and 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.

Course Contents:

Electrochemistry: Overview of basic concepts; Redox reactions, spontaneous reactions, Faradaic processes and non-faradaic processes, electrolytes, types of electrodes, standard electrode potentials, applications of electrode potential, electrochemical series, liquid junction potential, Nernst's equation, electrochemical cells, Faraday's laws of electrolysis. Theories of electrolytes; interfacial phenomenon, electrical double layer, Göuy, Stern, Helmholtz models. Voltammetry, electrode set up; reference and indicator electrodes, potentiometry, corrosion and its prevention, Batteries and fuel cells: working principle, structural components, types/examples. **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. **Surface Chemistry:** Interfaces, Gibbs surface excess, curved surfaces, capillary action, adsorption and adsorption isotherms, Freundlich and Langmuir adsorption isotherms, catalysis, colloids, emulsion and their industrial applications.

Practical:

- 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.

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).
8. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W.H. Freeman, New York, (2010).

Specialization (Analytical/Inorganic/Organic/Physical Chemistry)

BS 4th Year (7th& 8th Semester)

Analytical Chemistry

CHEM-671 Atomic Spectroscopy Credit Hours: 03

Flame Photometry: Origin and classification of atomic spectroscopic methods, origin of atomicspectrum, position of the signal, intensity of the signal, spectral line width,principle of flame photometry, fate of the sample in the flame, flame and itscharacteristics,instrumentation for flame photometry, merits and limitations. **Atomic Fluorescence Spectrometry:**Origin of atomic fluorescence, atomic fluorescence spectrum, types of atomicfluorescence 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 dependenceof absorption, quantitative methodology, instrumentation for atomic absorptionspectrophotometry, radiation sources, atomizers, flames, graphite furnacesand electrochemical atomizers, monochromators, detectors, handlingbackground absorption, interferences in atomic absorption spectrophotometry,sample handling in atomic absorption spectrophotometry, preparation of thesample, use of organic solvents, microwave, digestion, sample introductionmethods, applications of atomic absorption spectrophotometry. **Atomic Emission Spectrophotometry:** Introduction, principle of atomic emission spectrometry, atomic emissionspectrometry using plasma sources, plasma and its characteristics, inductively coupled plasma, direct current plasma, microwave induced plasma, choice ofargon as plasma gas, instrumentation for ICP-MS.

Recommended Books:

1. G. D. Christian, *Analytical Chemistry*, 6th ed., John-Wiley & Sons(2006).
2. D. C. Harris,*Quantitative Chemical Analysis*, 8th ed., W. H. Freeman andCompany (2011).
3. D. Kealey, and P. J. Haines, *BIOS Instant Notes in Analytical Chemistry,*Bios Scientific Publishers Limited (2002).
4. B. K. Sharma,*Instrumental Methods of Chemical Analysis*, 24th ed., GoelPublishing House(2005).
5. D. A. Skoog, and D. M. West, *Fundamentals of Analytical Chemistry*, 8th ed., Hot Reinehart Inc.(2008).
6. L. Ebdon, E. H. Evaus,A. Fischer, and S. J. Hill, *An Introduction toAnalytical Atomic Spectrometry*, John Wiley & Sons (1998).
7. B. Welz, M. Sperling, *Atomic Absorption Spectrometry*, 3rd ed.,Wiley-VCH(1998).
8. M. A. Farrukh, *Atomic Absorption Spectroscopy*, In Tech (2012).
9. R. Kellner, J. M. Mermet, M. Otto, M. Valcarcel, H. M. Widmer, *AnalyticalChemistry : A Modern Approach to Analytical Science*, Wiley-VCH (2004).

CHEM—672 Electroanalytical Techniques Credit Hours: 03

Aims and Onjectives:

By studying the course, the student will acquire the knowledge of various electroanalytical techniques.

Course Contents:

Potentiometry: Electrode potential, Nernst equation and its use for measuring half-cellpotential, different kinds of electrodes including glass and calomel electrodes,working of potentiometer and its applications including pH measurements, Ionselective electrode systems, Ion exchange membrane electrode, solid statemembrane 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, anodicstripping voltammetry. voltammetric equation, basic concept of polarographyand interpretation of various polarographic curves, measurement ofdecomposition potential, diffusion and limiting currents, derivation of Ilkovicequation, logarithmic analysis of polarographic wave, advantages andlimitation of dropping mercury electrode.

Recommended Books:

1. G. D. Christian, Analytical Chemistry, 6thed., John-Wiley & Sons (2006).
2. D. C.Harris, Quantitative Chemical Analysis, 8thed.,W.H. Freeman and Company (2009).
3. D. Kealey and P. J. Haines, BIOS Instant Notes in Analytical Chemistry,Bios Scientific Publishers Limited (2002).
4. B. K. Sharma, Instrumental Methods of Chemical Analysis, 24thed., GoelPublishing House (2005).
5. D. A. Skoog, and D. M. West, Fundamentals of Analytical Chemistry, 8th ed., Hot Reinehart Inc. (2008).
6. Fritz, Schulz, Electranalytical Methods: Guide to Experiments andApplications, 2nd revised, Springer-Verlag Berlin (2010).
7. P. M. S. Monk, Fundamentals of Electroanalytical Chemistry, John-Wiley &Sons Ltd(2001).

CHEM-673 Advanced Separation Techniques Credit Hours: 03

Aims and Objectives:

The students will get to know the basics and principles of gas liquid chromatography, HPLC, and capillary electrophoresis.

Course Contents:

Introduction: Classifications of chromatographic techniques, the chromatographicprocesses, rate theory of chromatography, Van-Deemter equation and itssignificance 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 andreverse phase separation), instrumentation, method development andapplications.**Capillary electrophoresis:**Theory and principle of CE, mobility, electro osmotic flow separation by CE,instrumentation, modes of operation, applications.

Recommended Books:

1. D. A. Skoog, P. M. West, F. J. Holler, and S. R. Crouch, Fundamentalsof Analytical Chemistry, 9thed., Cengage Learning (2013).
2. G. D. Christian, Analytical Chemistry, 6th ed., John-Wiley & Sons (2004)
3. D. Kealey, and P. J. Haines, BIOS Instant Notes in Analytical Chemistry,1sted., Taylor & Francis (2002).
4. B.K. Sharma, Instrumental Methods of Chemical Analysis, 24thed., GoelPublishing House (2005).
5. R. L. Grob, F. Eugene, Barry, Modern Practice of Gas Chromatography,4thed., John-Wiley & Sons (2004).
6. R. Kellner, J. M. Mermet, M. Otto,M. Valcarcel, and H. M. Widmer, Analytical Chemistry: A Modern Approach to Analytical Science, WileyVCH (2004).
7. V. R. Meyer, Practical High-Performance Liquid Chromatography, 5thed.,John-Wiley & Sons, Ltd. (2010).
8. S. Lindsay, High Performance Liquid Chromatography, 2nded., John Wiley & Sons, Ltd. (1992).A. Braitwaite, and F. J. Smith, Chromatographic Methods, 5th ed., KluwerAcademic Publishers (1999).
9. J. M. Miller, Chromatography: Concepts and Contrasts, 2nded., JohnWiley & Sons, Inc. (2005).
10. P. Camilleri, Capillary Electrophoresis: Theory and Practice, 2nded., CRCPress (1998).

CHEM-674 Luminescence Spectroscopy and Thermal Analysis Credit Hours: 03

Aims and Objectives:

The students will get to know the basics and principles of luminescence spectroscopy and thermal analysis.

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. G. D. Christian, *Analytical Chemistry*, 6th ed., John-Wiley & Sons (2006).

2. D. C. Harris, *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company (2011).
3. R. D. Braun, *Introduction to Chemical Analysis*, International StudentEdition (1985).
4. P. J. Haines, and Whitby, *Thermal Methods ofAnalysis Principles, Applications and Problems*, 1st ed., On Canada Mcgraw Hill Ltd., Springer (1995).
5. J. R. Lakowicz, *Principles of Fluorescence Spectroscopy*, 3rded., Springer(2006).
6. P. Gabbot, *Principles & Applications of Thermal Analysis*, Wiley-Blackwell(2007).
7. M. E. Brown, *Introduction to Thermal Analysis: Techniques andApplications*, 2nd ed., Kluwer Academic Publishers (2001).
8. D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8thed., (Int.), Cengage Learning(2004).
9. C. Burgess and D. G.Jones, *Spectrophotometry, Luminescence andColour; Science and Compliance*, Vol. 6, Elsevier Science (1995).

CHEM-681 Nuclear Analytical Techniques Credit Hours: 03

Aims and Objectives:

The students will get to know the basics principles, equations, advantages and limitations, and applications of radiotracer techniques.

Course Contents:

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

Recommended Books:

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

CHEM-682 Food and Drug Analysis Credit Hours: 03

Aims and Objectives:

The students will be able to gain knowledge about food and drug analysis.

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 andsoft 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 ofcrime scene evidences, fingerprinting, skeletal material to provide scientificopinion for legal.

Recommended Books:

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

CHEM-683 Molecular Spectroscopy Credit Hours: 03

Aims and Objectives:

The students will get to know the fundamental concepts, principles, and instrumentation of molecular spectroscopy techniques.

Course Contents:

Molecular structure and spectral transitions: Measurement of spectra, light scattering-elastic and inelastic, absorption and emission spectroscopy. Absorption spectroscopy in UV-Visible region: Absorbance and transmittance, spectral resolution and errors in concentration measurements, applications and comparison of fluorescence and phosphorescence spectroscopy, spectral interferences and spectra of mixtures, chemical

interferences, instrumental interferences. **Instrumentation:** Wavelength separations, sources and detectors for electromagnetic radiations. **Derivative spectroscopy:** Theory and applications. **IR and Raman spectroscopy:** Vibrational frequencies, qualitative analysis, IR spectra and Raman spectra, band intensities, quantitation, IR and Raman spectrophotometers, correlation charts and tables. NMR Spectroscopy: Introduction, principles and applications of NMR.

Recommended Books:

1. D. Harvey, *Modern Analytical Chemistry*, McGraw-Hill Companies Inc.(2000).
2. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, *Analytical Chemistry*, 2nded., Wiley-VCH, Verlag GmbH & Co. KGaA, Weinheim (2004).
3. D.L. Pavia, G.M. Lampman, and G.S. Kriz, *Introduction to Spectroscopy*, 3rded., Thomson Learning Inc.(2001).
4. K.A. Rubinson and J.F. Rubinson, *Contemporary Instrumental Analysis*, Prentice-Hall, Inc., USA(2000).
5. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, *Vogel's Textbook of Quantitative Analysis*, 6thed., Pearson Education Ltd.(2000).
6. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8thed., Thomson Books/Cole, Belmont, USA (2004).
7. F. Rouessac and A. Rouessac, *Chemical Analysis – Modern Instrumental Methods and Techniques*, John Wiley & Sons, Ltd., UK (2000).
8. G.D. Christian, *Analytical Chemistry*, 6thed., John Wiley & Sons Ltd., Singapore(2003).
9. D.C. Harris, *Quantitative Chemical Analysis*, 5thed., W.H. Freeman Company, New York (1999).

CHEM-684 Mass Spectrometery Credit Hours: 03

Aims and Objectives:

The students will get to know the basics of mass spectrometery.

Course Contents:

Introduction: theory, instrumentation and sample handling, Single and Double Focusing Techniques, Resolving Power, **Ionization Energy and energy Distribution; Ionization Methods:** Electron Impact, Chemical Ionization, Electrospray Ionization, Field Desorption, Fast Atom Bombardment, **Types of Ions:** Molecular Ions, Fragment Ions, Metastable Ions, Fragmentation Rules, Simple Bond Fission, Charge Site Initiation, Dissociation of Cyclic Compounds, McLafferty Rearrangement, Skeletal Rearrangement, Theory of Mass Spectral Fragmentation.

Recommended Books:

1. R. Ekman, J. Silberring and A. M. W. Brinkmalm *Mass Spectrometry Instrumentation, Interpretation and Applications*, John Wiley & Sons, (2009).
2. C. Dass, *Fundamentals of Contemporary Mass Spectrometry*, John Wiley & Sons, (2007).
3. C. Barshick, D. Dackworth, and D. Smith, *Inorganic Mass Spectrometr: Fundamentals and Applications*, Taylor & Fancis (2000).

CHEM-679 Field Experience

CHEM-689 Capstone Research Project/Advanced Lab in Analytical Chemistry Credit Hours: 03

The student shall undertake and complete short research project under the supervision of a teacher. The evaluation shall be based on its oral presentation or oral examination (viva) and written report.

The advanced level practical shall be offered involving different experimental facilities available in the section/department. The details of the laboratory work and the equipment involved shall be decided by the teacher concerned on the basis of the courses taught.

Inorganic Chemistry

CHEM-671 Atomic Spectroscopy Credit Hours: 03

Flame Photometry: Origin and classification of atomic spectroscopic methods, origin of atomicspectrum, position of the signal, intensity of the signal, spectral line width,principle of flame photometry, fate of the sample in the flame, flame and itscharacteristics,instrumentation for flame photometry, merits and limitations.**Atomic Fluorescence Spectrometry:**Origin of atomic fluorescence, atomic fluorescence spectrum, types of atomicfluorescence 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 dependenceof absorption, quantitative methodology, instrumentation for atomic absorptionspectrophotometry, radiation sources, atomizers, flames, graphite furnacesand electrochemical atomizers, monochromators, detectors, handlingbackground absorption, interferences in atomic absorption spectrophotometry,sample handling in atomic absorption spectrophotometry, preparation of thesample, use of organic solvents, microwave, digestion, sample introductionmethods, applications of atomic absorption spectrophotometry.**Atomic Emission Spectrophotometry:**Introduction, principle of atomic emission spectrometry, atomic emissionspectrometry using plasma sources, plasma and its characteristics, inductively

coupled plasma, direct current plasma, microwave induced plasma, choice ofargon as plasma gas, instrumentation for ICP-MS.

Recommended Books:

1. G. D. Christian, *Analytical Chemistry*, 6th ed., John-Wiley & Sons(2006).
2. D. C. Harris,*Quantitative Chemical Analysis*, 8th ed., W. H. Freeman andCompany (2011).
3. D. Kealey, and P. J. Haines, *BIOS Instant Notes in Analytical Chemistry*,Bios Scientific Publishers Limited (2002)
4. B. K. Sharma,*Instrumental Methods of Chemical Analysis*, 24th ed., GoelPublishing House(2005).
5. D. A. Skoog, and D. M. West, *Fundamentals of Analytical Chemistry*, 8th ed., Hot Reinehart Inc.(2008).
6. L. Ebdon, E. H. Evaus,A. Fischer, and S. J. Hill, *An Introduction toAnalytical Atomic Spectrometry*, John Wiley & Sons (1998).
7. B. Welz, M. Sperling, *Atomic Absorption Spectrometry*, 3rd ed.,Wiley-VCH(1998).
8. M. A. Farrukh, *Atomic Absorption Spectroscopy*, In Tech (2012).
9. R. Kellner, J. M. Mermet, M. Otto, M. Valcarcel, H. M. Widmer, *AnalyticalChemistry : A Modern Approach to Analytical Science*, Wiley-VCH (2004).

CHEM-672 Nuclear Chemistry Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about nuclear chemistry and nuclear reactions.

Course Contents:

Nuclear Reactions: Nature of nuclear reactions, nuclear reaction mechanism, nuclear cross sections, excitation functions, types of nuclear reactions, fission and fusion reactions and photonuclear reactions, Radioactivity decay, detection and interaction of radiations Half-life and average life of radioactive species, types of radioactive equilibrium, units of radioactivity. Radioactive decay series, Determination of half-lives, radiation detection and measurements, Geiger mullar counters, scintillation counters. Interaction of radiation with matter. Determination of alpha and beta particles range.

Recommended Books:

1. G. F. Friellander, J. W. Kennedy, and J. M. Miller, Nuclear and Radiochemistry, John Wiley and Sons, New York
2. Kaplan Traving, Nuclear Physics, Pak Publishers, Karachi.
3. Glasstone Samuel, Source book on atomic energy, von Nostrand, New York.
4. W. M. Gibbson, Nuclear reactions, Penguin books Inc., New York.
5. J. M. Reid, The atomic nuclear reactions, Penguin books Inc., New York.
6. Chopman and Ryedberg, Nuclear chemistry, Prentice Hall, New York.

CHEM-673 Bio-Inorganic Molecules Credit Hours: 03

Aims and Objectives:

Student will acquire sound knowledge about Bio-inorganic Molecules.

Course contents:

Biochemistry of selenium, Bio Chemistry of Organo selenium Compounds, Antioxidant Activity of Organoselenium Compounds, Toxicology of Organoselenium Compounds; The biochemistry of iron, Iron storage and transfer in bacteria, ion transport, haemoglobin and myoglobin, nature of haemo-dioxygen , Model systems, cytochromes, P/450 enzymes, iron sulphur protein , ferrodoxins, haemoerthrins, the biochemistry of Zn, Cu. Co, Mg, F_2, I_2 and Alkaline earth metals.

Recommended Books:

1. F.A. Cotton, and S.W, Advanced inorganic chemistry, John Wiley and sons, New York.
2. F. Basolo and R. Johnson, Mechanism of inorganic reactions, John Wiley and sons, New York.
3. F. Basalo and R. Johnson, Coordination chemistry, W.A. Benjamen, Row Publishers, New York.
4. J. E. Huheey, Inorganic Harper and Row Publisher, New York.
5. D. Jonson, Mechanism of inorganic reaction in solutions, McGraw-Hill, London.
6. Nicolaou, K. C.; Petasi, N. A. Selenium in Natural Products Synthesis; CIS: Philadelphia, PA, 1984.
7. Paulmier, C. SeleniumReagents and Intermediates in Organic Synthesis; Pergamon: Oxford, U.K., 1986.
8. Patai, S.; Rappoport, Z. The Chemistry of Organic Selenium and Tellurium Compounds;Wiley: New York, 1986; Vol. 1.

CHEM-674 Coordination Chemistry Credit Hours: 03

Aims and Objectives:

Student will acquire sound knowledge about coordination compounds, complex molecules, chelating effect, and organometallic compounds.

Course Contents:

Overview: Historical developments, preparation, and reactions of coordination compounds in aqueous and non-aqueous solvents, thermal dissociation of solid complexes. Complex stability: factors, thermodynamics, and stability constant. **Kinetics and mechanisms:** basic kinetic parameters, inert and labile complexes of coordination compounds. **Mechanisms of substitution reactions:** Dissociation, association, and interchange reaction pathways. **Octahedral substitution reactions:** Dissociation,

associative, the conjugate base mechanisms. Kinetic chelating effect. Square planar substitution reaction: Stereochemistry, trans effect. Oxidation-reduction reactions: Inner and outer sphere reaction mechanisms. Organometallics and their role in catalysis, comparative studies of coordination compounds belonging to main group and transition elements with reference to synthesis and stability. Intermetallic compounds.

Recommended Books:

1. G.L. Miessler and D.A. Tarr, *Inorganic Chemistry*, 5th ed., Pearson Education International (2013).
2. F. Basolo and R.C. Johnson, *Coordination Chemistry*, NBF Pakistan (1988).
3. J.E. Huheey, *Inorganic Chemistry, Principles of Structure and Reactivity*, 4th ed., Addison-Wesley, Reading/Singapore (1993).
4. F.A. Cotton, et al., *Advanced Inorganic Chemistry*, 6th ed., John Wiley, New York (1999).
5. P.L. Soni and V. Soni, *Coordination Chemistry: Metal Complexes*, CRC Press, Taylor& Francis (2013).

CHEM-681 Inorganic Reaction Mechanisms Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about inorganic reaction mechanisms.

Course Contents:

Introduction: D, ID, Ia and A mechanisms, activation parameter, order and rates of reaction, formation of complexes from equations, acid and base hydrolysis, displacement reaction in square complexes , trans effect, substitution reactions and mechanism of substitution in tetrahedral complexes. **Electron transfer processes**: "Outer sphere" reactions, ligand bridge (inner sphere) reactions, two electron transfer and redox reactions. **Theories of Acid-Base:** Acid-Base and Donor-Acceptor Chemistry: Acid and Base Strength; Hard and Soft. Acids and Bases.

Recommended Books:

1. F.A. Cotton, and S.W, Advanced inorganic chemistry, John Wiley and sons, New York.
2. F.Basolo and R. Johnson, Mechanism of inorganic reactions, John Wiley and sons, New York.
3. F.Basalo and R. Johnson, Coordination chemistry, W.A. Benjamen, Row Publishers, New York.
4. J.E. Huheey, Inorganic Harper and Row Publisher, New York.
5. D.Jonson, Mechanism of inorganic reaction in solutions, McGraw-Hill, London.

CHEM-682 Inorganic Polymers Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about chemistry of Inorganic polymers particularly about their classification, preparation, properties, analysis, and applications.

Course Contents:

Introduction: Classification, polymerization processes. Preparation and properties of: polysiloxanes, polyphosphazenes, polythiazyl and transition-metal polymers. **Characterization of polymeric materials:** molecular weight determination, IR and NMR spectroscopy, thermogravimetry, dynamic mechanical analysis, microscopy, differential scanning calorimetry. Applications of polymers.

Recommended Books:

1. J.E. Mark, H. R. Allcock and R. West, Inorganic Polymers, Oxford University Press,(2005).
2. F.G.A. Stone and W.A.G. Graham, Inorganic Polymers, Academic Press, Inc., London (1962).
3. F.G.R. Gimblett, Inorganic Polymer Chemistry, Butterworths, London (1963).
4. C.E. Carraher, Jr., J.E. Sheads amd C.U. Pittman, Jr., Advances in Organometallic and Inorganic Polymer Science, Marcel Dekker, Inc., New York (1982).
5. C.E. Carraher, Jr., Polymer Chemistry, 5th ed., Marcel Dekker, Inc., New York (2000).

CHEM-683 Organometallic Chemistry Credit Hours: 03

Aims and 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:

Definition and classification of organometallic compounds, sigma bonded organometallic compounds (Metal alkyls and Grignard reagents). Synthesis, properties and nature of bonding in pi complexes such as η^2-η^7. Catalysis, Types of catalysis, Organic synthesis via transition metal complexes (Hydroformylation, olefin hydrogenation, polymerization of ethene and oxidation of ethene to acetaldehyde).

Recommended Books:

1. M. Bochmann. Organometallic-1. Oxford University press (1994).
2. M. Bochmann. Organometallic-2. Oxford University press (1994).
3. A. Yamamoto. Organotransition metal chemistry. John wiley & sons, USA (1986).

4. P. Pawell. Principles of organometallic chemistry. 2nd edition, Chapman and Hall, New York (1988).

CHEM-684 Elementary Group Theory Credit Hours: 03

Aims and Objectives:

Students will be able to learn the foundations and concepts of group theory to facilitate the study of symmetric and inversely symmetric systems, identify the elements and processes of symmetry, classify chemical molecules based on the symmetry found in each of them, and use symmetry and group theory for different types of chemical systems.

Course Contents:

Introduction: symmetry; operations & elements, point groups, crystallographic and noncrystallographic point groups, assigning point groups, definition and properties of a group, subgroups, group multiplication table, matrix representation of a group, character tables. The great orthogonality theorem, rules derived from the theorem, developing of character tables for various point groups, matrices, matrix multiplication, character of a matrix, reducible representations and their reduction, symmetry and physical properties of molecules. Application of group theory: to valence bond theory and hybrid orbitals, crystal field theory and John-Teller distortion, MXn molecules with pi-bonding, pi-bonding in aromatic ring systems, vibrational spectroscopy, molecular vibrations using internal coordinates, bonding modes, geometric isomers, infrared and Raman active vibrations, exclusion rule, molecular orbital diagrams, metal sandwich compounds and ABn molecules.

Recommended Books:

1. K.C. Molloy, *Theory for Chemists: Fundamental Theory and Applications*, 2nd ed., Woodhead Publishing in Materials (2011).
2. L.R. Carter, *Molecular Spectrometry and Group Theory*, John Wiley and Sons (2004).
3. A. Vincent, *Molecular Symmetry and Group Theory*, 2nd ed., Wiley (2000).
4. F.A. Cotton, *Chemical Applications of Group Theory*, 3rd ed., Wiley India (2008).
5. A.B.P. Lever, *Introduction to Electronic Spectroscopy*, 2nd ed., Elsevier, Amsterdam (1984)

CHEM-679 Field Experience

CHEM-689 Capstone Research Project/Advanced Lab in Inorganic Chemistry Credit Hours: 03

The student shall undertake and complete short research project under the supervision of a teacher. The evaluation shall be based on its oral presentation or oral examination (viva) and written report.

The advanced level practical shall be offered involving different experimental facilities available in the section/department. The details of the laboratory work and the equipment involved shall be decided by the teacher concerned on the basis of the courses taught.

ORGANIC CHEMISTRY

CHEM-671 Spectroscopic Methods in Organic Chemistry-1 Credit Hours: 03

Aims and Objectives:

Students will acquire an adequate knowledge about fundamental and instrumental aspects of different spectroscopic techniques (UV-Visible spectroscopy, IR spectroscopy, and mass spectrometry) and will be able to perform structural elucidation of organic compounds using spectral data.

Course Contents:

Introduction: The electromagnetic spectrum; Units and their interconversion; The absorption of electromagnetic radiation by organic molecules. **Molecular formula and its determination:** Molecular mass determination; Rule of thirteen and molecular formula; Index of hydrogen deficiency. **UV-Visible spectroscopy:** Introduction; Theory; Sample handling and instrumentation; Chromophores: Conjugated dienes, trienes, polyenes, unsaturated carbonyl compounds, benzene and its derivatives, polynuclear aromatic hydrocarbons and diketones; Factors affecting absorption maxima; Empirical rules for calculation of lambda-max; Applications of UV-visible spectroscopy. **Infra Red spectroscopy:** Introduction; Theory; Sampling techniques; Instrumentation; Characteristics of vibrational frequencies of functional groups; Interpretation of IR spectra. **Mass spectrometry:** Introduction; Theory; Types of fragments: odd electron and even electron containing neutral and charged species; Nitrogen rule; Isotopic peaks; Meta-stable ion peaks; Sample handling; Instrumentation; Fragmentation patterns in different classes of organic compounds; Interpretation of mass spectra. Applications: Structure elucidation of organic molecules based on UV-visible, IR and MS data.

Recommended Books:

1. R.M. Silverstein, F.X. Webster and D.J. Kiemle, Spectrometric Identification of Organic Compounds, John Wiley & Sons Inc., USA (2005).
2. D.L. Pavia, G.M. Lampman and G.S. Kriz, Introduction to Spectroscopy: a Guide for Students of Organic Chemistry, Thomson Learning, Australia (2001).
3. D.W. Brown, A.J. Floyed and M. Sainsbury, Organic Spectroscopy, I. Wiley and Sons, Chichester (1998).
4. D.H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 4th ed., McGraw-Hill Book Co., London (1987).
5. M. Hesse, H. Nleir and U. Zech, Spectroscopic Methods in Organic Chemistry, Georg Thiemc, Stuttgart, New York (1997).
6. Y.C. Ning, Spectral Identification of Organic Compounds with Spectroscopic Techniques, Wiley-VCH, Weinheim (2005).
7. M. Younas, Organic Spectroscopy, Ilmi Kitab Khana, Lahore (2004).

8. Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1st ed., Alpha Science Int. Ltd., (2003).
9. Kalsi, P. S., *Spectroscopy of Organic Compounds*, 6th ed., New Age International, New Delhi, India, (2007).
10. Yadav, L. D. S., *Organic Spectroscopy*, Springer, UK, (2005).
11. Hollas, J. M., *Modern Spectroscopy*, 4th ed., John-Wiley & Sons, Inc., (2004). 44

CHEM-672 Chemistry of Heterocycles Credit Hours: 03

Aims and 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).

CHEM-673 Organic synthesis Credit Hours: 03

Aims and 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).

CHEM-674 Stereochemistry Credit hours: 03

Aims and Objectives:

Students will acquire an adequate knowledge about Stereochemistry.

Course Contents:

Introduction: History and Significance. Static Stereochemistry: Structure and Symmetry, configurations and conformations, methods for determination of relative and absolute configuration, stereochemical nomenclature. **Types of Chirality:** Central, Axial and planar chiral compounds, atropisomerism, molecular overcrowding and cyclostereoisomereism. **Dynamic stereochemistry;** stereochemical reactions, stereoselectivity and stereospecificity, prostereoisomerism and prochirality. **Analytical methods:** determination of enantiomers and diastereomers composition using chiroptical, chromatographic and NMR spectroscopic methods. **Resolution:** Diasteroisomers formation, Chiral derivatization agents (CDAs), Chiral resolving agents (CRAs), chromatographic, kinetic, mechanical and enzymetic resolutions, preferential crystallization.

Recommended Books:

1. Eliel, E. L.; Wilen, S. H Doyle, M.P. and Michael, P. Basic Organic Stereochemistry, Willey Inter Science, New York (2003).

2. Kalsi, P. S. Sterochemistry and mechanism through Solved problems, new age international publishers, New Delhi, India (2001).
3. Mislow, K. Introduction to stereochemistry, W.A. Benjamin, New York (1966).
4. Morris, D.G. Stereochemistry, Royal Society of Chemistry, UK. (2001).
5. M. North. Principles and application of stereochemistry, Stanely Thornes: Cheltenham, UK (1998).
6. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.

CHEM-681 Spectroscopic Methods in Organic Chemistry-1I Credit Hours: 3

Aims and 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, particularly with NMR.

Course Contents:

Nuclear Magnetic Resonance: Theory, Instrumentation and sample handling. **1H NMR Spectroscopy:** Chemical shifts, factors affecting chemical shifts, chemical shifts of organic compounds and their estimation, spin couplings and factors affecting spin couplings, chemical shift equivalence and magnetic equivalence, first order spin systems, double resonance experiments; selective spin decoupling, nuclear overhauser effect and NOE difference spectra. **13C NMR Spectroscopy:** Differences between 1H- and 13C-NMR spectra, chemical shifts,chemical shifts of organic compounds and their estimation,1H BB decoupled and DEPT spectra. **Applications:** Shift reagents; Dynamic NMR; Stereochemical assignments in different types of compounds; NMR in biochemistry and medicine; NMR spectra of polymers; Structure elucidation of organic compounds by joint applications of UV-visible, IR, NMR and MS.

Recommended Books:

1. D.L. Pavia, G.M. Lampman and G.S. Kirz, Introduction to Spectroscopy, Brooks/Cole Thomson Learning, USA (2001).
2. M. Hesse, H. Meier and B. Zeeh, Spectroscopic Methods in Organic Chemistry, Georg Thieme Verlag, Stuttgart, Germany (1997).
3. R. M. Silverstein, F.X. Webster and D.J. Kiemle, Spectrometric Identification of Organic Compounds, John Wiley & sons Inc., USA (2005).
4. M. Balci, Basic 1H- and 13C-NMR Spectroscopy, Elsevier (2005).
5. E. Breitmaier, Structure elucidation by NMR in Organic Chemistry – a Practical Guide, John Wiley & Sons, Ltd (2002).
6. L. M. Harwood and T.D.W. Claridge, Introduction to Organic Spectroscopy, Oxford University Press Inc., New York (1997).

7. H. Friebolin, Basic one-and two-dimensional NMR spectroscopy, 5th ed., Wiley-VCH, New York (2010).
8. Atta-ur-Rahman and M.I. Chaudhary, Solving Problems with NMR spectroscopy, Elsevier (1996).
9. J. B. Lambert and E.P. Mazzola, Nuclear Magnetic Resonance Spectroscopy: An Introduction to Principles, Applications, and Experimental Methods, Pearson Education (2004).
10. R. S. Macomber, A Complete Introduction to Modern NMR Spectroscopy, Johan Wiley & Sons (1998).
11. J. K.M. Sanders and B.K. Hunter, Modern NMR Spectroscopy: a Guide for Chemists, The University Press, Oxford (1993).
12. E. Breitmaier, Structure Elucidation by NMR in Organic Chemistry: a Practical Guide, John Wiley, West Sussex (2002).
13. M. Younas, Organic Spectroscopy, Ilmi Kitab Khana, Lahore (2004).
14. Y. C. Ning, Spectral Identification of Organic Compounds with Spectroscopic Techniques, Wiley-VCH, Weinheim (2005).
15. N. E. Jacobsen, NMR Spectroscopy Explained: Simplified Theory, Applications and Examples for Organic Chemistry and Structural Biology, John Wiley & Sons (2007).
16. E. Pretsch, T. Clerc, J. Seibl, W. Simon and K. Biemann, Tables of Spectral Data for Structure Determination of Organic Compounds, Springer (1998).

CHEM-682 Natural Products Chemistry Credit hours: 03

Aims and 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 elucidationand 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. Oyvind, M. A., and Kenneth, R. M., *Flavonoids: Chemistry, Biochemistry and Applications*, CRC, Taylor & Francis, New York, (2010).
5. Finar, I. L., Organic Chemistry, Vol. 2, *Stereochemistry and the Chemistry of Natural Products,* 5th ed., Pearson Education Ltd., Delhi, (2008).

CHEM-683 Named Organic Reactions Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge and understanding of different organic reactions.

Course Contents:

Name Organic Reactions: Recent developments, mechanistic, stereochemical aspects and synthetic applications of various Name reactions: Aldol Condensation, Diels-alder reaction, Michael Addition, Robinson annulations, Knoevenagal Condensation, Clasien Condensation, Dickmann Condensation, Mannich Reaction, Wittig reaction, Peterson reaction, Heck Reaction, Friedal-Craft reaction, Favorski rearrangement, Husdiecker reaction and fischer indole synthesis, pinacole Rearrangement, Birgmann,s cyclisation,Birch reduction.

Recommended Books:

1. Mundy, B.P. Ellerd, M.G. Favalozo F.G. and Favalozo, Jr. Name Reactions and Reagents in Organic Synthesis, john Wiley, New York (2005).
2. Smith, M. B. and Marks, Advanced Organic Chemistry, Reactions, Mechanism and Structure, 5th ed., John Wiley, New York (2001).
3. R.O.S. Norman, Principles of organic synthesis, 3rd ed., Chapman-Hall, London (1993).
4. Gilchrist, T.L. and Rees, C. W., "Carbenes, Nitrenes and Arynes' Nelson, London.
5. Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University press New York.Sykes, P.,"A guide book to Mechanism in organic Chemistry" longmann, London.
6. Carry, F. A. and Sundberg, R.J., " Advanced Organic Chemistry" Part A:" Structure and Mechanisms" oxford university press.
7. Bruchner, R., Advance Organic Chemistry-Reaction Mechanism" Harcourt Science and Technology company, New York.

CHEM-684 Retro Chemistry Credit Hours: 03

Aims and 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.

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).

CHEM-679 Field Experience

CHEM-689 Capstone Research Project/Advanced Lab in Organic Chemistry Credit Hours:03

The student shall undertake and complete short research project under the supervision of a teacher. The evaluation shall be based on its oral presentation or oral examination (viva) and written report.

The advanced level practical shall be offered involving different experimental facilities available in the section/department. The details of the laboratory work and the equipment involved shall be decided by the teacher concerned on the basis of the courses taught.

Physical Chemistry

CHEM-671 Chemical Kinetics Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about Kinetics of chemical reactions.

Course Contents:

Rate: Review of essentials of rate laws and order of reactions, 2nd and 3rd order reaction with same and differential and integrated rate equations. Reaction mechanisms; mechanistic interpretation of rate laws, equivalent kinetic expressions. **Reaction rate Theories:** KineticTheories of chemical reactions:Collision theory, Transition state theory (TST), Applications of TST;temperature effects; heat capacity of activation; composite rate constants; pressure effects and volume of activation; interpretation of activation parameters. **Composite reactions:** reversible 1st and higher order reactions, parallel and concurrent reactions, consecutive first order reactions; steady state approximation; rate controlling step; kinetics of polymerization; catalyzed reactions; characteristics of chain reactions; pH- rate profiles.

Recommended Books:

1. I.N. Levine, *Physical Chemistry*, McGraw Hill, New York (2002).
2. K.J. Laidler, *Chemical Kinetics*, 3rd ed., Pearson Education Ins., Singapore, (1987).
3. *An Introduction to Chemical Kinetics*, Michel Soustelle, Wiley-ISTE.(2011).
4. J.H. Espenson, *Chemical Kinetics and Reaction Mechanisms*, 2nd ed., McGrawHil l Singapore (1995).
5. P.L. Houston, *Chemical Kinetics and Reaction Dynamics*, Dover edition, New York, November 17, 2006.
6. A.A.M. Frost and R.G. Pearson, *Kinetics and Mechanism*, 3rd ed., Butterworths, London (1969).

CHEM-672 Photo Chemistry Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about photo chemistry.

Course Contents:

Scope of photochemistry: Energy transfer in photochemical reaction. Quantum yield of emission process radiation and non-radiation process. Kinetics and Quantum yields of radiative and nonradioactive process (fluorescence, phosphorescence, inter system crossing, internal conversion, quenching), and Stern-Volmer reactions. Photosensitized reactions. Photochemical reaction in gas phase. Flash photolysis. Advance approach to

kinetics of photochemical reactions. Applied photochemistry. Atmospheric photochemistry. Photosynthesis, photochemistry of polymers, photomedicines. Techniques in photochemistry, introduction, light source. Incandescent filament lamps, discharge lamps, lasers, synchrotron reaction.

Recommended Books:

1. Calvert J.G. and Pitts J.N. "Photochemistry" John Wiley, New York (1966).
2. Suppan P. "Principles of Photochemistry", the Chemical Soc., UK (1973).
3. Albert R.A., Robert J.S. and Moungi G.B. "Physical Chemistry". 4 ed., John Wiley and Sons (2004).
4. Ball D.W. "Physical Chemistry" 1 ed., Brooks/Cole Co. Inc. (2003).

CHEM-673 Thermodynamics Credit Hours: 03

Aims and Objectives:

Students will learn the fundamental principles of Thermodynamics.

Course Contents:

Basic concepts: State and path functions and their discrimination by Euler's theorem, Thermodynamic processes, Heat capacities, Chemical potential, Enthalpy and entropy and their dependence on volume (Joule-Thomson effect) Joule-Thomson coefficient and its determination, Free energy change, Relation between thermodynamic functions. **Laws of thermodynamics:** Zeroth, 1st, 2nd and 3rd laws of thermodynamics, Applications of 1st and 2nd laws of thermodynamics, Entropy and laws of thermodynamics. **Equilibrium thermodynamics:** Relation of entropy and energy with equilibrium constant, and their dependence on temperature, Van't Hoff's equation, Clausius-Clapeyron equation. Phase rule: Phase equilibrium, phase diagrams of one component system and multicomponent systems, cooling curves.

Recommended Books:

1. P.A. Peter, *Chemical Thermodynamics*, OxfordUniversity Press (1983).
2. I.M. Klotz and R.M. Rosenberg, *Chemical Thermodynamics: Basic Concepts and Methods*, 7th ed., Wiley Backwell (2008).
3. D.A. McQuarrie and J.D. Simon, *Molecular Thermodynamics*, University Science Books, U.S. (2004).
4. S.E. Brain, *Basic Chemical Thermodynamics*, 5th ed., ImperialCollege Press (2004).

CHEM-674 Polymer Chemistry Credit Hours: o3

Aims and 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.

Course Contents:

Introduction to Polymers, step-growth polymerization, polymer chain growth, kinetics of polymer chain growth, co-polymerization, emulsion polymerization, natural and inorganic polymers, physical aspects of polymers, molecular weight of polymers and methods of determination, viscosity, osmometry, light scattering method, diffusion, sedimentation, optical rotation method, structure of polymer chain, introduction to chain isomerism, stereochemistry.

Recommended Books:

1. Sperling, L. H. *Introduction to Physical Polymer Science*, 4th ed., WileyInterscience, New York, USA, (2006).
2. Odian, G., *Principles of Polymerization*, 4th ed., Wiley Interscience, (2004).
3. Carraher Jr, C. E., *Carraher's, Polymer Chemistry,* 8th ed., CRC Press, Inc., (2010).
4. Ravve, A., *Principles of Polymer Chemistry*, 3rd ed., Springer, (2012).
5. Allcock, H., Lampe, F. and Mark, J., *Contemporary Polymer Chemistry*, 3rd ed., Prentice Hall, (2003).

CHEM-681 Quantum Chemistry Credit Hours: 03

Aims and Objectives:

Students will develop understanding of Quantum Chemistry.

Course Contents:

Limitation of classical mechanics, wave and particle nature of matter, de-Broglie's equation, Heisenberg's uncertainity principle, concept of quantization of energy, Operators and their properties. Types of operators, Hemaltonian operator, Hermition operator, Angular momentum. Postulates of quantum chemistry, Eigen function and Eigen values, general wave equation, Schrödinger wave equation (Time dependent + Time independent). Particle in one dimensional box, three dimensional box, hydrogen atom and harmonic oscillator, Many electron systems. Treatment of simple harmonic oscillator, diatomic rigid rotor. Valence bond and molecular orbital theories. Pi-electron calculations.

Recommended Books:

1. Micheal D.F. "Elements of Quantum Mechanics" Oxford University Press (2005).
2. Griffiths, David J., "Introduction to Quantum Mechanics" 2nd ed., Prentice Hall (2004).
3. Hayward, David O., "Quantum Mechanics for Chemists" 1st ed., John Wiley (2003).
4. House, James E., "Fundamentals of Quantum Mechanics" 2nd ed., Elsevier-Academic Press (2003).

CHEM-682 Molecular Spectroscopy Credit Hours: 03

Aims and Objectives:

Students will learn about the molecular spectroscopy.

Course Contents:

Interaction of electromagnetic radiation with matter. Microwave and infrared spectroscopy. Rotational, vibrational and rotational-vibrational spectra of diatomic and polyatomic molecules. Electronic spectra of simple molecules. Nuclear magnetic resonance spectroscopy. Raman spectroscopy.

Recommended Books:

1. Whiffen D. H. "Spectroscopy" Longmans Green and Co.: London, (1966).
2. Barrow G. "Molecular Spectroscopy" McGraw Hill (1962).
3. Becker E. D. "High Resolution NMR; Theory & Chemical Application", New York, Academic Press (1980).
4. Graybal J.D. "Molecular Spectroscopy", New York, McGraw-Hill (1988).

CHEM-683 Nuclear Chemistry Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about the Nuclear Chemistry.

Course Contents:

Radioactivity, elemental particles, isotopes, isobars, isotones, transmutation and artificial radioactivity, Bohar,s theory of nuclear reaction, classification of nuclear reactions, nuclear reactions vs chemicals reactions, mass defect and binding energy, nuclear fusion and nuclear fission, Q.value of nuclear reaction. Atomic nucleus, nuclides, nuclear stability, nuclear energetic, nuclear models (shell + liquid drop model), non-spontaneous nuclear processes, nuclear reactors, beta decay systematic, nuclear spins. Atomic bomb, hydrogen bomb, uses of radioisotopes in reaction mechanism, in diagnosis of diseases, in industry, in agriculture. Determination of the age of the earth by rock dating method, determination of the age of recent objects by radioactive carbon dating method.

Recommended Books:

1. Albert R.A., Robert J.S. and Moungi G.B. "Physical Chemistry". 4 ed., John Wiley and Sons (2004).
2. Ball D.W. "Physical Chemistry" 1 ed., Brooks/Cole Co. Inc. (2003).
3. Vertes A. "Basics of Nuclear Science" Kluwer Academic Publisher London (2003).
4. Friedlander G. and Kennedy J.W. "Nuclear and Radiochemistry" 3 ed., Wiley, New York (1981).

CHEM-684 Surface Chemistry Credit Hours: 03

Aims and Objectives:

Students will acquire knowledge about the important physical and chemical aspects of nano and colloidal systems and the basics of thermodynamically and kinetically stabilized nanoparticles and colloidal solutions. They will also learn about the surfactant chemistry, characterization methods and applications of nanoparticles and colloidal solutions.

Course Contents:

Adsorption, types of adsorption, adsorption isotherm, Langmuir, Freundlich, B.E.T adsorption isotherm, application of B.E.T adsorption isotherm, Gas adsorption isotherm or Henry equation, Surface active and surface inactive substances, Solid surfaces. Gas solid interface. Thermodynamics of adsorption. Heterogeneous catalysis. Kinetic and mechanisms of catalyzed reactions. Enzymatic catalysis. Organized molecular assemblies. Colloidal solutions. Catalyst preparation methods. Industrial catalysts.

Recommended Books:

1. B.S. Bahl, A. Bahl, G.D. Tuli, "Essentials of Physical Chemistry"
2. Segal H. "Enzyme Kinetics" John Wiley New York (1975).
3. Schlutz A.R. "Enzyme Kinetics" (1964) Cambridge University Press England.

CHEM-679 Field Experience

CHEM-689 Capstone Research Project/Advanced Lab in Physical Chemistry Credit Hours: 03

The student shall undertake and complete short research project under the supervision of a teacher. The evaluation shall be based on its oral presentation or oral examination (viva) and written report.

The advanced level practical shall be offered involving different experimental facilities available in the section/department. The details of the laboratory work and the equipment involved shall be decided by the teacher concerned on the basis of the courses taught.

****