

**SCHEME OF STUDIES & CURRICULUM  
FOR  
BS CHEMISTRY  
(Semester / Term System)  
(Fall 2023)**



**INSTITUTE OF CHEMISTRY  
UNIVERSITY OF SARGODHA  
SARGODHA**

1. **Title of Degree Program:** BS in Chemistry

2. **Program Learning Objectives:** The Department of Chemistry was established in 1991 as a separate institution for post-graduate studies at the Government Postgraduate College, Sargodha, while it was affiliated with the University of Punjab, Lahore. After the up-gradation of this postgraduate college to University of Sargodha, Sargodha in November 2002, this department was working without any extension in the building and up-gradation of the general/research laboratories. This Department of Chemistry was upgraded by University of Sargodha in 2020 to Institute of Chemistry after necessary expansion of infrastructure. The institute is offering BS (Chemistry), MPhil (Chemistry) and PhD (Chemistry) programs designed to meet the ever-emerging needs in the field of chemical sciences. The Institute of Chemistry aims at following PLOs for BS (Chemistry) program.

- a) Comprehensive curriculum comparable to national and international standards.
- b) Peer review of curriculum and its continuous updating.
- c) Conducive environment for teaching and discussion
- d) Expand infrastructure for study, research/Practical understanding through experiments and research
- e) Seek collaboration with industry and research organizations.

3. **Program Structure:**

Duration	Minimum 4-Years (8-Semesters), Maximum 6-Years (12-Semesters)		
Admission Requirements:	1. Students with Pre-Medical / Pre-Engineering combinations in HSSC / A-level with Chemistry as an elective subject after 12-years of education. 2. Students with Pre-Medical / Pre-Engineering combinations in HSSC with Chemistry as an elective subject who have passed intermediate Part-I and awaiting Part-II result		
Degree Completion Requirements:	Minimum 2.00 CGPA out of 4.0 scale with following minimum breakup		
	General Education courses	GE	31 Credit hours
	Interdisciplinary courses	ID	12 Credit hours
	Disciplinary / Major courses	D	78 Credit hours
	Internship	I	3 Credit hours
	Capstone Project	R	3 Credit hours
			<b>127 Credit hours</b>

4. **General Education (Gen Ed) Requirements: (Mandatory/Core Courses):**

	Semester	Course Code	Course Title	Credit Hours	Prerequisite
1.	1	URCG-5118	Functional English	3(3-0)	Nil
2.	1	URCG-5105 URCG-5126	Islamic Studies (OR) Religious Education / Ethics	2(2-0)	Nil

3.	1	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
4.	2	URCG-5112	Fables, Wisdom and EPICS	2(2-0)	Nil
5.	2	URCG-5116	Science of Society-I	2(2-0)	Nil
6.	2	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
7.	2	URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)	Nil
8.	2, 4, 6, 8	URCG-5111	Translation of Holy Quran	NC	Nil
9.	3	URCG-5119	Expository Writing	3(3-0)	Nil
10.	3	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
11.	3	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
12.	4	URCG-5114	The Science of Global Challenges	3(2-1)	Nil
13.	4	URCG-5124	Entrepreneurship	2(2-0)	Nil
14.	4	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
<b>Total Credit Hours of GE Courses</b>				<b>31</b>	

### 5. Single Major Courses:

	<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Prerequisite</b>
1.	CHEM-5101	Inorganic Chemistry	4(3-1)	Nil
2.	CHEM-5102	Basic Mathematics for Chemists	2(2-0)	Nil
3.	CHEM-5103	Biochemistry	4(3-1)	Nil
4.	CHEM-5104	Organic Chemistry	4(3-1)	Nil
5.	CHEM-5105	Analytical Chemistry	4(3-1)	Nil
6.	CHEM-5106	Physical Chemistry	3(2-1)	CHEM-5102
7.	CHEM-5107	Basic Statistics for Chemists	2(2-0)	Nil
8.	CHEM-5108	Laboratory Safety Measures	2(2-0)	Nil
9.	CHEM-5109	Chemistry Special Topics	3(2-1)	Nil
10.	CHEM-6101	Inorganic Chemistry-I	4(3-1)	Nil
11.	CHEM-6102	Organic Chemistry-I	4(3-1)	Nil
12.	CHEM-6103	Physical Chemistry-I	3(3-0)	Nil
13.	CHEM-6104	Inorganic Chemistry-II	4(3-1)	Nil
14.	CHEM-6105	Organic Chemistry-II	4(3-1)	CHEM-5103
15.	CHEM-6106	Physical Chemistry-II	4(3-1)	CHEM-5102 CHEM-5107
16.	CHEM-6107	Industrial Chemistry	3(3-0)	Nil
17.	CHEM-6108	Forensic Chemistry	2(2-0)	Nil
18.	CHEM-6109	Spectroscopic Techniques – I	4(3-1)	Nil
19.	CHEM-6110	Chromatographic Techniques	3(3-0)	Nil
20.	CHEM-6111	Instrumental Methods of Analysis - I	3(3-0)	Nil
21.	CHEM-6112	Bioenergetics and Metabolism	4(3-1)	Nil
22.	CHEM-6113	Microbiology and Industrial Fermentation	3(3-0)	Nil
23.	CHEM-6114	Introduction to Bioinformatics	3(3-0)	Nil
24.	CHEM-6115	Advanced Inorganic Chemistry	4(3-1)	Nil
25.	CHEM-6116	Inorganic Polymers & Chemical Forces	3(3-0)	Nil
26.	CHEM-6117	Organometallic & Bio-inorganic Chemistry	3(3-0)	Nil

27.	CHEM-6118	Spectroscopic Methods in Organic Chemistry	4(3-1)	Nil
28.	CHEM-6119	Reaction Mechanism	3(3-0)	CHEM-6102
29.	CHEM-6120	Reactive Intermediates and Protective Groups	3(3-0)	Nil
30.	CHEM-6121	Surface Phenomena	4(3-1)	Nil
31.	CHEM-6122	Molecular Spectroscopy	3(3-0)	Nil
32.	CHEM-6123	Quantum Chemistry and Statistical Thermodynamics	3(3-0)	Nil
33.	CHEM-6124	Environmental Chemistry	3(3-0)	Nil
34.	CHEM-6125	Spectroscopic Techniques – II	4(3-1)	Nil
35.	CHEM-6126	FTIR, Raman Spectroscopy, ESR and Surface Analysis	3(3-0)	Nil
36.	CHEM-6127	Instrumental Methods of Analysis - II	3(3-0)	Nil
37.	CHEM-6128	Molecular Biology & Physical Techniques	4(3-1)	Nil
38.	CHEM-6129	Chemotherapy & Immunology	3(3-0)	Nil
39.	CHEM-6130	Introduction to Recombinant DNA Technology	3(3-0)	Nil
40.	CHEM-6131	Homogeneous Catalysis by Transition Metal Complexes	4(3-1)	Nil
41.	CHEM-6132	Inorganic Reaction Mechanism	3(3-0)	Nil
42.	CHEM-6133	Physical Methods in Inorganic Chemistry	3(3-0)	Nil
43.	CHEM-6134	Chemistry of Natural Products	4(3-1)	Nil
44.	CHEM-6135	Organic Synthesis	3(3-0)	CHEM-6105 CHEM-6119
45.	CHEM-6136	Stereochemistry	3(3-0)	Nil
46.	CHEM-6137	Kinetics of Heterogeneous Reactions	4(3-1)	Nil
47.	CHEM-6138	Polymers and Photochemistry	3(3-0)	Nil
48.	CHEM-6139	Nuclear Chemistry	3(3-0)	Nil
<b>Total Credit Hours of Major Courses</b>			<b>80 (Pre-Engineering Group/ 82 (Pre-Medical Group)</b>	

**6. Interdisciplinary/Allied courses: minimum 12 credit hours:**

	<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Prerequisite</b>
1.	ZOOL-5101 / PHYS-5101	Animal Diversity-I (Invertebrates) / Mechanics	4(3-1) / 4(3-1)	Nil
2.	ZOOL-5102 / PHYS-5102	Animal Diversity-II (Chordates) / Introduction to Electromagnetism	4(3-1) / 4(3-1)	Nil
3.	BOTN-5101 / MATH-5102	Diversity of Plants / Techniques of Integration and its Applications	4(3-1) / 4(4-0)	Nil
<b>Interdisciplinary Courses Credit Hours Total</b>			<b>12</b>	

**7. Field experience/internship: Minimum 03 credit hours:**

	<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Prerequisite</b>
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1	CHEM-6139	Field experience / internship	3(3-0)	
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8. **Capstone project: Minimum 03 credit hours:**

	<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Prerequisite</b>
1.	CHEM-6140	Capstone project	3(3-0)	

**Scheme of Studies**  
***BS in Chemistry***

**Semester-I**

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-1	URCG-5118	Functional English	3(3-0)	Nil
GE-2	URCG-5105 URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
GE-3	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
Major-1	CHEM-5101	Inorganic Chemistry	4(3-1)	Nil
Major-2	CHEM-5102	Basic Mathematics for Chemists (For Pre-Medical HSSC students only)	2(2-0)	Nil
Major-3	CHEM-5103	Biochemistry	4(3-1)	Nil

Semester Total Credit Hours with Pre-Engineering Group: 16

Semester Total Credit Hours with Pre-Medical Group: 18

**Semester-II**

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-4	URCG-5112	Fables, Wisdom and Epics	2(2-0)	Nil
GE-5	URCG-5116	Science of Society-I	2(2-0)	Nil
GE-6	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
GE-7	URCG-5127	Seerat of the Holy Prophet (SAW)*	1(1-0)	Nil
GE-8	URCG-5111	Translation of Holy Quran*	NC	Nil
Major-4	CHEM-5104	Organic Chemistry	4(3-1)	Nil
Major-5	CHEM-5105	Analytical Chemistry	4(3-1)	Nil

Semester Total Credit Hours with Pre-Engineering and Pre-Medical Groups: 16

\* For Muslim students only

**Semester-III**

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-9	URCG-5119	Expository Writing	3(3-0)	Nil
GE-10	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
GE-11	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
Major-6	CHEM-5106	Physical Chemistry	4(3-1)	CHEM-5102
Major-7	CHEM-5107	Basic Statistics for Chemists	2(2-0)	Nil
Major-8	CHEM-5108	Laboratory Safety Measures	2(2-0)	Nil

Semester Total Credit Hours with Pre-Engineering and Pre-Medical Groups: 16

**Semester-IV**

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-12	URCG-5115	The Science of Global Challenges	3(2-1)	Nil
GE-13	URCG-5124	Entrepreneurship	2(2-0)	Nil
GE-14	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
GE-8	URCG-5111	Translation of Holy Quran *	NC	Nil

Major-9	CHEM-5109	Chemistry Special Topics	4(3-1)	Nil
Interdisciplinary	ZOOL-5101 / PHYS-5101	Animal Diversity-I (Invertebrates) /Mechanics	4(3-1)/ 3(3-0)	Nil

Semester Total Credit Hours with Pre-Engineering and Pre-Medical Groups: 15

\* For Muslim students only

### Semester-V

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-10	CHEM-6101	Inorganic Chemistry-I	4(3-1)	Nil
Major-11	CHEM-6102	Organic Chemistry-I	4(3-1)	Nil
Major-12	CHEM-6103	Physical Chemistry-I	4(3-1)	CHEM-5102
Interdisciplinary	ZOOL-5102 / PHYS-5103	Animal Diversity-II (Chordates) / Introduction to Electromagnetism	4(3-1)/ 3(3-0)	Nil

Semester Total Credit Hours with Pre-Engineering Group: 15

Semester Total Credit Hours with Pre-Medical Group: 16

### Semester-VI

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-8	URCG-5111	Translation of Holy Quran *	NC	Nil
Major-13	CHEM-6104	Inorganic Chemistry-II	4(3-1)	Nil
Major-14	CHEM-6105	Organic Chemistry-II	4(3-1)	Nil
Major-15	CHEM-6106	Physical Chemistry-II	4(3-1)	CHEM-5102 CHEM-5107
Interdisciplinary	BOTN-5101/ MATH-5102	Diversity of Plants / Techniques of Integration and its Applications	4(3-1) / 4(4-0)	Nil

Semester Total Credit Hours: 16

\* For Muslim students only

### Summer Semester

Category	Course Code	Course Title	Credit Hours	Specialization
Compulsory	CHEM-6139	Field Experience / Internship	3(3-0)	Nil

### Semester-VII

Category	Course Code	Course Title	Credit Hours	Specialization
Major-16	CHEM-6107	Industrial Chemistry	3(3-0)	Nil
Major-17	CHEM-6108	Forensic Chemistry	2(2-0)	
Major-18	CHEM-6109	Spectroscopic Techniques – I	4(3-1)	Analytical Chemistry
Major-19	CHEM-6110	Chromatographic Techniques	3(3-0)	
Major-20	CHEM-6111	Instrumental Methods of Analysis - I	3(3-0)	
Major-18	CHEM-6112	Bioenergetics and Metabolism	4(3-1)	Biochemistry
Major-19	CHEM-6113	Microbiology and Industrial Fermentation	3(3-0)	
Major-20	CHEM-6114	Introduction to Bioinformatics	3(3-0)	
Major-18	CHEM-6115	Advanced Inorganic Chemistry	4(3-1)	Inorganic Chemistry
Major-19	CHEM-6116	Inorganic Polymers & Chemical Forces	3(3-0)	

Major-20	CHEM-6117	Organometallic & Bio-inorganic Chemistry	3(3-0)	Organic Chemistry
Major-18	CHEM-6118	Spectroscopic Methods in Organic Chemistry	4(3-1)	
Major-19	CHEM-6119	Reaction Mechanism	3(3-0)	
Major-20	CHEM-6120	Reactive Intermediates and Protective Groups	3(3-0)	
Major-18	CHEM-6121	Surface Phenomena	4(3-1)	Physical Chemistry
Major-19	CHEM-6122	Molecular Spectroscopy	3(3-0)	
Major-20	CHEM-6123	Quantum Chemistry and Statistical Thermodynamics	3(3-0)	

Semester Total Credit Hours: 15

### Semester-VIII

Category	Course Code	Course Title	Credit Hours	Specialization
Compulsory	CHEM-6140	Capstone project	3(3-0)	----
GE-8	URCG-5111	Translation of Holy Quran *	NC	
Major-21	CHEM-6124	Environmental Chemistry	3(3-0)	
Major-22	CHEM-6125	Spectroscopic Techniques – II	4(3-1)	Analytical Chemistry
Major-23	CHEM-6126	FTIR, Raman Spectroscopy, ESR and Surface Analysis	3(3-0)	
Major-24	CHEM-6127	Instrumental Methods of Analysis - II	3(3-0)	
Major-22	CHEM-6128	Molecular Biology & Physical Techniques	4(3-1)	Biochemistry
Major-23	CHEM-6129	Chemotherapy & Immunology	3(3-0)	
Major-24	CHEM-6130	Introduction to Recombinant DNA Technology	3(3-0)	
Major-22	CHEM-6131	Homogeneous Catalysis by Transition Metal Complexes	4(3-1)	Inorganic Chemistry
Major-23	CHEM-6132	Inorganic Reaction Mechanism	3(3-0)	
Major-24	CHEM-6133	Physical Methods in Inorganic Chemistry	3(3-0)	
Major-22	CHEM-6134	Chemistry of Natural Products	4(3-1)	Organic Chemistry
Major-23	CHEM-6135	Organic Synthesis	3(3-0)	
Major-24	CHEM-6136	Stereochemistry	3(3-0)	
Major-22	CHEM-6137	Kinetics of Heterogeneous Reactions	4(3-1)	Physical Chemistry
Major-23	CHEM-6138	Polymers and Photochemistry	3(3-0)	
Major-24	CHEM-6139	Nuclear Chemistry	3(3-0)	

Semester Total Credit Hours: 16

\* For Muslim students only

**Degree Program Total with Pre-Engineering Group: 127**

**Degree Program Total with Pre-Medical Group: 131**



## SEMESTER-I

URCE-5118

Functional English

3 (3+0)

The course aims at providing understanding of a writer's goal of writing (i.e. clear, organized and effective content and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master the grammatical academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to logically add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in an objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

### *Contents:*

1. Developing Analytical Skills
2. Transitional devices (word, phrase and expressions)
3. Development of ideas in writing
4. Reading Comprehension
5. Precis Writing
6. Developing argument
7. Sentence structure: Accuracy, variation, appropriateness, and conciseness
8. Appropriate use of active and passive voice
9. Organization and Structure of a Paragraph
10. Organization and structure of Essay
11. Types of Essays

### *Recommended Texts:*

1. Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.
2. Eastwood, J. (2011). *A Basic English grammar*. Oxford: Oxford University Press.
3. Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: Essential tasks and skills* (3<sup>rd</sup> ed.). Ann Arbor: The University of Michigan Press.
4. Swan, M. (2018). *Practical English usage* (8<sup>th</sup> ed.). Oxford: Oxford University Press.

### *Suggested Readings*

1. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). *Longman grammar of spoken and written English*. Harlow Essex: MIT Press.
  2. Cresswell, G. (2004). *Writing for academic success*. London: SAGE.
  3. Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
  4. Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing*. Washington: American Psychological Association
- Thomson, A. J., & Martinet, A. V. (1986). *A Practical English Grammar*. Oxford: Oxford University Press.

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam; Qur'an and Hadith, history and particular cultural contexts. The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It offers opportunities to get fully introductory foundational bases of Islam in fields that include Qur'anic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah..

- To make students understand the relevance and pragmatic significance of Islam in their lives.
- To make learners comprehend the true spirit of Islam with reference to modern world.
- To generate a sense of Islamic principles as a code of living that guarantee the effective solutions to the current challenges of being.
- To provide Basic information about Islamic Studies
- To enhance understanding of the students regarding Islamic Civilization
- To improve Students skill to perform prayers and other worships
- To enhance the skill of the students for understanding of issues related to faith and religious life.

#### Contents:

#### Introduction to Qur'anic Studies

1. Basic Concepts of Qur'an
2. History of Quran
3. Uloom-ul-Quran

مطالعہ قرآن (تعارف قرآن ، منتخب آیات کا ترجمہ و تفسیر: سورة البقرہ آیات 1-5، 482-482؛ سورة الحجرات آیات 1-18؛ سورة الفرقان آیات 26-77؛ سورة المومنون آیات 1-11؛ سورة الحزاب آیات 2، 41، 64-66، 24، 52-55؛ سورة النعم آیات 156-151؛ سورة الصف آیات 1-12؛ الحشر آیات 18-44؛ آل عمران آیات 154-154؛ النحل آیات 12-14؛ لقمن آیت 44، حم السجده آیت 65)

#### Introduction to Sunnah

1. Introduction of Hadith
2. Legal Status of Hadith
3. History of the compilation of Hadith 4. Kinds of Hadith

حدیث کا تعارف ، حدیث کی دینی حیثیت، حفاظت و تدوین حدیث، حدیث کی اقسام متن، حدیث: 1درج ذیل موضوعات پر احادیث کا مطالعہ

1- اعمال کا اجر نیت پر منحصر ہے۔ 4- بہترین انسان قرآن کا طالب علم اور اس کا معلم ہے۔ 6- کتاب و سنت گمراہی سے بچنے کا ذریعہ ہیں۔ 2- ارکان اسلام 5- اسلام ، ایمان ، احسان اور قیامت کی نشانیوں ، 2- بچوں کی نماز کی تلقین 7- دین کا گہرا فہم ہلا کی خاص عنایت ہے 8- حصول علم، نالوت قرآن اور عمل کی اہمیت و فضیلت 5، روز محشر کا محاسبہ ، 14- حقوق ہلا کے

ساتھ ساتھ حقوق العباد کا لحاظ رکھنا بھی الزم ہے 11- حسن خلق کی عظمت اور فحش و بد گوئی کی مذمت 14- دنیا و آخرت کی بہانہ

کی ضمانت چار چیزیں، 16۔ بالک کر دینے والی سات چیزیں، 12۔ بے عمل مبلغ کا عبرت ناک انجام 15۔ ہر

ش

خص نگران ہے اور ہر شخص مسئول

1. Sirah of the Prohet
2. Importance of the Study of Sirah
3. Character building method of the Prophet

(سیرت النبی ﷺ) مطالعہ سیرت کی ضرورت و اہمیت، تعمیر، سیرت و شخصیت کا نبوی منہاج اور عملی نمونے، اقامت دین کا نبوی طریق کار، اقامت دین بعدِ خالفت راشدہ، میثاق مدینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات، تشکیل اجتماعیت اور ت نبوی ﷺ کے مقاصد و حکمتیں

#### Islamic Culture & Civilization

1. Basic Concepts of Islamic Culture & Civilization
2. Historical Development of Islamic Culture & Civilization
3. Characteristics of Islamic Culture & Civilization
4. Islamic Culture & Civilization and Contemporary Issues

2. اسلامی تہذیب و تمدن (اسلامی تہذیب کا مفہوم، اسلامی کے عوامل و عناصر، اسلامی تہذیب کی خصوصیات، اسلامی تہذیب، علمی، معاشرتی اور سماجی اثرات، تہذیبوں کے تصادم کے نظریے کا تنقیدی جائزہ، تہذیبی تصادم کے اثرات و

نتائج، طبعی، حیاتیاتی اور معاشرتی علوم میں مسلمانوں کا کردار، نام و مسلمان سائنسدان) سوہ حسنہ، قرآن مجید میں سیرت سرور عالم کا

بیان، غزوا

#### Recommended Texts:

1. Hameed ullah Muhammad, —Emergence of Islam, IRI, Islamabad
2. Hameed ullah Muhammad, —Muslim Conduct of State
3. Hameed ullah Muhammad, —Introduction to Islam
4. Ahmad Hasan, —Principles of Islamic Jurisprudence Islamic Research, Institute, International Islamic University, Islamabad (1993)

#### Suggested Readings:

1. Dr. Muhammad Zia-ul-Haq, —Introduction to Al Sharia Al Islamial Allama Iqbal Open University, Islamabad (2001)
2. Dr. Muhammad Shahbaz Manj, Teleemat-e- Islam

*Contents:*

1. Meaning and Scope of Ethics.
2. Relation of Ethics with:
  - (a) Religion
  - (b) Science
  - (c) Law
3. Historical Development of Morality: (a). Instinctive Moral Life.
  - (b). Customary Morality.
  - (c). Reflective Morality.
4. Moral Theories:
  - (a). Hedonism (Mill)
  - (b). Intuitionism (Butler)
  - (c). Kant's Moral Theory.
5. Moral Ethics and Society.
  - (a). Freedom and Responsibility.
  - (b). Tolerance
  - (c). Justice
  - (d). Punishment (Theories of Punishment)
6. Moral Teachings of Major Religions: a). Judaism
  - b). Christianity
  - c). Islam
7. Professional Ethics:
  - a). Medical Ethics
  - b). Ethics of Students
  - c). Ethics of Teachers
  - d). Business Ethics

*Reference Books:*

1. William Lille. An Introduction to Ethics., London Methuen & Co. latest edition.
2. Titus, H.H. Ethics for Today. New York: American Book, latest edition.
3. Hill, Thomas. Ethics in Theory and Practice. N.Y. Thomas Y. Crowel, latest edition
4. Ameer Ali, S. The Ethics of Islam. Culcutta: Noor Library Publishers, latest edition
- Donaldson, D.M. Studies in Muslim Ethics. London: latest edition. 6. Sayeed, S.M.A.(Tr.) Ta'aruf-e-Akhlaqiat. Karachi: BCC&T, Karachi University

The course introduces students to information and communication technologies and their application in the workplace. Objectives include basic understanding of computer software, hardware, and associated technologies. How computers can be used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace. Students will get basic understanding of computer software, hardware, and associated technologies. They will also learn how computers are used in the workplace, how communications systems can help to boost productivity, and how the Internet technologies can influence the workplace.

*Contents:*

1. Introduction, Overview of Information Technology.
2. Hardware: Computer Systems & Components, Storage Devices.
3. Software: Operating Systems, Programming and Application Software.
4. Databases and Information Systems Networks.
5. File Processing Versus Database Management Systems.
6. Data Communication and Networks.
7. Physical Transmission Media & Wireless Transmission Media.
8. Applications of smart phone and usage.
9. The Internet, Browsers and Search Engines.
10. Websites and their types.
11. Email Collaborative Computing and Social Networking.
12. E-Commerce.
13. IT Security and other issues.
14. Cyber Laws and Ethics of using Social media.
15. Use of Microsoft Office tools (Word, Power Point, Excel) or other similar tools depending on the operating system.
16. Other IT tools/software specific to field of study of the students if any.

*Recommended Book*

1. Discovering Computers 2022: Digital Technology, Data and Devices by Misty E. Vermaat, Susan L. Sebok; 17<sup>th</sup> edition.

*Suggested Books*

1. Computing Essentials 2021 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 26<sup>th</sup> edition.
2. Computers: Understanding Technology by Fuller, Floyd; Larson, Brian: edition 2018.

This course covers a range of general topics of inorganic chemistry. It will provide a useful supplement to the advanced courses specified in the department. This course aims to enable the students to achieve the advanced knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of the representative and transition elements, as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work. Learning objectives emphasized in CHEM-5102 involve developing an understanding of basic principles of inorganic chemistry. It develops critical thinking skills enabling students to solve chemistry problems that incorporate their cumulative knowledge. Students learned in class to modern chemistry techniques which give them opportunities to upgrade their knowledge about advanced inorganic concepts. The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and preparation of students for professional positions in chemistry.

*Contents:*

1. Periodic Table and Periodicity of Properties: Modern Periodic Table, Group trends and periodic properties, Atomic and ionic radii, ionization potentials, electron affinities and electronegativities; Redox potential, electrochemical series and its applications. Corrosion and electroplating.
2. Acid Base Equilibria: Acids and bases, relative strengths of acids, pH, pKa, pKb. Hard and soft acid and Bases. SHAB Principle and its application. Buffers, types of buffer, Preparation, Buffer capacity and applications of buffers. Indicators: (Acid-base, Redox, Adsorption), Solubility product, Common ion effect and its applications.
3. Chemical Bonding: Nature of a bond, hybridization, Valence Bond Theory (VBT), The Concept of Resonance, Molecular Orbital Theory (MOT), Valence Shell Electron Pair Repulsion (VSEPR) theory. Special types of bonds such as Metallic bonds, Hydrogen Bonding, Bent bond, Ion-dipole-dipole bond, ion induced-dipole bond.
4. Chemistry of p-Block Elements: Chemistry of the following compounds: Boranes and Boride; aluminium halides, hydrides and Alums; Silicates (Structural aspects, classifications and applications); silicones (Structural aspects, classifications and applications), phosphazenes, Oxoacids of Phosphorous; Oxoacids and salts of sulphur; Noble gases (compounds of Xe, Kr, Ra; bonding and applications). Production of pure silicon chips for solar energy cells.
5. Chemistry of d-Block Elements: Electronic configuration. Characteristics. Nomenclature. Nature of bonding in coordination compounds: Werner's theory, VBT, MOT and CFT for coordination compounds. Isomerism in coordination compounds. Chelates: Classification and applications. Applications of coordination compounds (Medicinal, Industrial, Agricultural).
6. Chemical Industries: Metallurgy of Al, Cr and U, fertilizers (Urea and Phosphate fertilizers) Cement and Sugar.

*Inorganic Chemistry Lab:*

1. Qualitative Analysis; four radicals (cations and anions) for salt mixture.
2. Chromatographic separation of cations
3. Determination of total hardness of water using EDTA.
4. Estimation of manganese (II) using EDTA.
5. Estimation of copper (iodometrically).
6. Determination of thiosulphate ion (Iodometrically).
7. Determination of ferricyanide using KI solution.
8. Determination of chloride by Volhard's and Mohr's methods
9. Estimation of chloride ions using adsorption (Fluorescein) indicator.
10. Estimation of bromide ions using adsorption (Eosin) indicator.
11. Estimation of percentage of ferrous ions in the Mohr's salt using  $\text{KMnO}_4$ .
12. Percentage determination of ferric ions in ferric alum using  $\text{KMnO}_4$  solution.
13. Determination of purity of commercial potassium oxalate using  $\text{KMnO}_4$  solution.
14. Estimation of ferrous ions using  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.

*Recommended Texts:*

1. Shaheen, M.A. Concise Inorganic Chemistry (2021). *Jilani Notes, Sargodha*, Lahore
2. Lee, J. D. (1996). *Concise inorganic chemistry*. (5<sup>th</sup> ed.). UK: Chapman and Hall
3. Vogel, A. I. (1995). *A text book of macro and semi micro qualitative inorganic analysis*. New York: Longman Green and Co.
4. Shaheen, M.A. (2022) *Jilani Manual of Practical Chemistry Vol. IV*, Jilani Notes, Sargodha
5. Skoog, D. A., West, D.M., & Holler, F. J. (1994). *Analytical chemistry* (6<sup>th</sup> ed.). UK: Saunders College Publications.

*Suggested Readings:*

1. Graham, H., & Man, H. (2000). *Chemistry in context* (5<sup>th</sup> ed.). UK: Thomas Nelson Ltd.
2. Philp, M. (1996). *Advance chemistry*. UK: Cambridge Publishing.
3. David, H. (2000). *Modern analytical chemistry*. New York: McGraw Hil.

This course introduces students with basic mathematics that is used in chemistry. This is the fundamental course of serving as the foundation of mathematics for its use in chemistry and chemical calculation during the lab experiments and research. The course, equally, emphasizes basic concepts and skills needed for mathematical manipulation. It focus on the study of functions of a logarithmic and exponential functions, single variables, differential equations and their use in chemical problems, and use of Integration, Determinants and Matrices. Applications of differential equations include computations involving velocity and acceleration, the slope of a curve, and optimization. Student are also expected to learn solutions of linear equations (simple, determinant and matrices methods), operator theory, differentiation, integration and matrices. This course will also provide applications of eigen value problem and curve fitting in chemistry. Upon successful completion of course students will be able to derive basic mathematics equations use in chemistry and apply them to seek solution for related problems in the experiments.

*Contents:*

1. Introduction
2. Review of basic algebra
3. Graphs and their significance in chemistry
4. Trigonometric
5. Logarithmic functions
6. Exponential functions
7. Differentiation
8. Partial differentiation
9. Differential equations and their use in chemical problems
10. Concept of maxima and minima
11. Integration
12. Determinants
13. Matrices
14. Their properties and use in chemical problems.
15. Solutions of linear equations (simple, determinant and matrices methods)
16. Operator theory,
17. The eigen value problem
18. Curve fitting.

*Recommended Texts:*

1. Paul, M. (2006). *Mathematics for chemistry*. (1<sup>st</sup> ed.). Oxford, United Kingdom: Oxford University Press
2. Ghram, D. (1996). *Mathematics in chemistry*. (1<sup>st</sup> ed.). New York, USA: Prentice Hall Publishing.

*Suggested Readings:*

1. Tebutt, P. (1998). *Basic mathematics for chemists*. (2<sup>nd</sup> ed.). New York, USA: John Wiley & Sons.
2. Goldstein, L. J., Lay, D. C., Schneider, D. I., & Asmar, N. H. (2017). *Calculus and Its Applications* (14<sup>th</sup> ed.). London: Pearson



This is a basic biochemistry course designed to provide the fundamental concepts about biomolecules, their classifications, functions, and significance. This course demonstrates a broad knowledge of the fundamental introductory concepts of biochemistry where students will gain a deep understanding of function of biomolecules with respect to chemical and molecular processes that occur in and between cells. Students will learn about proteins, carbohydrates, lipids and nucleic acids and their types. Lab experiments related to qualitative and quantitative estimation of biomolecules are also part of this course. Upon the successful completion of course, students will be able to show a deep understanding of fundamental principles of biochemistry along with scientific reasoning to solve problems. Students will demonstrate a comprehensive understanding of the theory and practice of modern instrumentation and apply it to appropriate chemical problems. This compulsory course is followed by advance biochemistry courses in next semesters.

### *Contents*

1. History and scope of Biochemistry. Origin and nature of biomolecules.
2. Proteins: Amino acids, classification and properties of amino acid. Stereochemistry,
3. Primary, Secondary, Tertiary and Quaternary protein structures.
4. Motif and domains in proteins. Biological functions of proteins and peptides,
5. Enzymes: Chemical Nature, Nomenclature and Classification.
6. Enzyme activity. Coenzymes and immobilized enzymes, Specificity of Enzymes, introduction to enzyme kinetics
7. Enzyme Inhibition. Regulation of Enzyme activity.
8. Carbohydrates: Definition and Classification, Monosaccharides:
9. Pyranose and Furanose ring structures. Stereoisomerism and Optical isomerism.
10. Disaccharides; Structures, Polysaccharides; starch, Glycogen and Cellulose.
11. Modified carbohydrates, Glycoproteins and Glycolipids.
12. Derived sugars, Hemiacetal, Acetal and Glycosidic linkages,
13. Glycosaminoglycans and Glycoconjugates.
14. Lipids: Structures and classification of Fatty Acids, essential and non-essential fatty acids
15. Phospholipids, Fats and oils; Hydrogenation, Oxidation and Rancidity
16. Steroids, Eicosanoids, Fats and oils, Waxes
17. Nucleic Acids: Purines and pyrimidines, nucleosides and nucleotides
18. Structural and functional differences between DNA and RNA.
19. Types of DNA and RNA, their functions in biological systems.
20. Vitamins: A basic introduction, classification, and significance

### *Biochemistry Labs*

1. Safety Lab Practices – Safety signs and significance, introduction to lab hazards
2. Operation and use of micropipettes – types and uses, demonstrations.
3. Buffer preparation and use of pH meter
4. Qualitative Tests for carbohydrates; Molisch's Test, Fehling's Test, Benedict's Test, Barfoed's Test, Seliwanoff's Test, Bial's Test, Osazone Test, effect of Alkalis on Sugars
5. Quantitative Determination of Reducing Sugars by using Calorimetric Method (Spectrometric)
6. Hydrolysis of Glycogen or Starch
7. Qualitative tests for Amino Acids; Xanthoproteic acid Test, Millon's Test, Hopkins-Cole Test, Sakaguchi Test
8. Estimation of proteins by Bradford and Lowery methods
9. Separation of Amino Acids using Paper Chromatography and Thin Layer Chromatography (TLC)

10. Qualitative tests for fats, Sterols and Phospholipids
11. Determination of Ascorbic acid in Lemon Juice.
12. Saponification Tests and Iodine Values of Fat
13. Introduction to use of online available protein databases to get protein and DNA sequence.
14. Online visualization of Secondary and tertiary structures of Proteins.

#### *Recommended Texts*

1. Nelson, D. L. & Cox, M. M. (2017). *Lehninger principles of biochemistry*. (7<sup>th</sup> ed.). New York, USA: W. H. Freeman Publishers.
2. Voet, D. & Voet, J. G. (2016). *Biochemistry*. (5<sup>th</sup> ed.). New York, USA: John Wiley & Sons.
3. Boyer R. F. (2000). *Modern experimental biochemistry*. (3<sup>rd</sup> ed.). London, England: Pearson Press.

#### *Suggested Readings*

1. Murray, R. K., Grammer, D. K., Mayes, P. A., & Rodwell, V.W. (2000). *Harper's biochemistry*. (25<sup>th</sup> ed.). New York, USA: Appleton & Lange.
2. Stryer, L. (2010). *Biochemistry*. (7<sup>th</sup> ed.). New York, USA: Freeman & Co.
3. Ausubel, F. M. (2010). *Short protocols in molecular biology*. (5<sup>th</sup> ed.). New Jersey, USA: John Wiley & Sons.

## SEMESER-II

URCG-5112

Fables, Wisdom, and Epics

2(2-0)

The course will enable students to explore human experiences, cultivate an appreciation of the past, enrich their capacity to participate in the life of their times, and enable an engagement with other cultures and civilizations, both ancient and modern. But independently of any specific application, the study of these subjects teaches understanding and delight in the highest achievements of humanity. The three components of the course, including fables, wisdom literature and epic, will enable the learners to explore and understand the classic tradition in literature. Development of personal virtue, a deep Sufi ethic and an unwavering concern for the permanent over the fleeting and the ephemeral are some of the key themes explored in the contents that will develop an intimate connection between literature and life.

### *Contents*

1. Fables
  - The Fables of Bidpai
  - The Lion and the Bull
  - The Ring-dove
  - The Owls and the Crows
  
  - Selected poem from Bang-i-Dara
2. Gulistan-e- Sa'di
  - Ten hikāyāt from John T. Platts, *The Gulistan*
3. Epic
  - THE SHĀHNĀMA OF FIRDAUSI

### *Recommended Texts*

1. John T. P. (1876). *The Gulistan; or, Rose Garden of Shaikh Muslihu'd- Dīn Sa'dī of Shīrāz*. London: Wm. II. Allen.
2. Chishti, Y.S. (1991). *Sharaḥ-i bāng-i darā*. Lāhaur: Maktaba-i ta' mīr-i insāniyat

### *Suggested Readings*

1. Thackston, W. (2000). *A Millennium of Classical Persian Poetry*. Maryland: Ibex Publishers.
2. Wood, R. (2013). *Kalila and Dimna: Fables of Conflict and Intrigue*. United Kingdom: Medina Publishing, Limited.

This course will introduce students with the subject matter of social science, its scope, nature and ways of looking at social phenomenon. It will make the participants acquaintance with the foundations of modern society, state, law, knowledge and selfhood. While retaining a focus on Pakistani state and society, students will encounter theoretical concepts and methods from numerous social science disciplines, including sociology, politics, economics anthropology and psychology and make them learn to think theoretically by drawing on examples and case studies from our own social context. Students will be introduced to the works of prominent social theorists from both western and nonwestern contexts. Instruction will include the use of written texts, audio visual aids and field visits.

### Course Contents

1. Introduction to Social Sciences
  - Social world, Human Social behavior, Foundations of society
  - Evolution of Social sciences
  - Philosophy of Science
  - Scope and nature of social sciences
  - Modernity and social sciences
  - Branches of social science: Sociology, Anthropology, Political Science, Economics
- Society and Community, Historical evolution of Society
  - Types of Societies
  - Foraging society, Horticultural society, Pastoralist society
  - Agrarian societies, Industrial society, Postindustrial society
2. Philosophy of Knowledge in social Science and social inquiry
  - Understanding social phenomenon
  - Alternative ways of knowing
  - Science as a source to explore social reality
  - Objectivity, Value-Free research
  - Positivism vs Interpretivism
  - Qualitative vs Quantitative
3. Culture and Society
  - Idea of Culture, Assumptions of Culture
  - Types, Components, Civilization and culture
  - Individual and culture. Cultural Ethnocentrism, Cultural Relativism
  - Outlook of Pakistani culture
  - Global Flows of culture, Homogeneity, Heterogeneity
4. Social Stratification and Social inequality
  - Dimensions of inequality, social class
  - Gender, Race, Religion, Ethnicity, Caste
  - Patterns of social stratification in Pakistan
  - Class, caste system in agrarian society
  - Ascription vs Achievement, Meritocracy
  - Global stratification in modern world, Global patterns of inequality
5. Personality, Self and Socialization
  - Concept of self, Personality
  - Nature vs Nurture, Biological vs Social
  - Development of Personality
  - Socialization as a process, Agents of socialization
  - Socialization and self/group identity
6. Gender and Power
  - Understanding Gender
  - Social construction of Patriarchy
  - Feminism in Historical context, Gender Debates
  - Gender and Development
  - Gender issues in Pakistani society, Women Participation in politics, economy and education
  - Toward a gender sensitive society, Gender mainstreaming
- Pakistan: State, Society, Economy and Polity
  - Colonialism, colonial legacy, National identity

- Transformation in Pakistani society: Traditionalism vs Modernism
- Economy, Informality of Economy, Modern economy and Pakistan
- Political Economy, Sociology of Economy

*Recommended Texts*

1. Giddens, A. (2018). Sociology (11th ed.). UK: Polity Press.
2. Henslin, J. M. (2018). Essentials of Sociology: A Down-to-Earth Approach. (18th Edition) Pearson Publisher.
3. Macionis, J. J. (2016). Sociology (16th ed.). New Jersey: Prentice-Hall.
4. Qadeer, M. (2006) Pakistan - Social and Cultural Transformation in a Muslim Nation.
5. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.

*Suggested Readings*

1. Systems of Stratification | Boundless Sociology (no date).  
Available at: <https://courses.lumenlearning.com/boundless-sociology/chapter/systemsof-stratification/>
  2. Jalal, A. (ed.) (1995) 'The colonial legacy in India and Pakistan', in Democracy and Authoritarianism in South Asia: A Comparative and Historical Perspective. Cambridge: Cambridge University Press (Contemporary South Asia)
  3. Zaidi, S. A. (2015) Issues in Pakistan's Economy: A Political Economy Perspective. Oxford University Press. Chapter 26
  4. Akhtar, A. S. (2017) The Politics of Common Sense: State, Society and Culture in Pakistan. Cambridge: Cambridge University Press.
- Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.

مطالعہ سیرت النبی صلی اللہ علیہ وسلم Seerat of the Holy Prophet

Course Code

URCG-5127

Title	Description
Semester	
Nature of Course	
No. of C.Hrs.	1(1-0)
Total Teaching weeks	18
Objectives of the Course	<p>۱۔ طلبہ کو مطالعہ سیرت طیبہ کی ضرورت و اہمیت سے آگاہ کرنا</p> <p>۲۔ تعمیر شخصیت میں مطالعہ سیرت طیبہ کے کردار کو واضح کرنا</p> <p>۳۔ بیعت نبوی کے موقع پر اقوام عالم کی عمومی صورت حال سے آگاہ کرنا</p> <p>۴۔ رسول اکرم صلی اللہ علیہ وسلم کی سنی اور مدنی زندگی کا اس طرح مطالعہ کروانا کہ طلبہ ان واقعات سے نتائج کا استخراج کر سکیں</p> <p>۵۔ طلبہ کو محمد نبوی کی معاشرت، سیاست، معیشت سے آگاہ کرنا</p>

Course Description

S.No.	Title	Description
1	حضور صلی اللہ علیہ وسلم کے ابتدائی حالات زندگی	<p>۱۔ حضور صلی اللہ علیہ وسلم کا خاندانی حسب و نسب</p> <p>۲۔ پیدائش اور ابتدائی تربیت</p> <p>۳۔ لڑکپن اور جوانی کے حالات زندگی</p>
2	بیعت نبوی کے وقت دنیا کے حالات (۱)	<p>۱۔ بیعت نبوی کے وقت اہم تہذیبیں</p> <p>۲۔ عرب، مصر، حبشہ، ہندوستان، ساسانی</p>
3	بیعت نبوی	۱۔ سنی عہد میں دعوت اسلام
4	بیعت نبوی	۱۔ مدنی عہد میں دعوت اسلام
5	مخصائص النبی	آپ بطور پیغمبر امن
6	مخصائص النبی	بخشیت استاد و معلم
7	مخصائص النبی	بخشیت تاجر
8	مخصائص النبی	بخشیت سربراہ ریاست
9	مخصائص النبی	ذاتی محاسن اور عالیشان اثرات

10	مخصائص النبی	ناموس رسالت
11	اسوہ حسنہ اور عصر حاضر	غیر مسلموں سے تعلقات
12	اسوہ حسنہ اور عصر حاضر	اسوہ حسنہ کی روشنی میں گھریلو زندگی
13	اسوہ حسنہ اور عصر حاضر	مستشرقین اور مطالعہ سیرت
15	اسوہ حسنہ اور عصر حاضر	وطن سے محبت اور سیرت
16	اسوہ حسنہ اور عصر حاضر	مستشرقین کے اعتراضات اور ان کے جوابات

### نصابی کتب

نمبر شمار	نام مولف	نام کتاب
1	ابن ہشام	السیرۃ النبویہ
2	مولانا شبلی نعمانی، سید سلمان مدودی	سیرۃ نبوی صلی اللہ علیہ وسلم
3	قاضی محمد سلیمان سلمان منصور پوری	رحمۃ العالمین
4	مولانا سید ابوالحسن علی مدودی	نبی رحمت صلی اللہ علیہ وسلم
5	ڈاکٹر یسین مظہر صدیقی	محمد نبوی کا نظام حکومت
6	ڈاکٹر خالد علوی	الانسان کامل

### حوالہ جاتی کتب

نمبر شمار	نام مولف	نام کتاب
1	سید ابوالاعلیٰ مودودی	سیرت سرور عالم صلی اللہ علیہ وسلم
2	مولانا مفتی ارشد حسین مبارکپوری	الرحیق المختوم
3	پیر محمد کرم شاہ الازہری	ضیاء النبی صلی اللہ علیہ وسلم
4	ڈاکٹر اکرم الضیاء العربی	السیرۃ النبویۃ الصحیحۃ
5	مولانا عبدالرؤف دانا پوری	اصح اسیر

محمد

Since ancient times, numbers, quantification, statistics and mathematics has played a central role in scientific and technological development. In the 21st century, Quantitative Reasoning (QR) skills are essential for life as they help to better understand socio-economic, political, health, education, and many other issues, an individual now faces in daily life. The skills acquired by taking this course will help the students to apply QR methods in their daily life and professional activities. This course will also change student's attitude about statistics and mathematics. It will not only polish their QR skills, but also enhance their abilities to apply these skills.

### *Contents*

1. Introduction to quantitative reasoning
2. Overview of contributions of Mathematicians and Statisticians especially Muslim scholars.
3. Types of standard numbers
4. Proportions, rates, ratio and percentages
5. Odds and odds ratio
6. Scale of measurements
7. Number sequence and series
8. Unit analysis as a problem-solving tool
9. Data handling (small and large)
10. Data errors, absolute and relative and their applications
11. Descriptive statistics
12. Rules of counting: multiplication rule, factorial, permutation and combination
13. Probability and its application in real life
14. A graphical perspective through Venn Diagram
15. Financial indicator analysis, and money management (profit, loss, simple and compound interest)
16. Practical scenarios involving algebraic expressions: linear and quadratic

### *Recommended Texts*

1. Akar, G. K., Zembat, İ. Ö., Arslan, S., & Thompson, P. W. (2023). *Quantitative Reasoning in Mathematics and Science Education*. 1<sup>st</sup> Ed., Springer, USA.
2. Peck, R., Olsen, C., & Devore, J. L. (2015). *Introduction to statistics and data analysis*. 5<sup>th</sup> Ed., Brooks Cole, USA.
3. Devlin, K. J. (2012). *Introduction to mathematical thinking*. Palo Alto, CA: Keith Devlin.

### *Suggested Readings*

1. Triola, M. F., Goodman, W. M., Law, R., & Labute, G. (2006). *Elementary statistics*. Reading, MA: Pearson/Addison-Wesley.
2. Blitzer, R., & White, J. (2005). *Thinking mathematically*. Pearson Prentice Hall.



Course Contents:	<ul style="list-style-type: none"> <li>• تیسواں پارہ - ناظرہ مع تجوید</li> <li>• بنیادی عربی گرامر</li> <li>اسم اور اسکے متعلقات : اسم فاعل، مفعول، تفضیل</li> <li>،مبالغہ فعل اور اسکی اقسام : ماضی، مضارع</li> <li>،امر، نہی</li> <li>حرف اور اسکی اقسام : حروف علت، حروف جارہ، مشبہ بالفعل</li> </ul>
Memorization:	تیسویں پارے کی آخری بیس سورتیں (حفظ مع ترجمہ)

The students will acquire knowledge about the basic concepts of organic chemistry, chemistry of hydrocarbons, functional groups, and the mechanism of organic reactions. It will be useful for the qualitative analysis and synthesis of organic compounds. Understanding and knowledge of new and advanced field of organic and significances the importance of application of advanced techniques. This course is a foundation course for Organic Chemistry major courses of higher semester. The main objectives emphasized in this course involve developing an understanding of basic principles of organic chemistry. It develops critical thinking skills enabling students to solve general chemistry problems that incorporate their cumulative knowledge. Students learned in class advanced organic chemistry concepts which give them opportunities to upgrade their knowledge about advanced organic concepts. The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and prepare students for professional positions in the field of synthesis chemistry.

#### *Contents*

1. Basic concepts: atomic, molecular and hybrid orbitals: multiple localized and delocalized bonds, properties of bonds, inductive effect (+I, -I) and dipole moment. The concept of aromaticity, resonance, rules of resonance, resonance energy, resonance effect (including +M, -M), hyperconjugation, hydrogen bonding, tautomerism.
2. Hydrocarbons: classification of hydrocarbons, nomenclature. Methods of preparation, physical characteristics and chemical reactions of alkanes, alkenes and alkynes. Source of aromatic hydrocarbons.
3. Alkyl halides: nomenclature, method of preparation and chemical reaction with special reference to the nucleophilic substitution and elimination reaction of alkyl halide. Preparation, structure and synthetic application of Grignard reagent.
4. Alcohols & ethers: classification, nomenclature, properties, preparation and chemical reactions of alcohol/phenol and ether, Lucas test, polyhydric alcohols.
5. The carbonyls: classification, nomenclature, properties, preparation and chemical reactions of aldehydes, ketones, carboxylic acids and its derivatives. 2,4-DNPH, Tollen and Benedict tests. Introduction to amino acids.
6. Nitrogen compounds: classification, nomenclature, properties, preparation and chemical reactions of amines and diazonium; distinction between primary, secondary, and tertiary amines. Preparation and reaction of aniline.

#### *Organic Chemistry Lab.*

1. Qualitative organic analysis; systematic identification of an organic compound containing functional group(s) like COOH, OH, NH<sub>2</sub>, C=O.
2. Purification techniques (solvent extraction, distillation and recrystallization) etc.

#### *Recommended Texts*

1. Younas, M. (2006). Organic spectroscopy. Lahore: A. H. Publisher
2. Solomons, T. W. G. (2016). Fundamentals of organic chemistry. (12th ed.). New York: Wiley.
3. Vogel, A. I. (1996). A textbook of practical organic chemistry. New York: Prentice Hall.

#### *Suggested Readings*

1. Kemp, W. (1990). Organic spectroscopy. London: Macmillan
2. Chughtai, F. A. (1995). Organic reactions. Lahore: Majid Book Depot.
3. Streitwieser, A. Heathcock, C. & Kosower, E. M. (2017). Introduction to organic chemistry. (4<sup>th</sup> ed.). New York: Macmillan.

This course is aimed to build foundation of Analytical Chemistry among the beginners, introducing them with the basic terminology and phenomenon of Analytical Chemistry, methods and precautions in collection and preservation of different type of samples for chemical analysis. It provides fundamental to deep insight about characterizing a material into its constituents as well as proportion of different ingredients in given sample. All the techniques and precautions for sample collection, and preparation are included in this course. Accuracy of this information is influenced by mode of sampling. This course provides a comprehensive skill development for preparation of solutions for measurements, calibration of volumetric glassware, and measurement of reagents with different types of balances. Skill about data analysis is also included in this course. Besides, basic principle, operational mechanism and applications of three different chromatographic techniques is contained in this course. For advanced information, overview of spectroscopic techniques, with comprehensive focus on UV/Visible spectrophotometry is also included in this course. After studying this course, students will be able to work independently in any quality control laboratory of any industry.

### *Contents*

1. Data Handling: introduction to analytical chemistry
2. Sampling; types of samples, techniques/ steps involved in sample preparation
3. Drying and ignition
4. Weighing, analytical balance, its construction working
5. volumetric glassware; errors in measurements, calibration of glassware
6. Steps involved in chemical analysis, system for units of measurements and their interconversion
7. Chemical concentration and preparation of solutions
8. Calibration and calibration curves (construction and interpretation), Standard addition and internal standard methods
9. Statistical treatment of analytical data; Precision, accuracy and types of errors, sample, population, mean, average, median, range, standard deviation, variance, significant figures
10. Chemical equilibrium and its types
11. Separation techniques: chromatography (introduction, classification) TLC, column & ion exchange chromatography (with reference to principles & applications), electrophoresis & solvent extraction

### *Analytical Chemistry Lab – I*

1. Calibration of glassware (Pipette, Burette, Flask) used for volumetric Analysis.
2. Use of Analytical balance and calculation of standard deviation.
3. Use of pH meter for plotting acid - base titration curve and assay of commercial caustic soda.
4. Plotting of first differential curve for titration of acetic acid and commercial soda.
5. Measurement of solubility products of sparingly soluble salts.
6. Determination of HCl by titrating with NaOH and plotting of a titration curve.
7. Packing of chromatographic column and separation of mixture of dyes.
8. Separation of various components of plant extract by column chromatography.
9. Separation of mixture of dyes by Radial chromatography.
10. Separation of mixture of Amino acids by paper chromatography.
11. Coating of TLC plates and separation of mixture of dyes.
12. Separation of mixture of Amino acids by TLC.

### *Recommended Texts*

1. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4<sup>th</sup> ed.). New York, John Wiley & Sons.

## SEMESTER-III

URCE-5119

Expository Writing

3 (3+0)

This course prepares undergraduates to become successful writers and readers of English. The course helps students develop their fundamental language skills with a focus on writing so that they can gain the confidence to communicate in oral and written English outside the classroom. The course is divided into five units and takes a Project-based Learning approach. Unit themes target the development of 21<sup>st</sup> century skills and focus on self-reflection and active community engagement. The course completion will enable the students to develop communication skills as reflective and self-directed learners. They will be able to intellectually engage with different stages of writing process, and develop analytical and problem-solving skills to address various community-specific challenges.

### *Contents*

1. Self-Reflection
  - Introduction to the basics of the writing process
  - Introduction to the steps of essay writing
  - Prewriting activities: Brainstorming, listing, clustering and freewriting
  - Practicing Outlining of the essay
2. Personalized Learning
  - Learning Process, Learning Styles, Goal Setting and Learning Plan
3. Oral Presentation
  - Structure and Significance, Content Selection and Slide Presentation, Peer Review
4. Critical Reading Skills
  - Introducing Authentic Reading (Dawn and non-specialist academic books/texts)
  - Reading Strategies and Practice: Skimming, scanning, SQW3R, Annotating, Detailed reading and note-taking, Standard Test Practice: TOEFL and IELTS, Model Review Reports and Annotated Bibliographies
5. Community Engagement
  - Student-led brainstorming on local versus global issues, Identifying research problems
  - Drafting research questions, Drafting interview/survey questions for community research (in English or L1)
  - Engaging students in Critical reading, Presenting interview/ survey information, Field work
  - Writing Community Engagement Project
6. Letter to the Editor
  - Types of letters, Format and purpose of letter to the editor, Steps in writing letter-to-editor

### *Recommended Texts*

1. Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.
2. Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: Essential tasks and skills* (3<sup>rd</sup> ed.). Ann Arbor: The University of Michigan Press.

### *Suggested Readings*

1. Cresswell, G. (2004). *Writing for academic success*. London: SAGE.
2. Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
3. Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing*. Washington: American Psychological Association.

This course is based on quantitative reasoning 1 course. It will enhance the quantitative reasoning skills learned in quantitative reasoning 1 course. Students will be introduced to more tools necessary for quantitative reasoning skills to live in the fast paced 21st century. Students will be introduced to importance of statistical and mathematical skills in different professional settings, social and natural sciences. These quantitative reasoning skills will help students to better participate in national and international issues like political and health issues. This course will prepare the students to apply quantitative reasoning tools more efficiently in their professional and daily life activities. This course will help them to better understand the information in form of numeric, graphs, tables, and functions.

### *Contents*

1. Types of data and its graphical representation (Histogram, Stem and Leaf display, Box Plot, Scatter diagram, Histogram, Bar chart, etc.)
2. Solving practical problems using linear and exponential models
3. Population growth models
4. Analytical approach to solve simultaneous equations
5. Inequalities and their application
6. Comparing quantities using analytical tools
7. Logical reasoning and their application in modern age
8. Logical reasoning and decision making
9. Data tendencies via measure of location
10. Variability and Measure of dispersion
11. Measuring relationships via Regression analysis and correlation
12. Statistical inference: sampling techniques, estimation techniques and hypothesis testing for decision and policy making

### *Recommended Texts*

1. Akar, G. K., Zembat, İ. Ö., Arslan, S., & Thompson, P. W. (2023). *Quantitative Reasoning in Mathematics and Science Education*. 1<sup>st</sup> Ed., Springer, USA.
2. Sharma, A. K. (2005). *Text book of elementary statistics*. Discovery Publishing House.
3. Blitzer, R. (2014). *Precalculus*, 5<sup>th</sup> Ed.. Pearson Education, Limited. New York

### *Suggested Readings*

1. Gupta, S. C., & Kapoor, V. K. (2020). *Fundamentals of mathematical statistics*. 12<sup>th</sup> Ed, Sultan Chand & Sons.
2. Aufmann, R. N., Lockwood, J., Nation, R. D., & Clegg, D. K. (2007). *Mathematical thinking and quantitative reasoning*. Cengage Learning
3. Blitzer, R., & White, J. (2005). *Thinking mathematically*. Pearson Prentice Hall.

This course focuses on ideological background of Pakistan. The course is designed to give a comprehensive insight about the constitutional developments of Pakistan. Starting from the Government of India Act, 1935 till to date, all important events leading to constitutional developments in Pakistan will be the focus of course. Failure of the constitutional machinery and leading constitutional cases on the subject. Moreover, students will study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan. It will also cover the entire Constitution of Pakistan 1973. However, emphasis would be on the fundamental rights, the nature of federalism under the constitution, distribution of powers, the rights and various remedies, the supremacy of parliament and the independence of judiciary.

*Contents:*

- Ideology of Pakistan
  - Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
  - Two Nation Theory and Factors leading to Muslim separatism.
- Constitutional Developments
  - Salient Feature of the Government of India Act 1935
  - Salient Feature of Indian Independence Act 1947
  - Objectives Resolution
  - Salient Feature of the 1956 Constitution
  - Developments leading to the abrogation of Constitution of 1956
  - Salient features of the 1962 Constitution
  - Causes of failure of the Constitution of 1962
  - Comparative study of significant features of the Constitution of 1956, 1962 and 1973
- Fundamental rights
- Principles of policy
- Federation of Pakistan
  - President
  - Parliament
  - The Federal Government
- Provinces
  - Governors
  - Provincial Assemblies
  - The Provincial Government
- The Judiciary
  - Supreme Court
  - High Courts
  - Federal Shariat Courts
  - Supreme Judicial Council
  - Administrative Courts and tribunals
- Islamic Provisions in Constitution
- Significant Amendments of Constitution of Pakistan 1973

*Recommended Books:*

1. Constitutional and Political History of Pakistan by Hamid Khan
2. Mahmood, Shaukat and Shaukat, Nadeem. Constitution of the Islamic Republic of Pakistan, 3rd re edn. Lahore: Legal Research Centre, 1996.
3. Munir, Muhammad. Constitution of the Islamic Republic of Pakistan: Being a Commentary on the Constitution of Pakistan, 1973. Lahore, Law Pub., 1975.
4. Rizvi, Syed Shabbar Raza. Constitutional Law of Pakistan: Text, Case Law and Analytical Commentary. 2nd re edn. Lahore: Vanguard, 2005.
5. The Text of the Constitution of the Islamic Republic of Pakistan, 1973 (as amended).
6. Fundamental Laws of Pakistan by A.K. Brohi

This course is the first part of this program, introduction to Physical Chemistry. This foundation course of physical chemistry covers basic knowledge and its application for learning chemical principles of physics to chemistry. This course offer complementary approaches to the fundamental understanding of chemical systems. Students will acquire knowledge to enable themselves to understand the kinetic theory of gases, collision theory of reactions, 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. The general goal of learning physical chemistry is to obtain a vision of matter-energy relationship in physical and chemical systems. Learning objectives emphasized in CHEM-5101 involve developing an understanding of basic principles of physical chemistry. Students learned in class to modern physical chemistry techniques which give them opportunities to see how Physical Chemists are solving current, real-world problems.

### *Contents*

1. Physical States of Mater:  
Gases: Van der Waal's equation, critical Phenomena, Critical values of T, P and V, liquefaction of gases, molecular collisions, collision diameter, mean free path  
Liquids: viscosity, Parachor value, Refractive index, molar refraction and its applications. Dipole moment  
Solids: Unit cells. Bragg crystal analysis, crystal structure of NaCl, powder method of crystal structure analysis.
2. Solutions: composition, ideal and non-ideal solutions. Raoult's law. Colligative properties, ebullioscopy, cryoscopy, osmotic pressure, distillation and concept of azeotropes
3. Chemical Equilibrium: Law of Mass Action, equilibrium constant, relationship between  $K_c$ ,  $K_p$ ,  $K_x$  and  $K_a$  and Le-Chatelier's Principle
4. Atomic Structure: De Broglie equation. Black body radiation, quantization concept, Heisenberg Uncertainty Principle, Pauli Exclusion Principle, Hund's Rule

### *Physical Chemistry Lab*

1. Determination of surface tension and Parachor value by stalagmometer.
2. Determination of percent composition of liquid solutions from surface tension measurement.
3. Determination of viscosity and Rhechor value of liquids from viscosity measurement.
4. Determination of percent composition of liquid solutions using viscometer.
5. Determination of refractive index and molar refractivity by refractometer.
6. Determination of percent composition of liquid solutions by refractive index measurements.
7. Determination of heat of neutralization of an acid with a base.
8. Determination of molecular weight of a compound by elevation in boiling point (Ebullioscopic method).
9. Determination of molecular weight of a compound by lowering of freezing point (Cryoscopic method).

### *Recommended Texts*

1. Atkins, P., Paula, J., & Keeler, J. (2017). *Atkins' Physical Chemistry* (11<sup>th</sup> ed.). UK: Oxford University Press.
2. Kuhn, H., Försterling, H., & Waldeck, D. H. (2009). *Principles of Physical Chemistry* (2<sup>nd</sup> ed.). USA: Wiley Publisher.

### *Suggested Readings*

1. Akhtar, M. N., & Nabi, G. (2006). *Text Book of Physical Chemistry*. Lahore: Ilmi Kitab Khawna.
2. Das, R. C., & Behera, B. (2003). *Experimental Physical Chemistry*. Delhi: Tata McGraw Hill.



This course aims at providing students basic knowledge of statistics. Student will be able to use Simple linear regression, multiple regression (for two independent variables), and Correlation in terms of chemistry. Students will be provided with the theoretical concepts, tools and methods of statistics as well as the opportunity to work through example problems. This course also provides basic statistical concepts for measuring the central tendency and dispersion, probability distributions, the central limit theorem, sampling, estimation, hypothesis testing, analysis of variance, correlation and regression analysis, multiple regression and statistical forecasting. Upon the completing this course the students will be able to compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis, for forecasting and also perform ANOVA and F-test. This will further enhance student knowledge to understand both the meaning and applicability of a dummy variable and the assumptions which underline a regression model. Be able to perform a multiple regression using computer software.

#### *Contents*

1. Statistics- Introduction.
2. Definition, Descriptive and inferential statistics, Population, Sample, Data collecting. Use of Microsoft Excel for data analysis
3. Applications of statistics in chemistry.
4. Graphical Representation.
5. Simple Bar chart, Multiple Bar chart
6. Rectangle Sub-divided Chart, Histogram
7. Frequency Polygon, Histogram, Pi- Chart
8. Central Tendencies (A.M., G.M. Median, Mode, H.M. for Ungrouped Data.
9. Quantiles with Interpretation (for ungrouped data)
10. Quartiles, Percentiles, Deciles
11. Measures of dispersion (Mean Deviation, Variance, Standard Deviation, Coefficient of Variation).
12. Basic Probability Theory.
13. Regression, Definitions of Simple linear regression
14. Multiple regression (for two independent variables), and Correlation.
15. Estimation: Point estimate, interval estimates
16. Confidence Interval for Single Mean, Difference of Mean.
17. Testing of Hypothesis: t- test for single mean for paired samples and for Independent samples.
18. ANOVA, Multiple Comparison Test, (LSD and DUCANSAN).
19. Chi Square for Association.

#### *Recommended Texts*

1. Navidi, J. (2010). *Statistics for engineers and scientists*. (1<sup>st</sup> ed.). New York, USA: John Wiley.
2. Schuenemeyer, J. (2011). *Larry drew statistics for earth and environmental scientists*. New York, USA: John Wiley.

#### *Suggested Readings*

1. Miller, C. J. & Miller, N. J. (1993). *Statistics for analytical chemistry*. New York: Ellis Horwood Ltd.
2. Miller, N. J. & Miller, C. J. (2001) *Statistics and chemometrics for analytical chemistry*. (4<sup>th</sup> ed.). New York: Prentice Hall.

**CHEM-5108****Laboratory Safety Measures****2(2-0)**

- a) Fire/Electricity/Chemical/Biological/Radiation safety measures
- b) Common pitfalls in laboratory
- c) First aid in laboratory
- d) Laboratory managements
- e) Different lab skills such as glass blowing, preliminary calibration/maintenance of instruments

*Reference Books*

1. Armour, M.A. Hazardous Laboratory Chemical Disposal Guide. CRC Press, LLC. (2003).
2. Urban P.G. Bretherick's Handbook of Reactive Chemical Hazards. 7<sup>th</sup> ed. Academic Press, NY. (2006)
3. Prudent Practices in Laboratory Handling & Disposal of Chemicals. National Academy Press, Washington D.C., USA. (2008).
4. Safety in Academic Chemistry Laboratories, Vol. 1, 2; American Chemical Society. Washington DC (2003)

## SEMESTER-IV

### URCT-5115                      Course –II: The Science of Global Challenges                      3 (2+1)

Climate Change i.e., Global Warming, Natural and Anthropogenic Activities and their impact; Energy i.e., Renewable and non-renewable energy resources; Water Security i.e., water scarcity and waste water treatment; Land Degradation i.e., salinity, water logging, deforestation, land erosion; Food Security and roll of Biotechnology in food production; Global Health Pandemics i.e., Infectious diseases, vaccine, development of drug discovery for newly explored diseases

#### **Practical:**

1. Preparation of standard solution and their standardizations
2. Soil and Water Analysis

#### **Recommended Text:**

Usman, M. (2022). *Science of Global Challenges*. Ilmi Kitab Khana, Lahore

#### **Suggested Books**

1. Thieman, W.J. & Palladino, M.A. (2014). *Introduction to biotechnology*. Edinburgh Gate UK: Pearson Education Limited.
2. Daugherty, E. (2012). *Biotechnology: Science for the New Millennium*, 1st Edition, Revised, USA: Paradigm Publication.
3. Karaduman, I. C. (Ed.) (2014) *Global Challenges for the world*. Obroonnosc. Zeszytl Naukowe. Turkey

This course addresses the unique entrepreneurial experience of conceiving, evaluating, creating, managing, and potentially selling a business idea. The goal is to provide a solid background with practical application of important concepts applicable to the entrepreneurial environment. Entrepreneurial discussions regarding the key business areas of finance, accounting, marketing and management include the creative aspects of entrepreneurship. The course relies on classroom discussion, participation, the creation of a feasibility plan, and building a business plan to develop a comprehensive strategy for launching and managing a new venture.

#### *Contents*

1. Background: What is an Organization, Organizational Resources, Management Functions, Kinds of Managers, Mintzberg's Managerial Roles.
2. Forms of Business Ownership: The Sole proprietorship, Partnership, Joint Stock Company
3. Entrepreneurship: The World of the Entrepreneur, what is an entrepreneur? The Benefits of Entrepreneurship, The Potential Drawbacks of Entrepreneurship, Behind the Boom: Feeding the Entrepreneurial Fire.
4. The Challenges of Entrepreneurship: The Cultural Diversity in Entrepreneurship, The Power of "Small" Business, Putting Failure into Perspective, The Ten Deadly Mistakes of Entrepreneurship, How to Avoid the Pitfalls, Idea Discussions & Selection of student Projects, Islamic Ethics of Entrepreneurship.
5. Inside the Entrepreneurial Mind: From Ideas to Reality: Creativity, Innovation, and Entrepreneurship, Creativity – Essential to Survival, Creative Thinking, Barriers to Creativity, How to Enhance Creativity, The Creative Process, Techniques for Improving the Creative Process, Protecting Your Ideas, Idea Discussions & Selection of student Projects.
6. Products and technology, identification opportunities
7. Designing a Competitive Business Model and Building a Solid Strategic Plan: Building a strategic plan, Building a Competitive Advantage, The Strategic Management Process, Formulate strategic options and select the appropriate strategies, Discussion about execution of Students' Project.
8. Conducting a Feasibility Analysis and Crafting a Winning Business Plan: Conducting a Feasibility Analysis, Industry and market feasibility, Porter's five forces model, Financial feasibility analysis. Why Develop a Business Plan, The Elements of a Business Plan, What Lenders and Investors Look for in a Business Plan, Making the Business Plan Presentation.
9. Building a Powerful Marketing Plan: Building a Guerrilla Marketing Plan, Pinpointing the Target Market, Determining Customer Needs and Wants Through Market Research. Plotting a Guerrilla Marketing Strategy: How to Build a Competitive Edge, Feed Back & Suggestions on Student Project, Islamic Ethics for Entrepreneurial Marketing
10. E-Commerce and the Entrepreneur: Factors to Consider before Launching into E-Commerce, Ten Myths of E-Commerce, Strategies for E-Success, Designing a Killer Web Site, Tracking Web Results, Ensuring Web Privacy and Security, Feed Back & Suggestions on Student Project.
11. Pricing Strategies: Three Potent Forces: Image, Competition, and Value, Pricing Strategies and Tactics, Pricing Strategies and Methods for Retailers, The Impact of Credit on Pricing
12. Attracting Venture Capitalist: Projected Financial Statements, Basic Financial Statements, Ratio Analysis, Interpreting Business Ratios, Breakeven Analysis, Feed Back & Suggestions on Student Project,
13. Idea Pitching: Formal presentation, 5-minutes pitch, funding negotiation and launching.

#### *Recommended Texts:*

1. Scarborough, N. M. (2011). *Essentials of entrepreneurship and small business management*. Publishing as Prentice Hall, One Lake Street, Upper Saddle River, New Jersey 07458.

#### *Suggested Readings:*

1. Burstiner, I. (1989). *Small business handbook*. Prentice Hall Press.

The Civics and Community Engagement course is designed to provide students with an understanding of the importance of civic participation, culture and cultural diversity, basic foundations of citizenship, group identities and the role of individuals in creating positive change within their communities. The course aims at developing students' knowledge, skills and attitudes necessary for active and responsible citizenship.

*Contents:*

Introduction to Civics & Community Engagement

- Overview of the course: Civics & Community Engagement
- Definition and importance of civics
- Key concepts in civics: citizenship, democracy, governance, and the rule of law
- Rights and responsibilities of citizens

Citizenship and Community Engagement

- Introduction to Active Citizenship: Overview of the Ideas, Concepts, Philosophy and Skills
- Approaches and Methodology for Active Citizenship

Identity, Culture, and Social Harmony

- Concept and Development of Identity, Group identities
- Components of Culture, Cultural pluralism, Multiculturalism, Cultural Ethnocentrism, Cultural relativism, Understanding cultural diversity, Globalization and Culture, Social Harmony,
- Religious Diversity (Understanding and affirmation of similarities & differences)
- Understanding Socio-Political Polarization
- Minorities, Social Inclusion, Affirmative actions

Multi-cultural society and inter-cultural dialogue

- Inter-cultural dialogue (bridging the differences, promoting harmony)
- Promoting intergroup contact/ Dialogue
- Significance of diversity and its impact
- Importance and domains of Inter-cultural dialogue

Active Citizen: Locally Active, Globally Connected

- Importance of active citizenship at national and global level
- Understanding community
- Identification of resources (human, natural and others)
- Utilization of resources for development (community participation)
- Strategic planning, for development (community linkages and mobilization)

Human rights, constitutionalism and citizens' responsibilities

- Introduction to Human Rights
- Human rights in constitution of Pakistan
- Public duties and responsibilities
- Constitutionalism and democratic process

Social Institutions, Social Groups, Formal Organizations and Bureaucracy

- Types of Groups, Group identities, Organizations
- Bureaucracy, Weber's model of Bureaucracy
- Role of political parties, interest groups, and non-governmental organizations

Civic Engagement Strategies

- Grassroots organizing and community mobilization
- Advocacy and lobbying for policy change
- Volunteerism and service-learning opportunities

Social issues/Problems of Pakistan

- Overview of major social issues of Pakistani society

## Social Action Project

### *Recommended Books:*

1. Kennedy, J. K., & Brunold, A. (2016). *Regional context and Citizenship education in Asia and Europe*. New York: Routledge, Falmer.
2. Henslin, James M. (2018). *Essentials of Sociology: A Down to Earth Approach* (13<sup>th</sup> ed.). New York: Pearson Education
3. Macionis, J. J., & Gerber, M.L. (2020). *Sociology*. New York: Pearson Education

### *Reference Books:*

1. Glencoe McGraw-Hill. (n.d.). *Civics Today: Citizenship, Economics, and Youth*.
  2. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). *Government by the People* (16th ed.). Pearson.
  3. Sirianni, C., & Friedland, L. (2005). *The Civic Renewal Movement: Community-Building and Democracy in the United States*. Kettering Foundation Press.
  4. Bloemraad, I. (2006). *Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada*. University of California Press.
  5. Kuyek, J. (2007). *Community Organizing: Theory and Practice*. Fernwood Publishing.
  6. DeKieffer, D. E. (2010). *The Citizen's Guide to Lobbying Congress*. TheCapitol.Net.
  7. Rybacki, K. C., & Rybacki, D. J. (2021). *Advocacy and Opposition: An Introduction to Argumentation* (8th ed.). Routledge.
  8. Kretzmann, J. P., & McKnight, J. L. (1993). *Building Communities from the Inside Out: A Path Towards Finding and Mobilizing a Community's Assets*. ACTA Publications.
  9. Patterson, T. E. (2005). *Engaging the Public: How Government and the Media Can Reinvigorate American Democracy*. Oxford University Press.
- Love, N. S., & Mattern, M. (2005). *Doing Democracy: Activist Art and Cultural Politics*. SUNY Press.

<p>Course Contents:</p>	<p>o ایمانیات اور عبادات ہلا پر ایمان، فرشتوں پر ایمان، رسولوں پر ایمان، آسمانی کتابوں پر ایمان یوم آخرت پر ایمان، تقدیر پر ایمان نماز، روزہ ، زکوٰۃ، حج، جہاد o معاشرے کے حقوق خاندان کی تکوین . حق مہر . رضاعت و حمل . اولاد کو قتل کرنے کے ممانعت . شوہر کی نافرمانی . طالق . بیوہ کی عدت کے احکام . نکاح کا پیغام بھیجنا . عورت کی وراثت (اس کے شوہر کی طرف سے) . والدین کے حقوق . بیویوں اور اولاد کے بیچ عداوت . o خاندان کے حقوق مہمان کی عزت . اجازت طلب کرنے کے اصول . مجلس کے آداب . تعاون اور بھائی چارہ . گروہ بندی . محبت . لوگوں کے درمیان صلح . عفو و درگزر، غصہ پر قابو اور معاف کرنا . شعوب و قبائل . لوگوں کے بیچ اختلافات . حمایت و نگہبانی .</p>
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Grammar:	<p>قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)</p>
<p>Details of Chapters and verse Numbers:</p>	<ul style="list-style-type: none"> <li>▪ منتخب آیات مع ترجمہ و تجوید</li> <li>▪ البقرہ ((۱۱۷، ۲۳۸، ۴۵، ۱۱۸، ۲۷۸، ۱۷۷، ۴۵، ۳۴۷، ۱۵۸، ۷۱۸، ۴۲۸، ۵۳، ۴۲۸، ۴۷، ۲۸۷، ۳۴۸، ۲۲، ۸۲، ۲۸۷، ۴۲۸، ۲۴۸، ۱۱۷، ۲۳۷، ۲۲۷، ۱۱۸، ۵۲۷، ۳۲۷، ۲۷۸، ۲۴۷، ۷۵۸، ۲۲۷، ۱۸۸، ۲۸۸، ۱۳۸، ۲۸۸، ۲۸۸، ۷۳۸، ۱۳۸، ۴۳۸، ۱۳۸، ۸۲، ۵۲۷، ۳۳۸، ۸۲۷، ۱۲۷، ۳۲))</li> <li>▪ النساء ((۴۲، ۸۲، ۲۴، ۲۳۷، ۲۲، ۱۲، ۳۷، ۲۲، ۱۲، ۲۲، ۲۳، ۲۲، ۲۳، ۲۱۷، ۸۷، ۴۳، ۲۸۷، ۷، ۱۸، ۷، ۲، ۷۲۷، ۴۳، ۱۸، ۴۳، ۷۲۷، ۲، ۷، ۱۸، ۷، ۵۳، ۷۷، ۵، ۲۱۷، ۵۸، ۴۸، ۷۷، ۷۷، ۲۸۷، ۷۲۷، ۴۳، ۱۸، ۴۳، ۷۲۷، ۲، ۷، ۱۸، ۷، ۲۷، ۲۵۷، ۵۴، ۲۸۷، ۷۲))</li> <li>▪ النعام ((۸۸، ۸۲، ۵۷، ۱۳۷، ۷۴۷، ۲۵، ۵۴))</li> <li>▪ آل عمران ((۱۲، ۲۳، ۴۲، ۴۸۷، ۵۲، ۵۵۷، ۲۷، ۷))</li> <li>▪ المائدہ ((۵۴، ۸، ۸۲، ۲۳، ۲۷، ۸۲، ۸، ۴))</li> <li>▪ العراف ((۲۲۷، ۴۳))</li> <li>▪ التوبہ ((۱۸، ۲۷، ۷۱))</li> <li>▪ ہود ((۸۷))</li> <li>▪ الزمر ((۲))</li> <li>▪ النور ((۵۴، ۸۴، ۲۸، ۱۸، ۱۲، ۲۸))</li> <li>▪ محمد ((۳۳))</li> <li>▪ انفال ((۸۲، ۱۸))</li> <li>▪ الرعد ((۳))</li> <li>▪ الطالق ((۵))</li> <li>▪ الحج ((۴))</li> <li>▪ ابراہیم ((۵۵، ۳۸))</li> <li>▪ السراء ((۳۸، ۵۸))</li> <li>▪ الحقاف ((۴۷))</li> <li>▪ المومنون ((۱۸))</li> <li>▪ العنکبوت ((۲۵، ۴۸، ۲))</li> <li>▪ النحل ((۸۸))</li> <li>▪ لقمان ((۵، ۴۷، ۵۷))</li> <li>▪ الحزاب ((۴۳، ۲۳، ۱۴، ۲۵))</li> <li>▪ الشعراء ((۱))</li> <li>▪ الروم ((۷۸))</li> <li>▪ مریم ((۲۸، ۵۷))</li> <li>▪ المجادلہ ((۸۷، ۷۷))</li> </ul>



This course covers a range of specialized topics in chemistry which provide a useful supplement to the advanced courses specified in the department. Student will be able to learn the basic knowledge of biomolecules, simple heterocycles and introductory organic spectroscopy, is helpful in identification of organic compounds. In addition to it, basics of surface chemistry, modern material and detail study of unit operations in chemical industry and metallurgy can be a beneficial for new learners who are ambitious for specialized area of chemistry. The main objectives emphasized in this course involve developing an understanding of basic principles of different branches of chemistry. It develops critical thinking skills enabling students to solve general chemistry problems that incorporate their cumulative knowledge. Students learned in class to advanced chemistry concepts which give them opportunities to upgrade their applicable knowledge. This course is to develop study skills that students need to succeed in university-level advanced chemistry courses and preparation of students for professional positions in this field and their industrial skill.

### *Contents*

1. Introduction to Spectroscopy: IR and UV-Vis, Atomic Absorption Spectroscopy, Flame Emission Spectrometry, ICP (Principle, instrumentations, and applications).
2. Introduction to separation techniques
  - (a) Chromatography: Classification, Paper Chromatography, TLC, Column Chromatography, Ion-Exchange Chromatography.
  - (b) Solvent Extraction
3. Surface Phenomena and Colloids: (Physisorption and chemisorption, isotherms, types, properties, preparation and applications of colloids).
4. Computational Chemistry: Introduction, computational approaches to explore chemical phenomenon, Theories (wave function theory & density functional theory), methods, basis set
5. Modern Materials: (Introduction to liquid crystals, Inorganic polymers, Ceramics, Fiber glass, Thin films, Semiconductors and Composite materials).
6. Chemical Industries: (Metallurgy of Al, manufacturing of H<sub>2</sub>SO<sub>4</sub>, HNO<sub>3</sub>, fertilizers, cement and glass).

### *Chemistry Special Topics Lab*

1. Percentage determination of barium in barium nitrate by gravimetric method.
2. Gravimetric determination of nickel.
3. Estimate the glucose content in the sample by titration method
4. Determination of adsorption parameters using Langmuir adsorption isotherm of acetic acid on charcoal.
5. To determine the wavelength of maximum absorption of compounds using spectrophotometer.
6. To determine the concentration of Cr in water sample by using spectrophotometer.
7. To determine the concentration of Mn in water sample by using spectrophotometer.
8. To determine the concentration of the Sucrose, glucose and dextrose in samples by using polarimeter.
9. To determine the Iodine value of the oil and fat
10. Estimate the glucose content in the sample by titration method
11. Identification Al<sup>3+</sup>, Cr<sup>3+</sup> and Fe<sup>3+</sup> in samples by TLC
12. Determine the partition coefficient of iodine between H<sub>2</sub>O and CCl<sub>4</sub>
13. Qualitative analysis of lipids, proteins, carbohydrates

### *Recommended Texts*

1. Younas, M. (2005). *Organic spectroscopy*. Lahore: A. H. Publisher

2. Shaheen, M.A. (2022) Selected Topics in Chemistry, Jilani Notes, Sargodha
  3. Solomons, T. W. G. (2016). *Fundamentals of organic chemistry* (12<sup>th</sup> ed.). New York: Wiley,
  4. Shaheen, M.A. (2022) Jilani Manual of Practical Chemistry Vol. IV, Jilani Notes, Sargodha
- Suggested Readings*

1. Kent, J. A. (1997). *Riegel's hand book of industrial chemistry*. New Delhi: CBS Publishers and Distributors.
2. Arnikar, H. J. (1998). *Nuclear chemistry*. India: Krishna Prakashan Media (P) Ltd.
3. Gurdeep, R. (2002). *Advanced physical chemistry*. India: Krishna Prakashan Media (P) Ltd.

This course will provide the knowledge of evolutionary/phylogenetic relationship. It imparts the basic taxonomic characteristics and classification of all the invertebrate phyla. This includes more than 95% of all of the described species of animals and far more than 99% of all of the individual animals on the planet. The central theme running throughout this course will be phylogeny. It provides understanding of body organization, mode of feeding, digestion, reproduction and development of invertebrates. It delivers information to students about economic and ecological importance of invertebrates. Students will understand invertebrate organismal concepts in laboratory and field. The primary objectives for the laboratory section of this course includes; introduction of structure, function and behavior of selected invertebrate types through the observation of both living and preserved specimens, to reinforce basic laboratory skills of students like microscopy, dissection and careful observation, to provide students with the ability to recognize the major groups of invertebrate and to increasing understanding of the methods of investigating animal evolution.

### *Contents*

1. Introduction: Classification of organisms, Evolutionary relationships and Tree diagrams: Patterns of organization.
2. Animal-like protists: the protozoa: Evolutionary perspective; Life within a single plasma Membrane, Symbiotic Life-styles, Protozoon Taxonomy, Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure, Nutrition; Genetic Control and Reproduction; Symbiotic ciliates, Further Phylogenetic consideration.
3. Multicellular and tissue levels of organization: Evolutionary Perspective, Origins of Multicellularity; Animal Origins, Phylum Porifera, Cnidaria, Ctenophora, Characters and Classification, Maintenance functions.
4. The triploblastic and with acoelomate body plan: Phylum Platyhelminthes, Phylum Nematode, Gastrotricha, Evolutionary Perspective; Classification up to class, Body plan and functions.
5. Pseudocoelomate body plan: Phylum Aschelminths, Evolutionary perspective; General Characteristics; Classification up to order with External Features, Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum Rotifera, Phylum Nematoda and Phylum Kinorhyncha. Some important Nematode parasites of Humans.
6. Phylum Mollusca: Evolutionary perspective; Relationship to other animals; Origin of the Coelom; Characteristics, Classification up to class. The characteristics of shell and associated structures, Feeding, Digestion, Gas Exchange, Locomotion, Reproduction and Development, Other maintenance Functions and Diversity in Gastropods, Bivalves and Cephalopods.
7. Phylum Annelida: The Metameric Body Form; Evolutionary perspective; Relationship to other animals, Metamerism and Tagmatization, Classification up to Class. External Structure and Locomotion, Feeding and the Digestive system, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Regeneration, Reproduction and Development, Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration.
8. Phylum Arthropoda: Evolutionary Perspective: Classification and relationship to other Animals; Metamerism and Tagmatization; The Exoskeleton; Metamorphosis; Classification up to Class.
9. The Hexapods and Myriapods: Evolutionary Perspective: Classification upto class. External Structure and Locomotion, Nutrition and the Digestive system, Gas Exchange, Circulation and Temperature Regulation, Nervous and Sensory Functions, Excretion, Chemical Regulation, Reproduction and Development in Hexapoda, Insects Behavior, Insect and Human.
10. Phylum Echinoderms: Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class. Maintenance functions, regeneration, reproduction, and development in Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa.
11. Some lesser known Invertebrates: Lophotrochozoa, Entoprocta, Cycliophora, and Cheilostomata.

### *Animal Diversity-I (Invertebrates) lab*

Note: Classification of each members of each phylum upto order with adaptations in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.

1. Study of Euglena, Amoeba, Endameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of representatives of Phylum Porifera and prepared slides of spicules of sponges
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of Phylum Echinodermata.
10. Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.
11. Preparation of permanent slide of mouthpart of insects (after dissection).
12. How to make grade-wise series for preparation of temporary and permanent slides.

### *Recommended Texts*

1. Miller, A. S., & Harley, J. B. (1999, 2002, 2007, 2009, 2012 and 2016). *Zoology* (4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> ed.) Singapore: McGraw Hill.
2. Hickman, C. P., Roberts, L. C. & Larson, A. (2007). *Integrated principles of zoology* (11th and 12th ed.). Singapore: McGraw-Hill.

### *Suggested Readings*

1. Hickman, C. P., Roberts, L. C., & Larson, A. (2018). *Integrated principles of zoology* (15<sup>th</sup> ed.). Singapore: McGraw-Hill.
2. Pechenik, J. A. (2015). *Biology of invertebrates* (7<sup>th</sup> ed.). Singapore: McGraw-Hill
3. Kent, G. C., & Miller, S. (2001). *Comparative anatomy of vertebrates*. New York: McGraw-Hill

Mechanics is all about motion of a body. It deals with forces, motion and further to the laws of motion in inertial frames specifically. This course provides the students a broad understanding of the physical principles of the mechanics, to describe mechanical events that involve forces acting on macroscopic objects. The main objective of this course is to create quantitative skills in the students and to motivate them to think creatively and critically about scientific problems and experiments. Students are encouraged to share their thinking with teacher and the other students to examine different problem-solving strategies.

#### *Course Contents*

- 1 Motion in one/two/three dimensions.
- 2 Newtonian mechanics, Friction, Drag force, Work and kinetic/potential energy.
- 3 Linear momentum, Conservation of momentum/energy, Power, System of particles, Collisions in one/two dimensions.
- 4 Rotational dynamics, Moment of inertia, Principles of parallel and perpendicular axis theorem.
- 5 Determination of moment of inertia of various shapes.
- 6 Rotational dynamics of rigid bodies and its effect on the application of torque.
- 7 Angular momentum and its conservation, Effect of torque on the angular momentum.
- 8 The motion of planets and Kepler laws in detail, Motion of satellite and its energy consideration in planetary and satellite motion.
- 9 Fluid statics, Fluid dynamics.

#### *Recommended Books*

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamentals of physics* (10<sup>th</sup> Ed.). New York: Wiley.
2. Halliday, D., Resnick, R. & Krane, K. S. (2003). *Physics* (5<sup>th</sup> Ed.). New York: Wiley.

#### *Suggested Books*

1. Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15<sup>th</sup> Ed.). New York: Pearson.
2. Serway, R. A. & Jewett, J. W. (2014). *Physics for scientist and engineers* (9<sup>th</sup> Ed.). New York: Brooks/Cole.
3. Melissinos, A.C. (2008). *Experiments in modern physics*. New York: Academic press.

## SEMESTER V

CHEM-6101

Inorganic Chemistry – I

4(3+1)

The students will be able to learn the detailed concept of d-block elements, inner transition elements, non-aqueous solvents and structural elucidation of compounds. Nature of chemical bonding in coordination compounds is included in the course, which enables the students to understand the color and magnetic properties of compounds. The examples of salts with some properties different from those of double-salts enable us to think about the introduction and nomenclature of coordination compounds. The earlier knowledge of the electronic configuration of elements belonging to d-block elements makes the learning easier about f-block Lanthanides and Actinides. Further, non-aqueous chemistry provides information about reactions which otherwise cannot take place in aqueous polar environment. Moreover, different methods for the analysis of halide ions and transition metals ions will also be studied in lab work. Estimation of different metal ions in the water and biological samples is necessary to explain the properties and nature of such samples.

### Contents

1. An overview of theories of Bonding: VBT, MOT (LCAO method, Examples of molecular orbital treatment for homonuclear diatomic molecules, heteronuclear diatomic molecules, molecules involving delocalized  $\pi$ - bonding), VSEPR (Effect of lone pairs, Effect of electronegativity Isoelectronic principle. Hybridization, The extent of d orbital participation in molecular bonding.
2. Chemistry of Coordination Compounds: Introduction of d-block elements
  - a. Nature of Bonding: Valence bond theory, Crystal field and Ligand field theory
  - b. Molecular orbital theory and Jahn-Teller Theorem
  - c. The spectrochemical series, color, isomerism and stereochemistry of metal complexes
  - d. Geometry of complexes having coordination number 2 to 6
  - e. Applications of coordination compounds in chemistry, life and industry
  - f. Stability constants, Factors that influence complex stability, Stabilization of unusual oxidation states by coordination, Determination of stability constants
  - g. Chelates
3. Chemistry of Lanthanides and Actinides: Structure, occurrence and preparation  
Separation, electronic configuration and oxidation states  
Spectral and magnetic properties and Complex formation and their applications
4. Non – aqueous Solvents:
  - a. Introduction and classification of solvents
  - b. Types of reactions in non-aqueous solvents
  - c. Effect of physical and chemical properties of solvents
  - d. Study of reactions in liq.  $\text{NH}_3$  and liq.  $\text{SO}_2$
  - e. Reactions in Liq.  $\text{HF}$  and liq.  $\text{BrF}_3$  and in molten salt system

### Inorganic Chemistry Lab-I

1. Aqueous acid-base titrations:
  - (a) Estimation of  $\text{SO}_2$  and  $\text{SO}_3$  in air and discharged from an industrial process.
  - (b) Estimation of  $\text{CO}_2$
  - (c) Estimation of oxalic acid and  $\text{H}_2\text{SO}_4$  in a mixture.
  - (d) Estimation of  $\text{H}_3\text{BO}_3$  and  $\text{NaH}_2\text{BO}_3$  in a mixture.
  - (e) Determination of %age composition of a mixture containing  $\text{H}_3\text{BO}_3$  and  $\text{CH}_3\text{COOH}$ .
2. Precipitation Titrations: Estimation of following anions with the help of adsorption indicators:
  - (i) Chloride (ii) Bromide (iii) Sulphate (iv) Chloride and Iodide in a mixture.
3. Qualitative Analysis of inorganic mixture (six radicals) by micro and semi-micro techniques.
4. Analysis of ores (iron, copper, marble)

### *Recommended Texts*

1. Cotton, F.A., & Wilkinson, G. (2015). *Advanced inorganic chemistry*. (7<sup>th</sup> ed.). New York: John Wiley & Sons.
2. Greenwood, N.N., & Earnshaw, A. (1984). *Chemistry of the elements*. (2<sup>nd</sup> ed.). U.K.: Elsevier.
3. Shaheen, M.A. Advance Inorganic Chemistry (2003), Jilani Notes, Sargodha-Lahore
4. Fred Basolo, Ronald C. Johnson (2003) Coordination Chemistry, W.A. Benjamin, Inc
5. Shaheen, M.A. Manual of Advanced Practical Chemistry (2003), Jilani Notes, Sargodha-Lahore
- 6.

### *Suggested Readings*

1. De Lavis, R. (1997). *Principles of quantitative chemical analysis*. (1<sup>st</sup> ed.). New York, USA: WCB/McGraw Hill.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

It is a course designed to deliver fundamental concepts in organic chemistry for core understanding of forthcoming courses (CHEM-6111, CHEM-6125, CHEM-6242 and CHEM-6243) of organic chemistry specialization. The nomenclature of organic molecules (both carbocycles and heterocycles), involvement of electronic ( $-I$ ,  $+I$ )/resonance ( $-R$ ,  $+R$ )/steric factors in reactions and stereochemical aspects are major focus of this course. A major part of this course is associated with the study of stereoisomers. Stereochemistry spans the entire spectrum of organic, inorganic, biological, physical and especially supramolecular chemistry. It includes methods for determining and describing these relationships; the effect on the physical or biological properties these relationships impart upon the molecules in question, and the manner in which these relationships influence the reactivity of the molecules in question (dynamic stereochemistry). A basic concept on 3D structures, conformations of molecules, asymmetric synthesis, other stereochemical principles and attributes are essential. The completion of this course shall enable the students to apply fundamental concepts in organic chemistry and stereoisomerism.

#### Contents

1. IUPAC nomenclature of polyfunctional aliphatic, alicyclic, aromatic, heterocyclic, multicyclic (bicyclic, tricyclic etc.) organic compounds: concept of principal and subordinate functional groups, prefix, suffix etc.
2. Application of inductive, resonance, hyperconjugation effects, classification of tautomers. Effect of structure, medium and steric factors on the strength of acids, bases and on acid-base equilibria. Introductory linear free energy relationship.
3. Geometrical Isomerism: *cis/trans*, *E/Z* & *syn/anti* conventions, optical isomerism.
4. Chirality and symmetry, elements of chirality and elements of symmetry.
5. Optical isomerism of compounds up to three asymmetric centers, configuration vs conformation.
6. Wedge-head, saw-horse, Newman & Fischer projections.
7. Baeyer's strain theory, conformational isomerism in acyclic, alicyclic compounds (cyclobutane, cyclopentane, cyclohexane), mono / di-substituted cyclohexanes and condensed rings, locking groups.
8. Configurational isomerism in biphenyls, allenes and spiranes; relative (*D/L* convention) and absolute configuration (CIP / modified CIP rules & *R/S*, *r/s*, *aR/aS* conventions).
9. Racemization, resolution of racemic modification and introductory asymmetric synthesis.

#### Organic Chemistry Lab.- I

1. Separation & identification of two component mixture of organic compounds [containing functional group(s) like COOH, OH, NH<sub>2</sub>, C=O] by physical and chemical methods.
2. Preparation of simple organic compounds (Ethyl benzoate, benzoic acid, tribromophenol, aspirin, nitrobenzene).

#### Recommended Texts

1. Clayden, J., Greeves, N., and Warren, S. (2012). *Organic chemistry*. (2<sup>nd</sup> ed.). Oxford, London.
2. Solomons, T. W. G. (2016). *Fundamentals of organic chemistry*. (12<sup>th</sup> ed.). New York: Wiley.
3. Hendrickson, J.B., Cram, D.J. and Hammond, G.S. (1980), *Organic chemistry*. New York: McGraw-Hill Book Co.

#### Suggested Readings

1. Streitwieser, A., Heathcock, C. and Kosower, E. M. (2017). *Introduction to organic chemistry*. (4th ed.). New York: Macmillan.
2. Vogel, A. I. (1989). *Practical organic chemistry*. (4th ed.). London: Longman Publisher.



This course is mainly comprised of knowledge related to electrochemistry. As electrical potential caused by a chemical reaction or other way around is an important direction towards energy production. The course is designed to have a vast knowledge based on basic principles of electrochemistry, electrical conductivity and interionic interactions. Course content include conductance, its measurement, Arrhenius theory, Debye Huckel theory and impact of ionic environment of reaction. It includes the concepts of electrical potentials and electric current, electrochemical reactions, electrode and electrolytes: Working electrodes, Reference electrodes, electrolytes, electrochemical methods for the study of the electrode/electrolyte interface. Moreover, knowledge about phase equilibrium is also important in Physical chemistry. To meet this area of thrust for physical chemistry students, phase equilibrium, phase diagram, Clapeyron equation, single component, phase diagram for binary mixture, Raoult's law and Henry's law etc. are offered in this course.

Practical portion also has very informative and useful content which may lead interest in the field of research related to energy and electrochemistry.

#### *Contents*

Electrochemistry: Introduction to Electrochemistry, Conductance & Resistance, Factors affecting conductance, Measurement of conductance, Arrhenius Theory of electrolytic dissociation, Ostwald's Dilution Law, Theory of strong electrolytes, Kohlrausch's law and its applications, Debye Huckel Theory, Debye Huckel Limiting law, Activity and activity coefficients of electrolytic solutions, Determination of activities, Concentration cells, Determination of e.m.f. of concentration cells with and without transference, Fuel cells and hydrocarbon fuel cells.

Phase Equilibrium: Introduction to Phase Equilibrium, Single Component Phase Diagrams, Criterion for Phase Equilibrium, The Clapeyron Equation, The Clausius-Clapeyron Equation, Phase Diagrams for Binary Mixtures, Liquid-Vapor Systems - Raoult's Law, Non-ideality - Henry's Law and Azeotropes, Solid-Liquid Systems - Eutectic Points, Cooling Curves

#### *Physical Chemistry – I Lab*

1. Determination of  $pK_a$  and  $K_a$  value of a weak acid.
2. Determine the solubility of a sparingly soluble salt in water by conductivity measurement.
3. Determine the strength of a solution of NaOH by titrating against standard HCl solution using conductivity meter.
4. Determination of strength of HCl and  $CH_3COOH$  in the given mixture of both, by titrating it against solution of any base conductometrically.
5. Study of variation of conductance of solution of weak and strong electrolytes with concentration (a) pure solvents (b) binary mixture of solvents
6. Determination of activity coefficients by measuring electromotive force

#### *Recommended Texts*

1. Lehigh S.M. *Electrochemistry*. Volume 15. UK: Craig Banks Manchester
2. Patrick Fleming, *Physical Chemistry*, California State University East Bay
3. Mats Hillert, *Phase Equilibria, Phase Diagrams and Phase Transformations: Their Thermodynamic Basis* 2nd Edition

#### *Suggested Readings*

4. Atkins P.W. (2017). *Physical chemistry*. (11<sup>th</sup> Ed.) UK: ELBS Oxford University Press

5. Raj, G. (2010). *Advanced physical chemistry*. (3rd Ed.) Meerut Krishna Prakashan Media (P) Ltd.

This course will enable students to understand the taxonomic characteristics of protochordates and chordates. It provides knowledge about the phylogenetic relationships of protochordates and various classes of chordates. Students will understand the phylogenetic relations, physiological adaptations, behavior and diversity of Pisces, amphibians, reptiles and mammals and able to analyze the process of micro evolution within chordates. After this course the students will understand what the chordates are, can recognize different categories of chordates, understands the level of organization in chordate subphylum, can comprehend the general characters of chordates and know about the origin and evolutionary relationship in different subphylum of chordates. Upon successful completion of this subject students will be able to describe unique characters of urochordates, cephalochordates and fishes, can recognize life functions of urochordates to fishes, will understand the ecological role of different groups of chordates and understand the diversity of chordates and can identification of the morphological and anatomical structure for the major groups of vertebrates from an evolutionary point of view.

### Contents

1. Protochordates: Classification of protochordates. Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates, Reproduction; life histories and metamorphosis of protochordates. Phylogenetic relationships.
2. Fishes: Vertebrate Success in Water. Phylogenetic relationships of Pisces. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).
3. Amphibians: The first terrestrial vertebrates. Characteristics of amphibians Phylogenetic relationships. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura. Structure and locomotor adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.
4. Reptiles: The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodylia. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development of chelonia, squamata, Rhynchocephalia and crocodylian. Further phylogenetic considerations.
5. Birds: Classification, feathers, flight and endothermy. Phylogenetic relationships; ancient birds and the evolution of flight. Diversity of modern birds. Adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development. Migration and navigation.
6. Mammals: Classification, Specialized teeth, endothermy, hair and viviparity. Diversity of mammals. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

### Animal Diversity-II (Chordates) Lab

1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
2. Visit to PMNH for the study of diversity of chordates.

*Recommended Texts*

1. Campbell, N.A., (2011). *Biology* (9<sup>th</sup> ed.). California: Benjamin Cummings.
2. Miller, S. A., & Harley, J. B. (2010). *Zoology* (8<sup>th</sup> ed.). Singapore: McGraw-Hill.

*Suggested Readings*

1. Miller, S. A. (2002). *General zoology laboratory manual* (5<sup>th</sup> ed.). Singapore: McGraw-Hill
2. Hickman, C. P. Roberts, L. C., & Larson, A. (2009). *Integrated principles of zoology* (14<sup>th</sup> ed.). Singapore: McGraw-Hill
3. Pechenik, J. A. (2000). *Biology of invertebrates* (4<sup>th</sup> ed.). Singapore: McGraw-Hill

**PHYS-5103****Introduction to Electromagnetism****3(3-0)**

PHYS-5103 gives an introduction in electromagnetism with emphasis on the following topics: Electric fields and currents, magnetic fields and induction, simple electrical circuits and electromagnetic oscillations.

*Course Contents*

1. Coulomb's law in vacuum, Electric field due to discrete/continuous charges distributions, Electric dipole, Electric flux, Gauss's law and its applications.
2. Electric potential due to discrete/continuous charges distributions.
3. Work and Electric potential energy.
4. Capacitors and capacitance, Capacitance for various geometries, Capacitance with Dielectrics, Energy transfer in electric circuit.
5. Power in electric circuits, Calculating current in a single loop and multiple loop by using Kirchoff laws, Circuit analysis.
6. Growth and decay of current in RC-circuits and its analytical treatment. Magnetic field, Magnetic forces on a single point charge/current carrying conductor.
7. Torque on a current carrying loop and magnetic dipole, Biot & Savart Law and its analytical treatment and application.
8. Ampere's law and its applications, Electromagnetic induction and its laws.
9. Inductance, Inductance for various configurations, LR circuits, Growth and decay of current in RL circuits.
10. Electromagnetic Oscillation (Qualitative and Quantitative analysis using differential equations), Forced electromagnetic oscillations and resonance.
11. Alternating current circuits, Single loop RLC circuits (series and parallel), Power in AC circuits and phase angles
12. Measurement of resistance using a Neon flash bulb and condenser
13. Conversion of a galvanometer into Voltmeter & an Ammeter
14. To determine the self inductance of given coil.
15. To determine the mutual inductance b/w two coils.
16. To determine frequency of AC supply by electromagnetic sonometer/ Melde's experiment.
17. Measurement of low resistance coil by a Carey Foster Bridge.

*Recommended Texts*

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamental of Physics* (10<sup>th</sup> ed.). New York: Wiley.
2. Halliday, D., Resnick, R. & Krane, K. S. (2003). *Physics* (5<sup>th</sup> ed.). New York: Wiley.

*Suggested Readings*

1. Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15<sup>th</sup> ed.). New York: Pearson.
2. Ohanian, H. C. & Markert, J. T. (2006). *Physics for engineers and scientists* (3<sup>rd</sup> ed.). New York: W. W. Norton.
3. Serway, R. A. & Jewett, J. W. (2014). *Physics for scientist and engineers* (9<sup>th</sup> ed.). New York: Brooks/Cole.

<p>Cours e Conte nts:</p>	<p>o اخالق (تعارف، ضرورت و اہمیت، اقسام، معنویت ( اخالق حسنہ :  <ul style="list-style-type: none"> <li>• برائی کو نیکی سے مٹانا</li> <li>• نیکی کے کاموں میں مسابقت</li> <li>• لوگوں کے درمیان صلح</li> <li>• عدل و انصاف</li> <li>• سچائی</li> <li>• ایثار</li> <li>• سلیم قلب</li> <li>• مہمان نوازی</li> <li>• لغویات سے اعراض</li> <li>• عاجزی و انکساری</li> <li>• نگاہ اور آواز کو پست رکھنا</li> <li>• چال میں میانہ روی</li> <li>• شرمگاہوں کی حفاظت</li> <li>• صبر</li> <li>• شکر</li> <li>• امور میں میانہ روی</li> </ul> <p>اخالق سئبہ:  <ul style="list-style-type: none"> <li>• ظلم اور زیادتی</li> <li>• غرور و تکبر</li> <li>• نفسانی خواہشات کی پیروی</li> <li>• بدگمانی</li> <li>• جھوٹ</li> <li>• چغلی اور تہمت</li> <li>• تمسخر اور شیخی خوری</li> <li>• لہو و لعب</li> <li>• برے ناموں سے پکارنا</li> <li>• احسان جتانا اور تکلیف دینا</li> <li>• فضول خرچی اور حد سے بڑھنا</li> <li>• حسد اور تنگ دل</li> <li>• بے پردگی</li> </ul> </p> </p>
<p>Grammar:</p>	<p>• قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)</p>
<p>Details of</p>	<p>▪ منتخب آیات مع ترجمہ و تجوید</p>

<p>Chapters and verse Numbers:</p>	<ul style="list-style-type: none"> <li>▪ البقره (٨٧٧، ٤٥٨، ٣٢، ٨٢٧، ٨١٧، ٨٤٧، ٨١٧، ٨٤، ٣٤٧، ١١٧، ١٤٨، ٤٨٧، ١٧، ٧٣٨، ١٢، ٨٧٨، ٨٢٨، ٣٢٨، ٥٢٨، ٢١٧، ١٢٧، ٢٥٧، ٨٢٧، ١١، ١٨، ٨٨٨، ٢١، ٤٢٧، ٢٨٨، ٣٢، ٧١، ١٨، ٢٤٨، ٥٨٧، ٥٣)</li> <li>▪ آل عمران (٥٤٧، ٥٨، ٤٢٧، ٨٣٧، ٢٥٧، ٥٣٧، ٤٥٧، ١٧، ١١٨، ٤٨٧، ٣٣٧، ١٤، ٥٨)</li> <li>▪ النساء (٤٣٧، ٣٨، ٨٨، ٢١٧، ١١٧، ٤١٧، ٥٤، ١٨، ١٨، ٣١٧، ٢٣، ٤٨، ٥٨، ١٥، ١٤، ٥٨)</li> <li>▪ المائدة (٢٤، ١٤، ٣٢، ٣٧، ٢، ٧٥، ٢٧)</li> <li>▪ النحل (١٢، ٢٨٧، ٤١٧، ٣٧٧، ١٣، ٢٨٧، ٤٨٧)</li> <li>▪ الرعد (٤٨، ١٨، ٥٨، ٨٨، ٢)</li> <li>▪ العراف (٧٣، ٢٢، ٧٤، ٢٥٧، ١٥، ١٥، ٥، ١٨، ٥٥٧، ٢٢٧، ٤٢، ٧٢)</li> <li>▪ القصص (٥٤، ٥٢)</li> <li>▪ فصلت (٥٣)</li> <li>▪ النعام (٨٣، ١١، ١١، ١٣٧، ١٣٧، ٤٤٧، ١٢٧)</li> <li>▪ النمل (١٢، ٢٥)</li> <li>▪ الحج (١٣، ٢٤، ١٢، ٢٢، ١١)</li> <li>▪ الحجرات (٢، ٧٧، ٢، ٧٧، ٣، ٨٧، ٤٧، ١٧)</li> <li>▪ الحزاب (٣٨، ١٤، ٢٤، ٢٤، ٨٤، ٤٤، ٢٤، ٤٣، ٥٨، ٤٣)</li> <li>▪ الحشر (٢)</li> <li>▪ طه (٨١)</li> <li>▪ النعام (٥٢٧، ٧٥٧، ٢٧٧، ٧٤٧، ٣٢، ١٨٧)</li> <li>▪ ق (٥٣)</li> <li>▪ النفال (١٨، ٢٥، ٧٢)</li> <li>▪ الفتح (٤٧)</li> <li>▪ يونس (١٧، ٢٧، ٨٧، ٢٢، ٨٨، ٨٨)</li> <li>▪ الفرقان (٣٢، ٧٨، ١٢، ٣٢)</li> <li>▪ النور (٣٨، ٢، ٥، ١٣، ٧٣، ٣٣، ٣٣، ٧٢، ٧٣، ٨٨)</li> <li>▪ لقمان (٢، ٣٣، ٢٧، ٨٣، ٢٧)</li> <li>▪ السراء (١٣، ١٧٧، ٤، ١٣)</li> <li>▪ المزمل (٢٧)</li> <li>▪ المدثر (٢، ٥)</li> <li>▪ المدثر (٥١)</li> <li>▪ فاطر (٨٣)</li> <li>▪ الفتح (٢٨)</li> <li>▪ البلد (١٧)</li> <li>▪ الزمر (٣، ١٧)</li> <li>▪ الحجر (٤٢)</li> <li>▪ النجم (٧٣)</li> <li>▪ الريح من (١٢)</li> <li>▪ هود (٢، ٨١٧، ٣)</li> <li>▪ الكهف (٨، ٢٤)</li> <li>▪ الشورى (١٣)</li> <li>▪ غافر (٢٨، ١٨)</li> <li>▪ الحديد (١٨، ١٨)</li> </ul>
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- مريم (٢٤)
- النازعات (٧٥)
- التوبه (١١، ٥٢، ٤٢)
- الهمزه (٧)



Basic concept of dipole moments, intermolecular forces and effect of intermolecular forces on properties of solvent and solute will be discussed in detail in this course. The physical properties like dipole moment measure polarity of the molecules. The geometries and shapes of covalent compounds which possess single and double bonds are determined by Valence Shell Electron Repulsion Theory. The Valence Bond Theory in combination with hybridization approach makes it easy to closely know structures of proposed compounds. Further, the pi-acceptor ligands will be discussed in detail emphasizing the nature of bonding in coordination compounds and their chemical applications in industrial processes. Different organic reagents used in inorganic analysis will also be discussed and analysis will be performed in lab to estimate the inorganic species in different types of samples. Some inorganic compounds will also be prepared in the lab work to understand the basic preparation methods of compounds. After the successful completion of this course, students will be able to learn the properties and bonding in metal complexes as well as intermolecular forces.

### Contents

1. Dipole Moments and Intermolecular Interactions:
  - a. Introduction & measurements
  - b. Implications of dipole moment in inorganic molecules and dipole-dipole forces.
  - c. Dipole-induced dipole forces, London (dispersion) forces & other intermolecular force
  - d. Hydrogen bonding
  - e. Metallic Bonding (Free electron theory, Valence bond theory, Molecular orbital or band theory of metallic bonding Conductors, insulators and semiconductors)
2. pi – acceptor Ligands
  - a. Transition metal carbonyls (Mononuclear, Binuclear, Polynuclear).
  - b. The eighteen-electron rule as applied to metal carbonyls.
  - c. Evaluation of structures based on spectroscopic evidence
  - d. General methods of Preparation of Metal carbonyls.
  - e. Chemistry of metal carbonyls of Group VI-VIII (Preparation, Properties, structures and applications.
  - f. Nitrosyls (Preparation, Properties, structures and applications.
  - g. Applications of metal carbonyls and their derivatives to catalysis and organic synthesis.
3. Organic Reagents used in Inorganic Analysis:
  - a. Introduction, Types of reagents, their specific nature and methods of applications with specific examples [DMG, 8-Hydroxyquinoline, diphenylcarbazide, anthranilic acid, salicylaldehyde, cupron, nitron, cupferon, quinaldic acid, alizarin (1,2-dihydroxy anthraquinone)]
  - b. Advantages and disadvantages of organic reagents
  - c. Masking and demasking agents.
  - d. Complexometric titrations involving various reagents (EDTA etc.).
  - e. Chelates and chelate effect: Role of organic reagents in different analytical techniques.
4. Inorganic Chains, rings, cages and Clusters
 

Chains: Catenation, heterocatenation, silicates minerals, silicones, intercalation, one dimensional conductors, isopoly anions, Heteropoly anions, borazines, phosphazenes, phosphazenes polymers, other heterocyclic ring systems.

### Inorganic Chemistry Lab-I

1. Redox titrations [Cu(II) by Potassium iodate]
2. Estimation of Al by using 8-Hydroxyquinoline
3. Estimation of Cr by using 1,5-diphenylcarbazide
4. Preparation of inorganic compounds in pure state using different techniques of synthesis:
  - a. *tris* – Ethylenediamine Ni(II) chloride dihydrate
  - b. Pot. Trioxalatoaluminate (III)

- c. Ammonium Ni(II) sulphate
- d. Preparation of coordination compound of  $[\text{Ni}(\text{NH}_3)_6]$
- e. Synthesis of N,N'-disalicylaldehyde-1,3-propanediiminonickel(II)

5. Complexometric Titrations:

- (a) Estimation of  $\text{Mg}^{+2}$ ,  $\text{Zn}^{+2}$  with EDTA (Direct titration).
- (b) Estimation of  $\text{Ni}^{+2}$  with EDTA (Back titration).
- (c) Determination of  $\text{Ca}^{+2}$  and  $\text{Zn}^{+2}$  in mixture (Masking)
- (d) Determination of  $\text{Cd}^{+2}$  and  $\text{Zn}^{+2}$  in a mixture (Demasking).
- (e) Determination of  $\text{SO}_4^{2-}$  and  $\text{PO}_4^{-3}$  with EDTA (Indirect titration).

*Recommended Texts*

1. Greenwood, N.N., & Earnshaw, A. (1984). *Chemistry of the elements*. (2<sup>nd</sup> ed.). U.K.: Elsevier.
2. Sharpe, A. G. (2012). *Inorganic chemistry*. (4<sup>th</sup> ed.). New York: John Wiley & Sons.
3. James E. Huheey, (1993) *Inorganic Chemistry: Principles of Structure and Reactivity* (4<sup>th</sup> Ed) Harper & Row, UK
7. Shaheen, M.A. *Manual of Advanced Practical Chemistry* (2003), Jilani Notes, Sargodha-Lahore

*Suggested Readings*

1. Kotz, J. C., & Treichel, P. (2018). *Chemistry and chemical reactivity*. (10<sup>th</sup> ed.). New York: Saunders College Publishing.
2. Cotton, F.A., & Wilkinson, G. (2015). *Advanced inorganic chemistry*. (7<sup>th</sup> ed.). New York: John Wiley & Sons.

This course (Organic Chemistry-II) focuses on the classification, methods of determination, kinetic and stereochemical aspects of reaction mechanisms of organic reactions. It includes addition (to  $>C=C<$ ,  $-C\equiv C-$ ,  $>C=O$ ), substitution (nucleophilic & electrophilic) at  $sp^3$  &  $sp^2$  hybridized C and elimination reactions. This course is a foundation course for Reaction Mechanism (CHEM-6223, Organic Chemistry major course of semester-VII), Organic Synthesis (CHEM-6240, Organic Chemistry major course of semester-VIII) and Advance Organic Synthesis (CHEM-7146) of MSc and MPhil with organic chemistry specialization. Synthetic organic chemists have the power to replicate some of the most intriguing molecules of living nature in the laboratory and apply their developed synthetic strategies and technologies to construct variations of them. Such molecules facilitate biology and medicine, as they often find uses as biological tools and drug candidates for clinical development. In addition, by employing sophisticated catalytic reactions and appropriately designed synthetic processes, they can synthesize not only the molecules of nature and their analogues, but also myriad other organic molecules for potential applications in many areas of science, technology and everyday life. The practical work involves single step synthesis of small molecules followed by workup, isolation and purification of product.

### Contents

1. Introduction and classification of reaction mechanism on different basis. Benefits of thermodynamic and kinetic data towards reaction mechanism.
2. Kinetic vs thermodynamic control. Isotopic labeling and trapping of intermediates.
3. Selectivity (regio-, chemo- and stereoselectivity) and stereospecificity.
4. Addition reactions involving C=C, C≡C and C=O, MOT of C=C and C=O additions.
5. Syn vs anti additions, factors affecting addition reactions
6. Electrophilic and nucleophilic substitution reactions at aromatic systems, mechanisms involved (Arenium ion,  $SE_1$ , simultaneous attack & departure etc.).
7. Nucleophilic substitution reactions ( $S_N1$ ,  $S_N2$ ,  $S_M$ ,  $S_N1'$ ,  $S_N2'$ ,  $S_M'$ ,  $S_N1cA$ ,  $S_N2cA$ , neighboring group participation / anchimeric assistance etc.) at aliphatic C, Td mechanism.
8. Enol, enolate & enolization, acid/base catalyzed aldol condensations.
9. Introduction to active methylene compounds.
10. Conditions, mechanism and synthetic applications of Claisen, Claisen–Schmidt, Knoevenagel, Perkin, Reformatsky reactions, Stobbe's condensation, Darzen's glycidic ester synthesis,
11. Classification of elimination reactions (a,b,g-eliminations). Syn, anti and  $E_{1cB}$  eliminations.
12. Eliminations vs substitutions,  $E_1$  vs  $E_2$ , factors affecting eliminations.

### Reaction Mechanism-I Lab.

1. Estimation of phenol (PhOH), acetone ( $Me_2CO$ ), amino ( $NH_2$ ) groups.
2. Synthesis of azodyes, iodobenzene (PhI), iodoform ( $CHI_3$ ), sulphanilic acid ( $PhSO_2NHPh$ ), cinnamic acid, benzil & benzilic acid.

### Recommended Texts

1. March, J. (1992). Advanced organic chemistry. New York: Wiley.
2. Pine, S. H. (1987). Organic chemistry. New York: McGraw-Hill.
3. Clayden, J., Greeves, N., and Warren, S. (2012). Organic chemistry. (2<sup>nd</sup> .ed.). Oxford, London.

### Suggested Readings

1. Hendrickson, J. B., Cram, D. J., and Hammond, G. S. (1980). Organic chemistry. New York: McGraw-Hill Book Co.

2. Streitwieser, A., Heathcock, C. and Kosower, E. M. (2017). Introduction to organic chemistry. (4th ed.). New York: Macmillan.
3. Vogel, A. I. (1989). Practical organic chemistry. (5th ed.). London: Longman Publisher.

This course is designed to have basic concepts and strong foundation of Physical Chemistry. This course will cover laws of thermodynamics, Nernst heat theorem and its applications and knowledge of entropy in detail. Moreover, Maxwell's law and its derivation, Barometric formula, effect of altitude, temperature and molecular mass on vertical distribution of particles and kinetics of third order, opposing reactions, parallel and consecutive reactions is also part of this course. Kinetics of thermally excited chain reactions and theories of reactions will also be focused. As course covers main directions of physical chemistry i.e. kinetics and thermodynamics so it provides a sound foundation to the students in the field of physical chemistry. It makes the students capable of understanding the laws of thermodynamics and their applications. Intensive knowledge of chemical kinetics is very useful for the students to make them understand the dynamics of a chemical reactions and the ways to increase yield at lab and industrial scale.

### *Contents*

1. Chemical kinetics: Introduction to Kinetics and factors affecting rate of reaction, Concept of order of reaction, Zero, 1<sup>st</sup> order reactions, 2<sup>nd</sup> order of reaction & cases, Kinetics of third order reactions with all possible cases (same concentration, different concentrations, some reactants with same and some with different concentrations), Kinetics of opposing reactions (1<sup>st</sup> order opposed by 1<sup>st</sup> and 2<sup>nd</sup> order reactions, 2<sup>nd</sup> order opposed by 1<sup>st</sup> and 2<sup>nd</sup> order reactions), Rate constants of consecutive reactions, Parallel reactions and their rate constant. Arrhenius Equation, Activation Energy, Theories of reactions.
2. Thermodynamics, Introduction to Thermodynamics, First law of thermodynamics, Second law of thermodynamics and its applications, Third law of thermodynamics and determination of absolute entropy, Entropy of mixing, Partial molal quantities, Interpretation of Maxwell's law of distribution of velocities, derivation of average velocity, most probable velocity and root mean square velocity from the law. Barometric formula, effect of altitude, temperature and molecular mass on vertical distribution of particles.

### *Physical Chemistry– II Lab*

1. Determination of percentage purity of an optically active compound.
2. Determination of specific and molar rotations of optically active substance in solution by polarimetry.
3. Determine the order of reaction and rate constant for the inversion of cane sugar in the presence of an acid.
4. Determine order of reaction of the saponification of ethyl acetate.
5. Determination of activation energy of a chemical reaction
6. Determination of heat of solution of a substance from solubility measurements and to determine thermodynamic quantities like  $\Delta G^\circ$ ,  $\Delta H^\circ$ ,  $\Delta S^\circ$  of the solution.
7. Determine partial specific volume and partial molar volume in mixture of water & methanol.

### *Recommended Texts*

1. Marin, G. B., Yablonsky, G. S. (2011). *Kinetics of chemical reactions: decoding complexity*. Wiley-VCH Verlag GmbH.
2. Koretsky, M. D. (2010). *Engineering and chemical thermodynamics*. John Wiley & Sons Inc.

*Suggested Readings*

1. Raj, G. (2010). *Advanced physical chemistry*. (3rd Ed.) Meerut Krishna Prakashan Media (P) Ltd.
  2. Atkins P.W. (2017). *Physical chemistry*. (11<sup>th</sup> Ed.) UK: ELBS Oxford University Press.
- Bhatti, H. N. (2019). *Modern physical chemistry*. Pakistan: Caravan Book House Lahore.

**BOTN-5101****Diversity of Plants****4 (3+1)**

This course offers an evolutionary survey of the origin and diversification of land plants through geological time. The course will start with the green algae and on how plants may have transitioned from aquatic to the land environment. Land plants that will be discussed include bryophytes, lycophytes, pteridophytes, gymnosperms and angiosperms with emphasis on representative fossil and living taxa. Lectures will emphasize on life histories, anatomical and morphological adaptations, ecology and climate change, extinction, phylogenetics, economic importance, and conservation strategies of representative taxa. Plants are one of the most successful and abundant groups of organisms on earth, comprising the majority of terrestrial biomass, being integral to ecosystem structure, and providing humans with food, shelter, and materials. The laboratory will provide ample hands-on opportunities for analysis of plant anatomy and morphology, reproductive mechanisms, evolutionary adaptations, and identification of a variety of living and preserved specimens. Plants are multi-cellular and mostly photosynthetic organisms which found essentially everywhere, both in water and on land. Plants are really important for the planet and for all living things. Plants absorb carbon dioxide and release oxygen from their leaves, which humans and animals need to breathe.

*Contents*

Comparative study of life form, structure, reproduction and economic significance of:

1. Viruses (RNA and DNA types) with special reference to TMV
2. Bacteria and Cyanobacteria (*Nostoc*, *Anabaena*, *Oscillatoria*) with specific reference to bio fertilizers, pathogenicity and industrial importance;
3. Algae (*Chlamydomonas*, *Spirogyra*, *Chara*, *Vaucheria*, *Pinnularia*, *Ectocarpus*, *Polysiphonia*)
4. Fungi (*Mucor*, *Penicillium*, *Phyllactinia*, *Ustilago*, *Puccinia*, *Agaricus*) their implication on crop production and industrial applications.
5. Lichens (*Physcia*)
6. Bryophytes (*Riccia*, *Anthoceros*, *Funaria*)
7. Pteridophytes: Psilopsida (*Psilotum*) , Pteropsida (*Marsilea*), Sphenopsida (*Equisetum*) Lycopsida (*Selaginella*)
8. Gymnosperms (*Cycas*, *Pinus*, *Ephedra*)
9. Angiosperms: Monocot (Poaceae) , Dicot (Solanaceae)

*Diversity of Plants Lab*

1. Culturing, maintenance, preservation and staining of microorganisms.
2. Study of morphology and reproductive structures of the types mentioned in theory.
3. Identification of various types mentioned from prepared slides and fresh collections.

*Recommended Texts*

1. Bellinger, E. G. & Sigeo, D. C. (2015). *Freshwater algae*. USA: Wiley Publishers.
2. Prestre, P. G. (2017). *Governing global biodiversity: the evolution and implementation of the convention on biological diversity*. UK: Routledge Publishers.

*Suggested Readings*

1. Şen, B., & Grillo, O. (2018) *Selected Studies in Biodiversity*. USA: Intech Open Publishers.
2. Zotz, G. (2016). *Plants on Plants: The biology of vascular epiphytes*. Germany: Springer-Verlag.
3. Cronk, J. K., & M. S. Fennessy (2016). *Wetland plants: biology and ecology*. USA: CRC Press.
4. Pullaiah T., Bahadur, B., & Murthy, K. (2015). *Plant biodiversity*. Germany: Springer-Verlag.





Calculus demonstrates the beauty of math and the agony of math education. It relates the topics in an elegant, brain bending manner. Calculus II is a prerequisite for many popular college majors, including pre-med, Engineering, and Physics. This is the second course of the sequence, Calculus-I, II and III. MATH-5137 continues the study of the calculus begun in MATH-5136. The course focuses on definite integrals, which allow exact calculation of surface areas, volumes, the length of curves, and solutions of practical and theoretical problems. Applications of integral calculus include computations involving area, volume, arc length, center of mass, work, and pressure. More advanced applications include power series and Fourier series. Students learned in this course different math which give them opportunities to see how these techniques are solving current subject problems. This offer complementary approaches to the fundamental understanding of math systems. Students will acquire knowledge to enable themselves to understand the different theories.

### *Contents*

- 1 Techniques of integration
- 2 Integrals of elementary, hyperbolic and trigonometric function
- 3 Logarithmic and exponential functions
- 4 Integration by parts, substitution rule
- 5 Partial fractions, improper integrals
- 6 Applications of integrals
- 7 Area between curves
- 8 Average value of a function
- 9 Volumes of Solids, arc length
- 10 Area of a surface of revolution
- 11 Infinite series, Sequences and series
- 12 Convergence and absolute convergence
- 13 Tests for convergence, divergence test
- 14 Integral test, p series test, comparison test
- 15 Limit comparison test, alternating series test
- 16 Ratio test, root test
- 17 Power series, convergence of power series
- 18 Representation of functions as power series
- 19 Differentiation and integration of power series
- 20 Taylor and McLaurin series
- 21 Conic section
- 22 Parameterized curves and polar coordinates
- 23 Curves defined by parametric equations
- 24 Calculus with parametric curves
- 25 Tangents, areas, arc length, polar coordinates
- 26 Polar curves
- 27 Tangents to polar curves
- 28 Areas and arc length in polar coordinates

### *Recommended Texts*

1. Thomas, G. B., Weir, M. D., Hass, J., and Giordano, F. R. (2005). *Thomas' Calculus* (11<sup>th</sup> ed.). Boston: Addison Wesley.
2. Stewart, J. (2015). *Calculus* (8<sup>th</sup> ed.). Boston: Cengage Learning.

*Suggested Readings*

1. Anton, H., Bivens I. C., & Davis, S. (2016). *Calculus* (11<sup>th</sup> ed.). New Jersey: Wiley.
2. Goldstein, L. J., Lay, D. C., Schneider, D. I., & Asmar, N. H. (2017). *Calculus and Its Applications* (14<sup>th</sup> ed.). London: Pearson.
3. Hallett, D. H., *et al.* (2017). *Calculus Single and Multivariable* (7<sup>th</sup> ed.). New Jersey: John Wiley and Sons, Inc.
4. Larson, R., & Edwards, B. H. (2013). *Calculus* (10<sup>th</sup> ed.). USA: Brooks Cole.

## SEMESTER-VII

CHEM-6107

Industrial Chemistry

3(3+0)

Industry is backbone of the economy of any country and among different industries; chemical industries have versatile novelties in their operation. This course is aimed to provide understanding about upgradation of laboratory processes to commercial scale, installation of industrial units, quality assurance and quality control of a process. Parameters to determine feasibility for installation of an industrial unit, its impact on living organisms and vegetation are also contained in this course. Treatment of industrial effluents, sludge, and smoke are important segments of this course. Significance of research and development in an industry and its need in domestic industries is part of this course. Safety measures including fire extinguishing, saving from toxic chemicals and first-aids in an industry are also part of the course. Chemical reactions, raw materials, process conditions and scope of different industries listed in contents are part of the course. After studying this course, students will have sufficient knowledge about working in any industrial unit as well as one will be able to work at his own.

### *Contents*

1. Chemical processes
2. Unit operations, unit process
3. Chemical process control and instrumentation
4. Safety; Hazards such as fire or toxic materials
5. Research and development
6. Important modern industries, their chemistry and technology
7. Pharmaceutical industry
8. Paper and pulp industries; kraft reaction
9. Oil, fats and waxes
10. Soap and detergent industries
11. Water conditioning
12. Flavors and food additives
13. Sugar and starch, steel
14. Cement industries

### *Recommended Texts*

1. Shreve, R.N., & Brink, J.A. (1977). *Chemical process industries*. New York: McGraw Hill.
2. Witcoff, H.A., & Reuben, B.G. (2012). *Industrial organic chemicals*. (3<sup>rd</sup> ed.). New York: Wiley.

### *Suggested Readings*

1. Smith, R. (2016). *Chemical process design*. (2<sup>nd</sup> ed.). New York: McGraw Hill.
- Relevant research articles

This course provides a comprehensive knowledge about applications of forensic procedures in chemistry. Students will learn about types of evidence and methods to collect them. This course will provide a detailed knowledge about toxicology and forensic biology and explains the principles of operation for common chemistry laboratory instrumentation used in forensic science, using knowledge of chemical structure and properties and instrument design. Furthermore, it will also allow to understand the role of law, ethics, courtroom testimony, quality assurance and professional practice in forensic science. The importance and evidential value of separation and identification techniques, and the scope and limitations of these techniques, is also emphasized in relation to the analysis of forensic samples. Upon successful completion of the course, students will be able to understand the fundamental principles utilized in forensic science and can demonstrate a knowledge of the applications of chemistry and criminal justice in forensic science.

### *Contents*

1. History of Forensic science/forensic chemistry
2. Applications of forensic chemistry in other sciences e.g. Botany, Zoology, Geology, Odontology, Pathology etc
3. Types and classification of evidence, Physical, chemical biological evidence, Classifications of forensic evidence
4. Fingerprint analysis, history, types, latent vs visible fingerprints
5. Chemical tests for latent and visible fingerprints, AFIS, fingerprint database.
6. Hair as a forensic physical evidence, composition and structure of hair, differences between human and animal hair and identification.
7. Fiber as a forensic evidence, composition, chemical composition of fiber, microscopic analysis, chemical tests for fiber analysis.
8. Glass as a forensic evidence, Physical and chemical properties of glass, chemical analysis
9. Trace evidence, Physical and chemical properties, qualitative and quantitative
10. Metal analysis
11. Microscopic analysis. Trace evidence types, characterization, chemical tests, collection, analysis, exhibiting in court. Analysis of paints, vehicles, fire, bullet, and cartridge analysis,
12. Tests for explosive residues, glass comparisons. Anthropometry, body measurement.
13. Toxicology, History, relation with other sciences
14. Introduction to poisons, narcotics, toxins, laws related to poisons.
15. Classification of poisons, organic, inorganic and mechanical poisons,
16. Corrosives, irritants, neurotics, and miscellaneous poisons
17. Mechanisms of poisons, methods of administration, routes of excretion. Diagnosis of poisons. Analytical chemistry techniques for drug and poison analysis, narcotics analysis.
18. Serology, forensic analysis of blood patterns, and chemical tests for identifications.
19. Forensic biology and DNA analysis; DNA CODIS databases, PCR, blotting, RE digestion, RFLP, STRs, VNTRs analysis, DNA Fingerprinting, paternity tests.
20. Example cases in forensic chemistry related to above-mentioned topics.

### *Recommended Texts*

1. Bell, S. (2012). *Forensic chemistry*. (2<sup>nd</sup> ed.). New York, USA: Prentice Hall.
2. Jackson, A. R. W. & Jackson, J. M. (2016). *Forensic science*. (4<sup>th</sup> ed.). New York, USA: Prentice Hall.

*Suggested Readings*

1. Khan, J. Kennedy, T.J. & Christian, D.R. Jr. (2012). *Basic principles of forensic chemistry*. New Jersey, USA: Humana Press.
2. Walker, J. M. (1994). *The basic protein and peptide protocols*. New Jersey, USA: Humana Press.

This course is aimed to provide an advanced knowledge about three spectroscopic techniques, which are widely used in different industries for analytical characterization of samples. Atomic absorption spectrometry is used for elemental analysis of different samples, while atomic emission spectroscopy is used for elemental analysis of hard materials like refractory and ceramics. Among both of these techniques, different atomizers are used to ensure the accurate determination of analyte at low concentrations. Flame emission spectroscopy uses flame as source of excitation and is used for identification of common salts, usually of alkali metals. UV/Visible spectrophotometry is used for analysis of molecular species and is rapid, economical preliminary technique. These techniques are widely used in different industrial units to analyze a wide range of products of daily use, ranging from soil, fertilizer, food, cosmetic and material objects. After learning this course, students will be able to work in any research or industrial laboratory with comprehensive background-knowledge based operational skill.

#### *Contents*

1. Atomic Spectrometry: Atomic Absorption and Flame Emission Spectrometry, instrumentation and applications
2. Emission Spectrometry with plasma and electrical discharge sources
3. UV/Visible Spectrophotometry: basic principle, instrumentation and applications.

#### *Spectroscopic Techniques – I Lab.*

1. Measurement of  $\lambda_{\max}$  and calculation of Molar absorptivity of potassium permanganate.
2. Plotting of calibration graph and measurement of unknown sample concentration.
3. Use of standard addition method in Spectrophotometry.
4. Determination of iron (II) using 1,10-phenanthroline method.
5. Determination of iron (III) using thiocyanate method involving solvent extraction.
6. Determination of phosphate by Spectrophotometry using molybdenum blue method.
7. Determination of Sodium in tap water sample by using Flame photometer.
8. Determination of Potassium in tap water sample by using Flame photometer.
9. Determination of Calcium in chalk sample by using Flame photometer.
10. Determination of Calcium in drinking water by EDTA.
11. Identification of free salicylic acid in aspirin by using TLC.
12. Determination of Methylene blue value of activated charcoal.
13. Determination of iron in tap water by AAS.
14. Determination of copper content in milk samples by AAS.

#### *Recommended Texts*

1. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

#### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4<sup>th</sup> ed.). New York, John Wiley & Sons.

This course is aimed to provide an advanced level information for students opting analytical chemistry as field of specialization. It provides comprehensive overview of two commonly used chromatographic techniques ranging from fundamental principles, instrumentation and applications for analysis of different types of samples. Gas chromatography is used for analysis of gaseous samples like petroleum products, air samples, dust, industrial smoke, and perfumeries. High performance liquid chromatography is used for analysis of liquid samples or solutions like foods, pharmaceuticals. Students will be able to learn optimization of different parameters affecting the quality of separation. Van-Deemter equation gives insight about all the factors contributing towards plate height and decrease efficiency of separation. By learning the course, students would be able to predict the material to be used as stationary phase, mobile phase, length and width of chromatographic column. This will be able to develop cost-effective methods saving time and cost of analysis, which is fundamental target of any industry.

#### *Contents*

1. Gas–Liquid chromatography
2. Concepts of theoretical plates
3. Van–deemter equation
4. High–performance liquid chromatography, instrumentation and applications of these techniques

#### *Recommended Texts*

3. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
4. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

#### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4th ed.). New York, John Wiley & Sons.

This course is aimed to provide a comprehensive overview of different instrumental techniques of industrial significance. For rapid, economical and accurate analysis, electroanalytical techniques are the techniques of choice; amongst which potentiometry is an economical technique with comparable results. Ion-selective electrodes are used for determination of any specific ions in a sample without any interference of matrix. In this course, significance of different electrodes used in potentiometry, methods for development of new electrodes and their representative applications are included. Fluorescence and phosphorescence spectroscopic techniques are electromagnetic techniques used for analysis of atomic and molecular species, on the basis of luminescence characteristics of sample. Efficiency and applications of these luminescence techniques will be compared with UV/Visible spectroscopic techniques. Basic principles, instrumentation, recent advances, limitations, domains and scope of each of these techniques is contained in this course. After studying this course, students will be able to work on these instruments in any of the research or industrial laboratories.

#### *Contents*

1. Potentiometry: Nernst equation, reference electrodes, Ion-selective electrodes, Glass electrodes for pH measurements, Potentiometric titrations
2. Fluorescence and Phosphorescence spectrometry: Atomic and Molecular Fluorescence, basic principles and applications, Structural factors, measurements
3. Comparison of Luminescence and UV–Visible absorption methods.

#### *Recommended Texts*

1. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

#### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4<sup>th</sup> ed.). New York, John Wiley & Sons.



This course aims at providing a better understanding of metabolic pathways, their control mechanisms, and disorders. This includes both theory and practical modules that are offered to the students who have adapted Biochemistry as a major or minor subject. This course focuses on the metabolic pathways in living cells from prokaryotes to Eukaryotes, and how these pathways are regulated and disturbed in disease state, and how metabolic energy is obtained and transduced to meet a cell's requirements. This focus will allow calculations of bioenergy produced and assimilate in the metabolic pathways and will enhance the knowledge of students about how these pathways are integrated. Students will learn about enzymes involved in metabolic reactions and their reaction mechanisms, regulation of metabolic routes for energy production in form of ATP and diseases related to metabolic dysfunctions. Student will also be able to enhance their knowledge about metabolic diseases and their treatments.

### *Contents*

1. Principles of Bioenergetics and Biochemical, Types of reaction involved in metabolism,
2. Carbohydrate Metabolism: Glycolysis; mechanism of reactions of enzymes.
3. Regulation of glycolysis. Reaction energy calculations. Net ATP consumption. Energy calculations
4. Gluconeogenesis; dedicated reaction, regulations, and net energy calculations.
5. Non oxidative metabolism; Fermentation, types
6. Pentose Phosphate Pathway; relationship to glycolysis, gluconeogenesis
7. Metabolism of carbohydrates other than glucose; fructose, galactose, mannose starch and Glycogen.
8. The Citric Acid Cycle; regulations, reaction mechanism.
9. Fatty Acid Metabolism; Beta oxidation of even and odd chain fatty acids, Lipid Biosynthesis
10. Oxidative Phosphorylation, Electron transport chain and Photophosphorylation.
11. Protein Metabolism; amino Acid Oxidation and production of Urea,
12. Biosynthesis of Amino Acids
13. Nucleotide metabolism, synthesis, and degradation.

### *Bioenergetics and Metabolism Lab.*

1. Isolation of serum and plasma from human blood
2. Estimation of fasting/random glucose levels in human serum by colorimetric methods (DNS method, glucose peroxidase method).
3. Estimation of Hemoglobin in human blood.
4. Estimation of total protein serum/urine proteins by Colorimetric method.
5. Estimation of urea, creatinine triglycerides Glutathione, ammonia and cholesterol
6. Liver function tests and lipid profiles from human serum
7. Estimation of Sodium (Na<sup>+</sup>), Potassium (K<sup>+</sup>) and Chloride (Cl<sup>-</sup>) from serum using flame photometer.
8. Estimation of heavy metals in human serum using atomic absorption.
9. Isolation and enzymatic hydrolysis of Glycogen from Liver
10. Sterilization and Preparation of culture media i.e use of autoclave
11. Steak, pour and spread plate methods.
12. Testing sensitivity to antimicrobial substances, Preparing serial dilutions of cultures
13. Use of microscope and differential staining: Gram's staining method
14. Online resources for metabolic pathways i.e. KEGG, MetaCyc

### *Recommended Texts*

1. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry*. (7<sup>th</sup> ed.). New York, USA: W. H. Freeman Publishers.
2. Voet, D., & Voet, J. G. (2016). *Biochemistry*. (5<sup>th</sup> ed.). New York, USA: John Wiley & Sons.
3. Boyer R. F. (2000). *Modern experimental biochemistry*. (3<sup>rd</sup> ed.). London, England: Pearson Press.

### *Suggested Readings*

1. Swaminathan, R. (2011). *Handbook of clinical biochemistry*. (2<sup>nd</sup> ed.). Singapore: World Scientific Publishing Company.
2. Walker, J. M. (1994). *The basic protein and peptide protocols*. New Jersey, USA: Humana Press.

This course is offered to the students who adapt Biochemistry as a major subject and provides a comprehensive understanding of industrial applications of microorganisms in production and fermentation processes. This course provides technical information on fermenter design, operation and growth kinetics of microbes involved in the fermentation processes. Types of fermentations and the commercial products derived from microbes are also discussed in this course. Students will get hands on experience in the microbial production of biopolymer, enzymes, bioactive compounds, and biomass. Based on the skills acquired in this course, graduate students would have a mini project / review writing/ assignment as an additional component. Upon the completion of course, students will be able to have a better understanding of microorganisms, their classification, identification, and characterization techniques. Students will also learn about industrial fermentation processes involved in production of Cheese, Alcohol, Citric acid, Acetic acid and Antibiotic synthesis. The students will also be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.

#### *Contents*

1. Definitions and Scope of Microbiology and fermentation.
2. Classification, methods of isolation, microscopic examination, general morphology and cytology of microorganisms.
3. General effects of environments on microorganisms.
4. Nutrition of microorganisms.
5. Growth (Normal growth Cycle and Continuous Culture) and Reproduction, Pure culture Study.
6. Introduction to industrial microbiology and chemical biology.
7. Types of fermentations and their limitations
8. Industrial Uses of Bacteria, Molds, Yeast and viruses.
9. Industrial designs of fermenters
10. Microbial production of Cheese, Alcohol, Citric acid, Acetic acid, Antibiotic, enzyme production, Fermented Foods, Vinegar production, Amino Acid.
11. Petroleum Microbiology and Deterioration of Materials (Paper, Textile and Cordage, Painted Surface).
12. Use of microbial enzymes in industry
13. Microbial assays

#### *Recommended Texts*

1. Willey, J. Sherwood, L. & Woolverton, C. J. (2017). *Prescott's microbiology*. (10<sup>th</sup> ed.). New York, USA: Prescott Publishers.
2. Dawis, B. D., Dulbecco, R., Eisen, H. N., & Ginsberg, H. S. (2002). *Microbiology*. New York, USA: Harper & Row.

#### *Suggested Readings*

1. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry*. (7<sup>th</sup> ed.). New York, USA: W. H. Freeman Publishers.
2. Voet, D., & Voet, J. G. (2016). *Biochemistry*. (5<sup>th</sup> ed.). New York, USA: John Wiley & Sons.

The course covers basic bioinformatics with focus on microbial genomic sequencing data with respect to comparative genomics and proteomics. This course will provide a better understanding of biological databases, their uses, mass data retrieval, deposition. The course also focuses on comparative sequence analyses using the available public databases and literature. On completion of the course, the student should be able to identify and choose appropriate biological databases to solve a given biological problem, perform and evaluate pairwise and multiple sequence alignment, outline the process from sequence data to an annotated genome and explain the principles behind the different steps, perform basic annotation, manage basic commands in a Unix or windows environment. The students will be able to choose and apply existing software on given biological problems, critically analyse, evaluate and compile received results. Student will also learn practical's aspects of protein modelling and their interactions with other biomolecules forms the basis of interactomes.

#### *Contents*

1. Introduction, Review of DNA replication, transcription, and translation, Genome organization
2. DNA and Protein Databases, data storage, file formats, information retrieval
3. Database queries, sequence retrieval, Creation of restriction endonuclease maps
4. Dot plots, Sequence alignment, Local alignment, Global alignment, Multiple alignments
5. Genetic distances, Distance based phylogenies, Phylogenetic tree construction.
6. Consensus sequences, Finding genes and open reading frames in DNA sequences
7. Protein Secondary Structure prediction and Protein homology modelling
8. SwissProt PDB viewer and Swiss-model server
9. Data mining
10. Introduction to Python
11. Protein-Protein, Protein-DNA, Protein-Ligand interactions
12. Microarray analysis and applications of microarrays
13. Comparative genomics continued, Future directions of bioinformatics.

#### *Hands-on-training*

1. Introduction to NCBI, databases, usages
2. Data retrieval, file formats conversions
3. Basic Python programming
4. Use of python for data retrieval
5. Restriction endonuclease mapping
6. BLAST, interpretation.
7. Construction of distance and character based phylogenetic trees.
8. Determination of consensus sequences, locating genes (gene prediction) and open reading frames in DNA sequences
9. Protein Secondary structure prediction
10. Protein Tertiary structure prediction
11. Protein model assessment and refinement
12. Introducing MD simulations

#### *Recommended Texts*

1. Lesk, M. J. (2002). *Introduction to Bioinformatics*. Oxford, UK: Oxford University Press.

2. Ussery, D., W. Wassenaar, T. M., & Borini, S. (2009). *Computing for Comparative Microbial Genomics: Bioinformatics for Microbiologists (Computational Biology)*. Berlin, Germany: Springer.

*Suggested Readings*

1. Das S. K., & Thatoi, H. N. (2017). *Practical Biotechnology: Principles and Protocols*. Delhi, India: I. K. International Publishing House.
2. Kumar, D., & Antonarakis, S. (2016). *Medical and Health Genomics*. (1<sup>st</sup> ed.). New Jersey, USA: Academic Press.

Stereochemistry Periodicity: Concepts of Stereochemistry and Periodicity (Periodic Properties), Introduction, First and Second row anomalies, the use of d-orbitals by non-metals, Reactivity and d-orbital participation, The use of p-orbitals in pi-bonding, Periodic anomalies of non-metals and post transition metals.

Nuclear Chemistry: Introduction, classification of Nuclides, Radioactivity and radioactivity series, artificial radioactivity, units of radioactivity, Determination of Half-life, Nuclear Fission and Fusion reactions, Applications of radio Isotopes as traces.

Structure of Inorganic Solids: Introduction, The close packing of spheres, the structure of ionic solids, Ionic radii, Crystal structures and defect solid state.

Thermal Methods of analysis: Introduction, instrumentation and applications.

*Advanced Inorganic Chemistry Lab.*

1. Use of some organic reagents for the estimation of various elements
  - a) 8-Hydroxyquinoline Al (III) and Fe (III)
  - b) Nitron ( $\text{NO}_3^{-1}$ )
  - c) Salicyladoxine Ni (II) in presence of Cu (II)
  - d) Anthranilic acid Co (II) and Zn (II)
  - e) Pyrogallol  $\text{Bi}^{3+}$
2. Chromatographic Techniques –
  - Column, Thin layer and Paper chromatographic techniques for the qualitative separation of inorganic compounds
  - Applications of Solvent extraction and ion exchange technique
1. Synthesis of following Inorganic compounds / Complexes in a pure state and determine their state of purity
  - a.  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}$
  - b.  $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$
  - c.  $[\text{Co}(\text{NH}_3)_5$
  - d.  $\text{ONO}]\text{Cl}$
  - e.  $[\text{Co}(\text{en})_3]\text{Cl}_3$

*Recommended Books*

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4<sup>th</sup> Ed., Harper and Row, New York, (2001).
2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3<sup>rd</sup> Ed., Wiley, New York, (1995).
3. Atkins, P. and Jones, L., "Chemicals Principles" Freeman & Co., NY (2002).
4. Cotton, F.A., Wilkinson, G., Murillo C.A. and Bochmann, M. "Advanced Inorganic Chemistry", 6<sup>th</sup> Ed., Wiley-Interscience, New York, (1999).

This course aims to understanding of general concept of polymerization, types of polymerization, inorganic polymers, their properties, stability and applications. Inorganic polymers are polymers with a skeletal structure that does not include carbon atoms in their backbone. Polymers containing inorganic and organic components are sometimes called hybrid polymers, and most so-called inorganic polymers are hybrid polymers. Most of the ceramic material in use in routine life has its origin from inorganic polymers. Blending of metal cluster compounds with carbonates, borates or phosphates gives rise to a wide range of tensile material equally applicable in ceramic appliances and other industrial reaction vessels. The material strength is governed more by a study of the forces responsible within substances for inter- and intra-molecular bonding. After the successful completion of this course, students will be able to synthesize the inorganic polymers of desired properties, elaborate the stability and structure of inorganic polymers and the factors affecting their properties.

#### *Contents*

1. Inorganic Polymers: Molecular species
2. Polymeric sulphur and nitrogen compounds
3. Cyclophosphazines & Polyphosphazines
4. Boranes
5. Silicones, Classification of silicones
6. Polyionic species: Isopropyl ions
7. Heteropoly anions of transition elements
8. Polysilicates
9. Polyphosphates
10. Metal cluster compounds

#### *Recommended Texts*

1. Miessler, G.L. and Tarr, D.A. (2004). *Inorganic chemistry*. (3<sup>rd</sup> ed.). New York: Pearson Education, Inc.
2. Jordan, R.B. (1998). *Reaction mechanisms of inorganic and organometallic systems*. (2<sup>nd</sup> ed.). U.K.: Oxford University Press.
3. Sharpe, A.G. (2012). *Inorganic chemistry*. (4<sup>th</sup> ed.). New York: John Wiley & Sons.

#### *Suggested Readings*

1. Huheey, J.E., Keiter, E.A., Keiter, R.L., & Medhi, O.K. (2006). *Inorganic chemistry: principles of structure and reactivity*. Mumbai, India: Pearson Education.
2. Hill, A.F., & Hill, A. (2002). *Organotransition metal chemistry*. Cambridge, U.K.: Royal Society of Chemistry.
3. Astruc, D. (2007). *Organometallic chemistry and catalysis*. Berlin, Germany: Springer.

Bioinorganic chemistry is a field that examines the role of metals in biology. Bioinorganic chemistry includes the study of both natural phenomena such as the behavior of metalloproteins as well as artificially introduced metals, including those that are non-essential, in medicine and toxicology. Interaction of various inorganic compounds with the biological species enables the scientist to design and formulate medicines for different diseases. Preparation of organometallic compounds by using different reaction conditions will also be discussed to lead a new era of research for preparation of stable metal complexes having metal-carbon bonding. Moreover, the role and interaction of different metal ions will also be discussed in living organisms. Further, the metal-carbon bonding unlike carbon-carbon bonding provides basis for catalysis. Starting from polymerization of ethylene by Zeigler and Natta leading to industrial revolution, the recent M-C bond chemistry has been studied in detail to materialize those reactions which otherwise are not possible. The fundamental rules like Eighteen-electron-rule explain the stability of organometallic compounds.

#### Contents

1. Nature of metal-carbon bonds
2. Compounds with metal-carbon single bonds
3. Compounds with metal-carbon  $\pi$ - bonds
4. Classification of organometallic compounds
5. Compounds of transition metals: single, double and triple bonds to carbon
6. Compound and types of acyls, alkylidene complexes
7. Compound of alkylidyne complexes
8. Delocalized hydrocarbon systems (alkene, olefins, allyl and butadienes)
9. Alkyne complexes and cyclic  $\pi$  complexes (four, five and six member rings)
10. Fundamental processes in reactions of organotransition metal complexes
11. Ligand coordination and dissociation
12. Oxidative addition
13. Reductive eliminations
14. Insertion & extrusion reactions: reaction of coordinated ligands
15. Applications of organometallic compounds in synthetic chemistry
16. Applications of organometallic compounds in industry.
17. Bio-inorganic chemistry: introduction
18. Bio-inorganic chemistry: Environmental intrusion
19. Role of inorganic species in vivo
20. main group ions ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ )
21. Trace elements: general roles, lanthanides & actinides, Zn, Cu, Cr, Mo, W, Co, Si, Se, Sn, I.
22. Storage and transport of iron
23. Metalloenzymes

#### Recommended Texts

1. Huheey, J.E., Keiter, E.A., Keiter, R.L., & Medhi, O.K. (2006). *Inorganic chemistry: principles of structure and reactivity*. Mumbai, India: Pearson Education.
2. Roat-Malone, R. M. (2007). *Bioinorganic chemistry: a short course*. New York: John Wiley & Sons.

#### Suggested Readings

1. Hill, A.F., & Hill, A. (2002). *Organotransition metal chemistry*. Cambridge, U.K.: Royal Society of Chemistry.
2. Astruc, D. (2007). *Organometallic chemistry and catalysis*. Berlin, Germany: Springer.



This course (Spectroscopic Methods in Organic Chemistry) focuses on the physical methods of characterization of isolated natural products (animal, fungal, marine and terrestrial sources), derivatives of natural products, bio/synthetic polymers and synthetic organic molecules of pharmacological importance. The new molecular entities isolated/ synthesized are studied by these methods, which require only 5-10 mg quantity of the analyte as compare to chemical methods of analyses, to elucidate their molecular structure. This course does not cover the medical aspects of spectroscopy (commonly called Radiology) in broader spectrum. In fact, this course is a foundation course for Advance NMR (CHEM-7140) and advance MS (CHEM-7147) courses of MPhil with organic chemistry specialization.

The practical work involves the synthesis of a few small molecules in the laboratory by a reported protocol followed by workup, purification (involving crystallization, partitioning, solvent extraction, chromatography etc.) and comparative study of IR, UV, NMR and MS spectra of substrate and product(s).

#### Contents

1. Basic principle & EMR, spectral regions (bands), allowed and forbidden transitions, spectrum.
2. Application of Schrödinger wave equation to rotational and vibrational transitions.
3. Basic principle, instrumentation and interpretation of IR spectroscopy. Classification of IR band on the basis of functional groups, factors affecting IR absorbance and applications of IR spectroscopy.
4. Mathematical relationship between absorbance (A) and transmittance (T) in UV-Vis spectroscopy. Chromophore, bathochromic / hypsochromic shifts, factors affecting  $\lambda_{\max}$  and importance of  $\epsilon$  value.
5. Woodward-Fieser rule for calculating  $\lambda_{\max}$  of cyclic conjugated dienes, carbonyls and acyclic systems. Absorption by aromatic compounds. Applications of UV-Vis spectroscopy
6. Difference between spectroscopy and spectrometry; radical cations and radical anions vs carbonium ion.
7. Parts of a mass spectrometer (MS); basic principle, instrumentation, different methods of ionization in MS [EI, CI, APCI, FAB(+), FAB(-), ESI, MALDI].
8. Modes of fragmentation of various functional groups of organic molecules, Low resolution and high-resolution mass spectrometry, radioactive abundance and ratio of isotopes of C, Cl, Br, S & P.
9. Determination of molecular mass, molecular formula and molecular structure, Interpretation of a mass spectrum.
10. NMR active nuclei, basic principle (Spin flipping, Spin relaxation) and instrumentation
11. Chemical shift ( $\delta$  in ppm) and coupling constant ( $J$  in Hz) factors affecting them
12. Spin-spin splitting, multiplicity ( $s, d, t, q, dd, ddd, dddd$ ) of  $^1\text{H}$  signals. Interpretation of  $^1\text{H}$ -NMR spectra.
13. First and second order  $^1\text{H}$ -NMR spectrum, introductory broad band, DEPT-45°, DEPT-90° and DEPT-135°  $^{13}\text{C}$ -NMR spectra.
14. Structure elucidation of organic compounds (containing 10-15 Cs with a variety of functional groups) by joint applications of IR, UV,  $^1\text{H}$ -NMR,  $^{13}\text{C}$ -NMR spectroscopy and mass spectrometry.

#### Spectroscopic Methods in Organic Chemistry Lab.

1. Experimental purification techniques e.g., distillation, solvent extraction, chromatography etc.
2. Multi-step synthesis of some organic compounds
3. Characterization of above synthesized compounds by joint applications of spectroscopic and mass spectrometric methods of analyses

#### Recommended Texts

1. Williams, D. and Fleming, I. (1995). *Spectroscopic methods in organic chemistry*. New York: McGraw-Hill.
2. Younas, M. (2005). *Organic spectroscopy*. Lahore: A. H. Publisher.

### *Suggested Readings*

1. Anderson, R. J., Bendell, D. and Groundwater, P. (2004). *Organic spectroscopic analysis – a tutorial chemistry texts (serial-22)*. Cambridge: RSC Publisher.
2. Kemp, W. (1990). *Spectroscopy*. London: Macmillan.
3. Vogel, A. I. (1989). *Practical organic chemistry*. (5<sup>th</sup> ed.). London: Longman Publisher.

This course is the continuity of study of organic reaction mechanisms in which rest of the polar mechanism (redox, molecular rearrangements and pericyclic cyclization) are addressed. This course is a foundation course for Organic Synthesis and Advance Organic Synthesis. The reaction mechanism of a chemical reaction is a step-by-step description of the course on which the starting materials are converted into the products. The course is described on a molecular level and contains information about the position of all atoms and electrons of the reactants (including the solvent etc.) at each point of the reaction course (called reaction coordinate) and, thus, about all the shifting and movements of electrons and atoms. At the end of this course the students shall be able to predict the mechanism of reaction and the synthetic methodologies of small organic molecules.

#### Contents

1. Oxidation state of organic compounds. Oxidation of C=C (using  $\text{KMnO}_4$ ,  $\text{OsO}_4$ , ozonolysis and epoxidation). Mild oxidation of  $1^\circ$ -ols  $\rightarrow$  CHO,  $2^\circ$ -ols  $\rightarrow$  ketone.
2. Harsh oxidation of alcohols, amines and nitriles.
3. Reduction involving metal/metal complexes (Wilkinson's vs Crabtree catalysts), hydrides [ $\text{NaBH}_4$ ,  $\text{LiAlH}_4$ , DIBALH, Red-Al and  $\text{NaB}(\text{CN})\text{H}_3$ ] reductions and reductions involving single electron transfer (SET).
4. Classification of molecular rearrangements.
5. Mechanism of intramolecular 1,2-shifts involving migration of a group from C to C, C to N, N to C, C to O and O to C.
6. Mechanism and examples of Wagner–Meerwein, Pinacol–Pinacolone, Benzidine–Benzillic acid, Favorski, Wolf, Beckmann, Hofmann, Curtius, Lossen, Schmidt, Steven, Baeyer–Villiger, Dakin and Fries rearrangements.
7. Introduction and classification, of pericyclic reactions.
8. Electrocyclization involving  $4n / 4n+2 \pi$  electron systems.
9. Cycloadditions including Diels–Alder, Alder–ene and 1,3-dipolar additions
10. Frontier orbital and symmetry conservation approaches in respect to electrocyclic and cycloaddition reactions
11. Sigmatropic reactions, Cope, Ireland–Claisen rearrangements.

#### Recommended Texts

1. Smith M. B. and March, J. (2019). March's advanced organic chemistry. (8th ed.). John Wiley, NY.
2. Morrison, R. T. and Boyd, R. N. (1987). Organic chemistry, Allyn & Bacon, Boston.
3. Clayden, J., Greeves, N., and Warren, S. (2012). Organic Chemistry. (2nd ed.). Oxford, London.

#### Suggested Readings

1. Streitwieser, A., Heathcock, C. and Kosower, E. M. (2017). *Introduction to organic chemistry*. (8th ed.). New York: Macmillan.
2. Vogel, A. I. (1989). *Practical organic chemistry*. (5th ed.). London: Longman Publisher.
3. House, H. O. (1972). *Modern synthetic reactions*. California: Benjamin.

Protecting groups are used in synthesis to temporarily mask the characteristic chemistry of a functional group because it interferes with another reaction. A good protecting group should be easy to put on, easy to remove and in high yielding reactions and inert to the conditions of the reaction required. In many preparations of delicate organic compounds, some specific parts of their molecules cannot survive the required reagents or chemical environments. Then, these parts, or groups, must be protected. For example,  $\text{LiAlH}_4$  is a highly reactive but useful reagent capable of reducing esters to alcohols. It will always react with carbonyl groups, and this cannot be discouraged by any means. Neutral reactive intermediates (radicals, carbenes, nitrenes, and arynes) occupy a fascinating place in the history of organic chemistry. First regarded as mere curiosities, neutral reactive intermediates ultimately came under the intense scrutiny of physical organic chemists from a mechanistic point-of-view. This concise text concentrates on how these electron-deficient species now play a key role in synthetic chemistry research. Important reactions are clearly and simply laid out with carefully chosen examples that illustrate their use in organic synthesis.

#### *Contents*

1. Introduction and classification of reactive intermediates
2. Generation, detection, reactions and synthetic applications of following reactive intermediates  
Free radicals, carbenes, carbenoids, nitrenes, carbocations, carbanions, and arynes
3. Concept of chemoselectivity and role of protecting groups
4. Protection, deprotection and retention conditions of following functional groups
  - a. alcohols / phenols (acetals, ethers, silylethers and esters)
  - b. amines (carbamates and amides)
  - c. aldehydes / ketones (acetals / ketals, thioacetals / thioketals, and functionalized ketals)
  - d. carboxylic acids (esters and functionalized esters)
5. Applications of protecting groups in organic synthesis
6. Phase transfer reagents, calixarenes, homogenous and heterogeneous catalysis, organocatalysis, click chemistry, microwave assisted synthesis, sonochemistry etc.

#### *Recommended Texts*

1. March, J. (1992). *Advanced organic chemistry*. New York: Wiley.
2. Hendrickson, J. B., Cram, D. J. and Hammond, G. S. (1980). *Organic chemistry*. New York: McGraw-Hill.
3. Pine, S. H. (1980). *Organic chemistry*. New York: McGraw-Hill.

#### *Suggested Readings*

1. Streitwieser, A., Heathcock, C. and Kosower, E. M. (2017). *Introduction to organic chemistry*. (4<sup>th</sup> ed.). New York: Macmillan.
2. Warren, S. (2008). *Organic synthesis*. New York: Wiley.

This course is about the colloids and surfactants. In this course, main focus is on surface tension, adsorption isotherms, Freundlich, Langmuir and BET isotherms, surfactants, micellization, methods of preparation of gels and emulsions, precipitation in gels, emulsifiers and breaking of emulsions. Moreover, orientation theory, sols and their preparation, properties of sols, optical properties of sols, determination of particle size, kinetic properties of sols, sedimentations of suspensions, electrical properties of solutions electrophoresis and electroosmosis and stability of suspensions, molecular wt. determination of macromolecules are also part of this course. Course is designed in a way that student may be able to prepare colloids (sols, emulsions and gels) by different physical and chemical methods and use them in research and application fields. Knowledge about different adsorption isotherms and the factors affecting adsorption process gives detailed understanding of sorption mechanism which leads their command to prepare efficient sorbents to remove pollutants and contaminations and to purify water etc.

#### *Contents*

Surface tension and interfaces, Adsorption at liquid surface, Physical and Chemical Adsorption, Derivation of Adsorption isotherms (Freundlich and Langmuir adsorption isotherm, BET Equation), Colloids and classification, Preparation of sols, Purification of sols, Optical and electrical properties of solutions, Hardy Schulz Rule & Flocculation of Sols, Emulsions and types, Emulsification & Demulsification, Surfactants, micellization, Gels, Classification and preparation, Determination of particle size, Sedimentations of suspensions, Stability of suspensions, The cause of semi-permeability, Mechanism of osmotic pressure, Molecular wt. determination of macromolecules, Determination of the molecular weight by osmometry

#### *Surface Phenomena Lab*

1. Verification of Freundlich adsorption isotherm for organic acids
2. Experimental verification of Langmuir adsorption isotherm.
3. To prepare  $As_2S_3$  sol and verification of Tyndall effect
4. Preparation of  $Fe(OH)_3$  and observing the scattering of incident light.
5. Determination of flocculation value of a sol by using monovalent, divalent and trivalent ions of electrolytes to verify Hardy-Schulze rule.
6. Preparation of buffer solution and measurement of exact pH-value by pH meter.

#### *Recommended Texts*

1. Kontogeorgis, G. M. & Kiil, S. (2016). *Introduction to applied colloid and surface chemistry*. John Wiley & Sons Inc.
2. Thomas, J. M. & Thomas, W. J. (2015). *Principles and practice of heterogeneous catalysis*. Germany: Wiley-VCH Verlag GmbH.

#### *Suggested Readings*

1. Somorjai, G. A., Yimin, L. (2010). *Introduction to surface chemistry and catalysis*. John Wiley & Sons Inc.
2. Cosgrove, T. (2010). *Colloid science: principles, methods and application*. John Wiley & Sons Inc.
3. Pashley, R., Karaman, M. (2004). *Applied colloid and surface chemistry*. John Wiley & Sons Inc.

The objective of this course is to comprehend the basics of spectroscopic techniques in a precise and compact way and to understand its foundation based on equations of quantum mechanics. Course focuses on classification of spectroscopy, rotational spectra of rigid linear molecules, harmonic and inharmonic oscillator models for the energy of a diatomic molecule, types of vibrational modes, interpretation of IR spectra of simple molecules. Moreover, a comprehensive and detailed knowledge about fermi resonance, applications and sampling techniques, H-atom spectrum, energies of atomic orbital, electronic angular momentum and the fine structure, Raman & Rayleigh scattering and vibrational Raman spectrum and nuclear magnetic resonance spectroscopy will be discussed in detail. The student will learn about updated skills of analysis at laboratory as well as at industry. Analysis by different techniques and the deep insight of interaction of electromagnetic radiation with matter reveals the phenomena occurring and the interpretation of meaningful signals to conclude quantitative and qualitative analyses is a part of this course. After studying this course, the students will be able to analyze samples through different spectroscopic techniques and they will be able to understand the way to interpret the meaning of signals for qualitative and quantitative analysis.

#### *Contents*

Introduction of Spectroscopy and Energy regions, Classification of spectroscopy, Classification of molecules on the basis of relative  $I_A$ ,  $I_B$ ,  $I_C$ , Rotational spectra of rigid linear molecules, Effect of Isotopic substitution on spectra, Determination of bond lengths, Rotational spectra of symmetric, asymmetric, spherical tops, Instrumentation for MW spectroscopy, Harmonic and inharmonic oscillator models for the energy of a diatomic molecule, Types of vibrational modes, Interpretation of IR spectra of simple molecules Fermi resonance, applications and sampling techniques, Types of electronic transition, H-atom spectrum, energies of atomic orbital, Electronic angular momentum and the fine structure, Idea of Raman scattering Rayleigh scattering and molecular polarizability, Rotational Raman spectra of linear molecules, Symmetric top molecules and spherical top molecules, Vibrational Raman spectra, Nuclear magnetic resonance spectroscopy

#### *Recommended Texts*

1. Castellan G. W. (2004). *Physical chemistry* (3<sup>rd</sup> ed.). Dehli, India: Norasa Publishing House.
2. Banwell, C. N. & McCash, E. M. (1994). *Fundamentals of molecular spectroscopy*. (2<sup>nd</sup> ed.). UK: The Bath Press Avon.

#### *Suggested Readings*

1. Raj, G. (2010). *Advanced physical chemistry*. (3<sup>rd</sup> ed.). Meerut Krishna Prakashan Media (P) Ltd.
2. Related Research Papers

Quantum Mechanics and Statistical Thermodynamics is a comprehensive course for the students having interest in Physical Chemistry as their specialization. This course covers two major areas (i.e. Quantum Chemistry and Statistical Thermodynamics) of Physical Chemistry. The objective includes to make the students able to understand the foundation of Quantum Chemistry along with derivation of Schrodinger Wave Equation, interpretation of wave function and its mathematical requirements and the application of knowledge to understand the structure of atom & molecules and a glance into sub-atomic phenomenon, properties and occurrences. The Boltzmann distribution law and partition function, partition function and thermodynamics functions like internal energy and entropy are important part of the syllabus to be covered. As course covers two main directions i.e. Quantum Chemistry and Statistical Thermodynamics, so studying this course will make students capable of applying their knowledge to solve the issue related to the mentioned fields. Students will be able to understand this basic knowledge understand the properties of molecules and their reactions, energetics and probability of an electron to exist.

#### *Contents*

Quantum Chemistry: Introduction to Quantum Mechanics, Electromagnetic Theory of Radiations, Plank's Quantum Theory, Schrodinger's wave equation, Interpretation of wave function ( $\psi$ ), Observable, operators and functions, Eigen value, Eigen function, Orthogonality and normalized wave functions, Motion of particle in three-dimensional box and idea of degeneracy, Application of Schrodinger wave equation to derive magnetic, azimuthal and principal quantum number, Postulates of quantum Mechanics, Mathematical treatment of rigid rotator and calculation of bond length of simple molecule,  
Statistical thermodynamics: Probability, statistical treatment of entropy, Sterling approximation and probability, Maxwell's law of distribution of velocities, The Boltzmann distribution law and partition function, Partition function and thermodynamics functions like internal energy and entropy. Translational, rotational, vibrational and electronic partition function and their comparison.

#### *Recommended Texts*

1. Bogolubov, N. N. & Bogolubov, N. N. Jr. (2009). *Introduction to quantum statistical mechanics*. (2<sup>nd</sup> ed.). Russia.
2. Atkins P.W. & Friedman, R. S. (2010). *Molecular quantum mechanics*. UK: Oxford University Press.

#### *Suggested Readings*

1. Raj, G. (2010). *Advanced physical chemistry*. (3rd Ed.) Meerut Krishna Prakashan Media (P) Ltd.
2. Atkins P.W. (2017). *Physical chemistry*. (11<sup>th</sup> Ed.) ELBS Oxford University Press
3. William C. Schieve, W. C. (2009). *Quantum statistical mechanics*. UK: Cambridge University Press.
4. Polkinghorne, J. (2002). *Quantum theory: a very short introduction*. UK: Oxford University Press.

SEMESTER-VIII

URCQ-5111

Translation of the Holy Quran-IV

1(0-1)

<p>Cours e Conte nts:</p>	<p>o تجارت اور وراثت: • مال کی تقسیم • نادان کا مال • عوام الناس کا مال • عورتوں کا مال • یتیموں کا مال • کفار کا مال • جائز مال • معاہدے • رہن • قرض o سائنسی حقائق: • تخیلی ق کائنات • اجرام فلکی • شجر و حجر • زمین و آسمان کے اسرار • ہوائیں اور طوفان • بہائم اور مویشی</p>
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	<ul style="list-style-type: none"><li>▪ الجمعة (٧٧، ٨٢، ١٧، ٧٧، ٤)</li><li>▪ القمر (١)</li><li>▪ الواقعة (٢٢)</li><li>▪ الفاطر (١٨، ٣٧)</li><li>▪ الملك (٢٧)</li><li>▪ الصف (١٧)</li><li>▪ الجن (٣٧)</li><li>▪ الثور أى (٢٨)</li><li>▪ الزخرف (٧٧)</li><li>▪ الفيل (٧)</li></ul>
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This course is aimed to familiarize the students about components of environment, their origin, composition, chemical reactions, fate, and sink. Distribution of water, chemistry of surface, fresh, marine and underground water is part of hydrosphere. Lithosphere deals with the ores, mines, and minerals contained in soil; their determination and extraction are part of this course. Types of soil, chemical composition and reactivity of soil components is also included in this course. Composition of Origin and sources of different pollutants, their reactivity and toxicity in environment, measures to control them are also included in the course. Role of different pollutants in causing acid rain and its impact on quality of life is also part of the course. Source of gases imparting greenhouse effect, its significance, impact on vegetation and environment and artificial greenhouse are part of the course. After studying the course, students will be able to work with any environmental protection organization or sanitation agency. Different techniques for characterization of environmental samples are also included. The acquired knowledge will be helpful for skill development and career building of students, especially in environmental sciences.

#### *Contents*

1. The Human Environment
2. The litho, bio and hydrosphere
3. The nature and composition of natural waters
4. Water pollution
5. Chemistry of soil
6. Composition of the atmosphere
7. Oxides of carbon, sulphur and nitrogen in air pollution
8. Atmospheric Monitoring
9. Instrumental methods of environmental chemistry
10. Ozone demolition
11. Acid rain
12. Green House Effect

#### *Recommended Texts*

1. Manahan, S.E. (2017). *Environmental Chemistry*. (7<sup>th</sup> ed.). New York: CRC press.
2. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate Instrumental Analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
3. Harris, D.C. (2016). *Quantitative Chemical Analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.
4. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical Chemistry*. (4<sup>th</sup> ed.). New York, John Wiley & Sons.

#### *Suggested Readings*

5. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of Analytical Chemistry*. (9<sup>th</sup> Ed.) Philadelphia: Saunders College Publishing.

This course gives comprehensive overview about principle, instrumentation and applications of two important spectroscopic techniques. Mass spectrometry is used for determination of elemental composition of samples as well as for molecular analysis, determination of exact molecular mass of a compound using isotopic masses and is ultimate technique for structure elucidation of a compound. Components and operational skills of high-resolution mass spectrometers providing very accurate information are also part of this course. Spectroscopic techniques based on X-rays include X-ray diffraction, X-ray fluorescence, X-ray absorption, X-ray emission and X-ray crystallography; each of these have their typical applications with different detection devices. X-rays find wide application in medical diagnostics, internal structure of large molecules, security check of packed baggage. X-ray crystallography is used for 3-D structure determination of single crystals. X-ray fluorescence spectrometers are used in cement industry. After studying this course, students will be able to work on these instruments in any research or industrial laboratory, independently.

### *Contents*

1. Mass Spectroscopy: Principle of Mass spectroscopy, Instrumentation in details
2. Quantitative and Qualitative application in analytical chemistry
3. X-rays Spectroscopy: Nature and production of X-rays
4. X-rays absorption, X-rays emission, Instrumentation
5. X-rays fluorescence analysis, Diffraction studies single crystal analysis

### *Spectroscopic Techniques – II Lab*

1. Verification of deviations from Beer-Lambert's law.
2. Determination of chloride content in drinking water samples by mercury(II) thiocyanate spectrophotometric method.
3. Determination of copper in various food samples by diethyldithiocarbamate spectrophotometric method.
4. Determination of aspirin in pharmaceutical preparation and caffeine in tea and coffee by U.V Visible Spectrophotometry involving extraction.
5. Analysis of analgesic by HPLC.
6. Quantitative and qualitative analysis of different fruit juices for vitamin C by HPLC.
7. Estimation of Sodium and Potassium in biological fluids by flame photometry.
8. Determination of calcium in milk samples by flame photometry.
9. Determination of Magnesium in tap water, food, leaves etc by AAS.
10. Determination of manganese content in tea leaves by AAS.
11. Determination of sulphate and phosphate in commercial samples by complexometric titrations using EDTA.
12. Determination of iron in pharmaceutical samples by redox titration.
13. Determination of Sodium bicarbonate contents in baking Soda powder by conductometric titration with HCl.

### *Recommended Texts*

1. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4th ed.). New York, John Wiley & Sons.

This course is aimed to provide a comprehensive overview about four spectroscopic techniques, based on different modes of analysis; mentioned in title. Basic principle, detailed instrumentation, applications, limitations, scope and domain of each of these techniques is part of this course. Infrared spectroscopy gives fast, economical, and reliable information about identification of functional groups of sample components. Raman spectroscopy is based on principle of light scattering and is complement to infrared spectroscopy and can analyze those samples, which could not be analyzed by infrared spectroscopy. Electron spin resonance spectroscopy is based on spinning of nuclei and gives very authentic information about presence of certain compounds in sample. Surface analysis finds wide scope in corrosion resistance, paints, thin films, pharmaceutical coatings and medicines. Auger electron spectroscopy, photoelectron spectroscopy and electron spectroscopy for chemical analysis are the techniques of choice for the characterization of surface of any material. These techniques are widely used in different industries including food, pharmaceutical and fabrics industries. Students after having these instrumental skills will be well versed in handling these machines either in their future research activities or professional career spheres.

#### *Contents*

1. Origin of Molecular spectra
2. Origin of infrared and Raman spectra
3. Normal coordinate and normal vibrations
4. Symmetry of normal vibration and selection rules
5. Selection rule for infrared and Raman spectra
6. Metal isotope spectroscopy
7. Vibrational spectra in gaseous phase and inert gas matrices
8. Comparison of Raman with Infrared spectroscopy
9. Quantitative/Qualitative analysis, Instrumental detail and their use as analytical tool
10. Electron spin resonance spectroscopy: Instrumentation, Samples and sample holder
11. ESR spectra and Hyperfine interaction
12. Applications, Spin labels and spin traps
13. Surface Analysis: Introduction, Electron spectroscopy techniques
14. X-Rays photoelectron spectroscopy, Instrumentation for XPS
15. Sample introduction and handling for surface analysis
16. Analytical applications of XPS

#### *Recommended Texts*

1. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

#### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4<sup>th</sup> ed.). New York, John Wiley & Sons.

This course is aimed to provide an overview about an important spectroscopic technique, i.e. nuclear magnetic resonance spectroscopy and number of techniques based on thermal methods of analysis. Nuclear magnetic resonance spectroscopy is an electromagnetic technique, based on spinning of nuclei and is recognized as an ultimate technique for structure elucidation of compounds with different spatial arrangement of atoms in a molecule. Nuclear reactions linked with radioactive decay gives an important in-depth information about nuclear characteristic of sample; used for identification of sample molecules. Nuclear reactors, accelerators and sources of neutron generation are also contained in this course. Thermogravimetry, differential thermal analysis, differential scanning calorimetry are the techniques based on thermal modes of analysis. These techniques give information about stability of molecules, pyrolysis reactions, kinetics, thermodynamics, and decomposition rates of polymers, medicines and food materials. Energetics of molecule as function of temperature are also included in this course. Students studying this course will be able to work in any hi-tech laboratory at their own with good background troubleshooting skills.

#### *Contents*

1. Nuclear Magnetic Resonance
2. Nuclear emission Alpha particles, Beta particles, Gamma – rays
3. Neutron activation analysis
4. Nuclear reactors; materials and working
5. Nuclear reactions
6. Radiochemical decay and activity
7. Necessary instrumentation including sources, accelerators and detectors
8. Thermal method of Analysis
9. Thermogravimetric analysis (TGA), Differential thermal analysis (DTA) and differential scanning Calorimetry (DSC)
10. Thermogravimetric curves and interpretation of thermograms
11. Pyrolysis and thermometric titration, type of measurements and applications of these techniques

#### *Recommended Texts*

1. Robinson J.W., Frame E.S., & Frame G.M. (2014). *Undergraduate instrumental analysis*. (7<sup>th</sup> ed.). New York: Marcel Dekker.
2. Harris, D.C. (2016). *Quantitative chemical analysis*. (9<sup>th</sup> ed.) New York: W.H. Freeman and Company.

#### *Suggested Readings*

1. Skoog, D.A., West, D.M., Holler, F.J., & Crouch S. R. (2014). *Fundamentals of analytical chemistry*. (9<sup>th</sup> ed.) Philadelphia: Saunders College Publishing.
2. Christian, G.D., Dasgupta, P.K., & Schug, K.A. (2013). *Analytical chemistry*. (4<sup>th</sup> ed.). New York, John Wiley & Sons.

This course provides a deep understanding of molecular biology central phenomenon including DNA replication, transcription, and translation with respect to their functionality at the molecular level and including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells. This course is designed as a theory and practical course and introduces some of the major ideas and experimental approaches in molecular biology using biophysical methods and techniques. Student will learn basic concepts about physical techniques that are involved in characterization of biomolecules in the theory portion, while same techniques will also be performed in the lab. Students will also learn to understand and apply general concepts of cell and molecular biology to relevant, specific problems and will be able to describe and discuss the properties and biological significance of the major classes of molecules found in living organisms and the relationship between molecular structure and biological function.

### *Contents*

1. Molecular dogma; DNA as a genetic material, introduction to types and function of DNA
2. Structure of Chromatin and its functions.
3. DNA replication in prokaryotes and Eukaryotes
4. Type of DNA polymerases and functions
5. DNA damage; types of mutations. DNA repair; NER, MMR, homologous DNA repair.
6. Virus DNA/RNA replication and its protein regulation
7. Transcription in prokaryotes and Eukaryotes
8. Differences and types of DNA polymerases, operons
9. Splicing; introns, exons and ribozymes. Gene regulation, post transcriptional modifications.
10. Translation; tRNA structure and functions, activation, protein synthesis, regulation
11. Post translational modifications.
12. Protein characterization using different biophysical methods.
13. UV/Vis Spectrophotometry, FT-IR, Circular Dichroism (CD), Surface Plasmon Resonance (SPR)
14. Gel electrophoresis (SDS-PAGE, and agarose gel electrophoresis)
15. Ultra-, analytical and gradient centrifugation
16. Cryo-electron microscopy, protein NMR, X-ray crystallography/Diffraction.
17. Applications of PCR and DNA sequencing
18. Mass spectrometry and use of isotopes in molecular biology.

### *Molecular Biology & Biophysical Techniques Labs*

1. Isolation of proteins from plant and animal samples using various cell disruption methods e.g., amylase
2. Protein precipitation by  $\text{NH}_4\text{SO}_4$  method, using acid and organic solvent methods.
3. Protein dialysis and ultrafiltration
4. Estimation of proteins using UV, Bradford and Lowry's methods.
5. Characterization of proteins i.e., amylase activity assays
6. Plasma proteins separation by SDS PAGE
7. Chromatographic (Ion exchange and size exclusion) separation and purification of proteins
8. Estimation and Isolation of total DNA/RNA from bacteria/tissues
9. Preparation of plasmid DNA from bacteria.
10. Restriction enzyme digestion
11. Characterization/separation of DNA by Agarose Gel Electrophoresis
12. Primer designing and amplification of sample DNA by PCR (PCR demonstration)



13. Understanding to DNA sequencing (sequencing analysis by a demo sample file)
14. Characterization of proteins using online tools i.e Protpram

#### *Recommended Texts*

1. Nelson, D. L. & Cox, M. M. (2017). *Lehninger principles of biochemistry*. (7<sup>th</sup> ed.). New York, USA: W. H. Freeman Publishers.
2. Voet, D., & Voet, J. G. (2016). *Biochemistry*. (5<sup>th</sup> ed.). New York, USA: John Wiley & Sons.
3. Boyer, R. F. (2000). *Modern experimental biochemistry*. (3<sup>rd</sup> ed.). London, England: Pearson Press.

#### *Suggested Readings*

1. Swaminathan, R. (2011). *Handbook of clinical biochemistry*. (2<sup>nd</sup> ed.). Singapore: World Scientific Publishing Company.
2. Walker, J. M. (1994). *The basic protein and peptide protocols*. New Jersey, USA: Humana Press.
3. Lodish, H., Berk, A. Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Martin A. A. (2016). *Molecular cell biology*. (8<sup>th</sup> ed.). New York USA: W. H. Freeman.

This course provides insights about classification, characterization, and diagnosis of various types of cancers and its therapies in respect to theoretical knowledge of the disease process. It will examine the concepts of epidemiology, aetiology and pathology of cancer along with contemporary and emerging treatment modalities and their effects. The course serves as an ideal primer for students who seek an entry point to the domain of cellular transformation, carcinogenesis, and immune surveillance. This course will also examine cancer vaccine development (dendritic, genetic, anti-idiotypic, use of adjuvants) as well as the use of vaccination to counter microbial causes of cancer. Students will learn about chemical structures, mechanism of action and mechanism of drug resistance of various classes of antibacterial, antifungal, antiviral, antipyretic, analgesic, and antimalarial drugs. The course will also provide basic concepts about immune system, its functioning, principles of Innate, adaptive, cell-mediated, and humoral immunity.

#### *Contents*

1. Cancer: Reasons, Types and definition of various terms
2. Metastasis, Benign and malignant tumors, Oncogenes, Proto-oncogenes, hyperplasia
3. Chemotherapy: Definition, different treatment strategies
4. Problems associated with chemotherapy, mechanism of drug resistance.
5. Chemotherapeutic Agents: Chemical structure
6. Mechanism of action and mechanism of drug resistance of various classes
7. Antitumor-antibiotics, Antimetabolites, Alkylating agents, Microtubule Inhibitors
8. Steroids and their Antagonists, Aromatase inhibitors
9. Monoclonal antibodies, Platinum based drugs, Irinotecan and topotecan.
10. Etoposide, L-Asparaginase, Interferons and Imatinib.
11. Chemical structures, mechanism of action and mechanism of drug resistance of various classes of antibacterial, antifungal, antiviral, antipyretic, analgesic, and antimalarial drugs.
12. Immunology: Fluid systems of the body, Blood groups (A, B, O and Rh system)
13. Components of Immune system, Definitions and Principles of Innate, adaptive, cell-mediated and humoral immunity, and the complement system.
14. Antibodies: Classes, biochemical structures, characteristics, and functions.
15. Mechanism of allergy, hypersensitivity, acquired immunity, Immunodeficiencies and antigen- antibody reaction.

#### *Recommended Texts*

1. Sharma, A. K. (2019). *Immunology: an introductory textbook*. Singapore: Jenny Stanford Publishing.
2. Gadebusch, H. (2019). *Chemotherapy of infectious Disease*. (1<sup>st</sup> ed.). Florida, USA CRC Press.

#### *Suggested Readings*

1. Kuby, (2002). *Immunology*. (5<sup>th</sup> ed.). New York, USA: Macmillan Publishing Co.
- Dawis, B. D., Dulbecco, R., Eisen, H. N., & Ginsberg, H.S. (2002). *Microbiology*. New York, USA: Harper & Row.

The course also introduces introduction to various methods and applications involved in recombinant DNA technology including polymerase chain reaction (PCR), DNA cloning, DNA sequencing, restriction enzymes, gene libraries, blotting techniques, expression of recombinant proteins, gene mapping, transgenic animals, and gene therapy. Student will learn about the genomic libraries, cDNA libraries and their applications with emphasis to their role in agriculture, production of therapeutic proteins.

#### *Contents*

1. DNA Cloning and applications.
2. Restriction enzymes, restriction maps,
3. Enzymes in recombinant DNA technology
4. Gene vectors including plasmids, bacteriophages, cosmids
5. DNA vectors, shuttle and expression vectors
6. Gene splicing, genomic libraries, screening methods for gene libraries
7. DNA and RNA blotting
8. Chromosome walking; PCR; site specific mutagenesis
9. Overexpression of proteins
10. Restriction fragment length polymorphisms and disease detection (e.g. cystic fibrosis)
11. Stem cell technology
12. Social and commercial considerations.

#### *Recommended Texts*

1. Brown, T. A. (2016). *Gene cloning and DNA manipulation, an introduction*. (7<sup>th</sup> ed.). New Jersey, USA: Blackwell Publishing Inc.
2. Primrose, S. B. Twyman, R. M & Old, R.W. (2006). *Principles of gene manipulation*. (7<sup>th</sup> ed.). New Jersey, USA: Wiley-Blackwell.

#### *Suggested Readings*

1. Walker, J. M. (1994). *The basic protein and peptide protocols*. New Jersey, USA: Humana Press.
2. Lodish, H., Berk, A. Kaiser, C. A., (2016). *Molecular cell biology*. (8<sup>th</sup> ed.). New York USA: W. H. Freeman.

This course aims to the understanding of homogeneous catalysis by transition metal complexes of different ligands to synthesize different compounds having useful applications. Catalysis is responsible to economize processes and revolutionize the industrial era. Beginning with the polymerization of ethylene to produce polythene, an important commercial product of daily use in life at room temperature and normal atmospheric pressure, to the state-of-the art production of silicon from sand for solar technology, all are the fruitful outcomes of catalysis. Transition metals play a pivotal role in bringing about all the dreams to come true. Different analytical techniques such as conductometry, spectrophotometry and potentiometry will be studied for the estimation and identification of chemical species in lab work. Accurate and precise determination of different hazardous species in biological and lab samples is very important for the health of workers and consumers. After the successful completion of course, students will be able to explain the concept of catalysis carried out by the metal complexes formed by inorganic ligands or hybrid ligands.

### *Contents*

Reaction of CO and Hydrogen (Hydroformylation, Reductive Carbonylation, Reduction of CO by hydrogen, Synthesis gas and the water gas shift reaction)

Carbonylation reaction (Synthesis of methanol and methyl acetate, Adipic ester, other Carbonylation reactions, Decarbonylation reactions)

Catalytic addition of molecules to C–C multiple bonds (Homogeneous hydrogenation, Hydrocylation and Hydrocyanation)

### *Homogeneous Catalysis by Transition Metal Complexes Lab.*

#### Instrumental Methods of Analysis

##### Conductometry

1. Titration of strong acid and weak acid with a strong base
2. Precipitation Titration involving  $\text{AgNO}_3$  and  $\text{KCl}$
3. Determination of dissociation constant ( $K_a$ ) for acetic acid

##### Spectrophotometry (Colorimetry)

1. Microdetermination of Cr (III) by diphenylcarbazide
2. Determination of Fe (II) by 1:10 - Phenanthroline
3. Determination of Nitrites
4. Determination of Fe (III) by 8 – hydroxyquinoline

##### Potentiometry

1. Determination of  $K_1$ ,  $K_2$ , and  $K_3$  for  $\text{H}_3\text{PO}_4$
2. Determination of Chloride in the presence of Iodide and evaluation of  $K_{sp}$  of  $\text{AgI}$  and  $\text{AgCl}$
3. Determination of  $\text{Co}[\text{II}]$
4. Determination of  $\text{Fe}[\text{II}]$

### *Recommended Books*

1. Edition, Oxford University Press, UK (1998).
2. Kotz, J.C. and Treichel, P. Chemistry and Chemical Reactivity, 4<sup>th</sup> Edition, Saunders College Publishing, NY (1999).
3. Angelici, R.J. Synthesis and Technique in Inorganic Chemistry, 1<sup>st</sup> Edition, University Science Books, CA (1986).
4. Garry L. Miessler, D. and Tarr, A. "Inorganic Chemistry" 3<sup>rd</sup> Edition, Pearson Education, Inc. NY (2004).
5. Purcell K.F. and Kotz, J.C. "An Introduction to Inorganic Chemistry" Saunder, College, Philadelphia (1980).

This course aims to the understanding of kinetics and mechanism of different inorganic reactions. The mechanism of a chemical reaction is the most important part which is normally not visible to the chemist. However, the pace of a chemical reaction is controlled by the kinetic parameters that govern these changes. Geometry of the transition state of metal catalyst is always important because it guides the reaction pathway in the forward or backward direction. The two most significant steps in a typical catalysis are the oxidative addition and the reductive elimination. Moreover, different types of effects such as cis-effect, trans-effect, steric effects of inert ligand etc. also govern the synthesis of different types of products. After the successful completion of this course, students will be able to learn the factors affecting the kinetics and stability of inorganic products. Moreover, they will also be able to carry out different oxidative and reductive reactions.

#### *Contents*

Kinetics and Mechanisms of Inorganic Reactions: Rate law, Stationary State approximation, Inert and labile complexes, Substitution reaction

- i) Octahedral Complexes (Acid hydrolysis, Acid catalyzed equation, Anation reactions, Base hydrolysis, Attack on ligands, Steric effects of inert ligand)
- ii) Square planar Complexes (Nucleophilic reactivity, Trans effect, Cis effect, effect of leaving group. Electron transfer processes (outer and inner sphere reactions). Complimentary and Non - Complimentary reactions.

Mechanism of Oxidative Addition and Reductive Eliminations: Oxidative Addition, One electron oxidative addition, Addition of Oxygen, Addition of bimetallic species, Hydrogen addition, HX addition, Organic halides, Reductive Elimination.

#### *Recommended Books*

1. Jordan, R. B., Reaction Mechanisms of Inorganic and Organometallic Systems, 2<sup>nd</sup> Edition, Oxford University Press, (1998).
2. Kotz, J. C. and P. Treichel, Chemistry and Chemical Reactivity, 4<sup>th</sup> Edition, Saunders College Publishing, (1999).
3. Garry L. Miessler, Donald A. Tarr, "Inorganic Chemistry" 3<sup>rd</sup> Edition, Pearson Education, Inc. (2004).
4. Keith F. Purcell and John C. Kotz, "An Introduction to Inorganic Chemistry" Saunder, College, Philadelphia (1980).

This course aims to the understanding of different physical methods used for the analysis of inorganic products such as thermogravimetric analysis. Analysis of the product formed in a chemical reaction is an important step in chemical laboratory preparations. Different analytical techniques are used for this purpose ranging sensitivity from mg level to as low as Nano gram level. Isolation and purification of a product from the reaction mixture is accomplished by techniques like solvent extraction, thin layer chromatography, column chromatography etc. After the successful synthesis of a new compound the most important is now to find out its applications. Certain physical techniques are meant for the purpose of analysis of product like TGA, DTA, DSC, chromatography, conductometry and potentiometry etc. After the successful completion of this course, students will be able to understand the different techniques used for the purification, isolation and determination of inorganic specie from the reaction mixture as well as the importance of physical methods of analysis.

#### *Contents*

Thermogravimetric Analysis, Thermogravimetry (TG), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC), Separation Methods (Solvent Extraction, Column, TLC and Ion Exchange Chromatography), Potentiometry, Conductometry.

#### *Recommended Books*

1. Structure and Reactivity", 4<sup>th</sup> Ed., Harper and Row, New York, (2001).
2. Jordan, R.B., Reaction Mechanisms of Inorganic and Organometallic Systems, 2<sup>nd</sup> Edition, Oxford University Press, UK (1998).
3. Kotz, J.C. and Treichel, P. Chemistry and Chemical Reactivity, 4<sup>th</sup> Edition, Saunders College Publishing, NY (1999).
4. Angelici, R.J. Synthesis and Technique in Inorganic Chemistry, 1<sup>st</sup> Edition, University Science Books, CA (1986).

This course is a foundation course for Natural Product Chemistry (CHEM-7148) and Steroids (CHEM-8108) courses of MPhil and PhD classes, respectively, with Organic Chemistry specialization. Natural products have high structural diversity and unique pharmacological or biological activities due to the natural selection and evolutionary processes that have shaped their utility over hundreds of thousands of years. In fact, the structural diversity of natural products far exceeds the capabilities of synthetic organic chemists within the laboratory. Thus, natural products have been utilized in both traditional and modern medicine for treating diseases.

This course focuses on the biosynthesis, isolation of new natural products, rational structural modifications of known natural products scaffolds for new lead discovery, total synthesis of complex natural products and green chemistry. Special emphasis is given to the development of synthetic methodologies to facilitate generation of diversity around the scaffolds, which can be utilized as key intermediates for total synthesis. The new molecular entities generated are screened for pharmacological activities with focus on cancer and anti-bacterial properties. The practical work involves the purification of selected natural products and the synthesis of a few small sized natural products.

#### *Contents*

1. Primary and secondary metabolites, introduction to natural products and classification on different basis; isolation of different secondary metabolites exploiting their boiling point, molecular size, solubility and polarity
2. Hormones (endocrines, exocrines, paracrines), pheromones (chemical communication) and allomones (chemical defense)
3. Classification, biosynthesis, biological importance, laboratory synthesis and structure elucidation of alkaloids (ephedrine, adrenaline, atropine, indole, quinine, morphine etc.) by chemical and spectroscopic methods
4. Classification, biosynthesis, laboratory synthesis and structure elucidation of terpenoids (limonene, carvone, pinene, menthol, camphor, pentacyclic triterpenoid, tetraterpenoid) by chemical, spectroscopic and spectrometric methods
5. Basic nomenclature, classification, biosynthesis, biological importance, laboratory synthesis and structure elucidation of steroids (ecdysteroid, corticocoid, gonadal, AAS & neuro steroid, phytosterol, brassinolide, withanolide etc.) by chemical, spectroscopic and spectrometric methods of analyses
6. Classification, biosynthesis, RDA, bioavailability, laboratory synthesis and metabolic role of vitamins (A, B, C, D, E and K)
7. Classification, biosynthesis, biological importance, laboratory synthesis and structure elucidation of flavonoids by chemical, spectroscopic and spectrometric methods.

#### *Chemistry of Natural Products Lab.*

1. Multistep synthesis of different types of organic compounds. Purification of the products by chromatographic and other techniques.
2. Isolation and purification of some natural products.
3. Conformation of natural products by different techniques e.g., elemental analysis, spectroscopy

#### *Recommended Texts*

1. Finar, I. L. (2001). *Natural product chemistry*. Vol-I, London: Longman.
2. Clayden, J., Greeves, N., Warren, S. and Wothers, P. (2012). *Organic chemistry*. (2<sup>nd</sup> ed.). Oxford University Press.
3. Dewick, P. M. (2008). *Medicinal natural products - a biosynthetic approach*. (3<sup>rd</sup> ed.). England: Wiley.

#### *Suggested Readings*

1. Bhat, S. V. (2005). *Chemistry of natural products*. (1<sup>st</sup> ed.). Berlin: Springer.
2. Vogel, A. I. (1989). *Practical organic chemistry*. (5<sup>th</sup> ed.). London: Longman Publisher.



This course is a foundation course for Advance Organic Synthesis (CHEM-7146) of MPhil class, with Organic Chemistry specialization. This course focuses on general methods and strategies for the synthesis of complex organic molecules. Emphasis is on strategies for stereoselective synthesis, including stereo controlled synthesis of complex acyclic compounds. The transformation of functional groups by substitution reactions, protecting groups, dummy groups, electrophilic addition to C-C double and triple bonds, hydroboration, reactions with organoboranes, reduction of carbonyl, C-C double and triple bonds, hydrogenation, hydride reductions are included in this course. The stereo control in pericyclic reactions (cycloadditions, sigmatropic rearrangements, electrocyclic reactions), group transfer reactions are also part of this course including introduction to retro synthesis. After the end of course the students are supposed to be able to: plan syntheses of organic molecules by proper choice of starting materials, reagents and reaction conditions and shall be able to predict competing reactions and plan simple synthetic routes based on retrosynthetic synthesis strategy.

#### Contents

1. Introduction to C–C bond formations
2. Different methods for carbanion generation (organometallics, active methylene, ylides)
3. Effect of medium (solvent, bases, temperature, additives etc.)
4. Alkylation of esters, aldehydes, ketones and carboxylic acid using enolate chemistry.
5. Regioselectivity in enolate formation,
6. C-alkylation vs O-alkylation.
7. Role of active methylenes as synthetic equivalents
8. Specific enol equivalents and their merits and demerits
9. Aldol condensation, Claisen condensation, Mannich reaction
10. Direct vs conjugation addition to  $\alpha,\beta$ -unsaturated carbonyls (Michael additions, Robinson's annulation)
11. C–N bond formation (synthesis of amides, amines, imines), reductive amination for the synthesis of amines
12. C–O bond formation (oxidation of olefins using different reagents)
13. Introduction to retrosynthesis, Functional group inter-conversion (FGI)
14. One group and two group disconnections
15. Disconnection of simple alcohols, and their derivatives,  $\alpha,\beta$ -unsaturated carbonyl compounds, 1,3-dicarbonyl compounds and 1,5-dicarbonyl compounds, Functionalized aromatic systems
16. Concept of umpolung, acyl anion equivalents

#### Recommended Texts

1. Clayden, J., Greeves, N., Warren, S. and Wothers, P. (2012). Organic chemistry. (2nd ed.). Oxford University Press.
2. Smith, M.B. and March, J. (2019). March's advanced organic chemistry. (8th ed.). New York: John Wiley.
3. Warren, S. (2008). Organic synthesis. New York: Wiley.

#### Suggested Readings

1. March, J. (1992). Advanced organic chemistry. New York: Wiley.
2. Vogel, A. I. (1989). Practical organic chemistry. (5th ed.). London: Longman Publisher.

Stereochemistry is the study of the relative arrangement of atoms or groups in a molecule in 3D space. These days' chiral drugs have become an integral part of pharmaceutical industry and replacing racemic (enantiopure) drugs. This course shall lay foundation for asymmetric transformations with an emphasis on mechanisms, structure-reactivity relationships and applications in organic synthesis. After acquiring the given advanced stereochemistry knowledge, students will be able to apply these principles and reactions in organic synthesis research activities with productive outcomes and gain in their professional career.

### Contents

1. Instrumentation of a polarimeter; derivation and calculation of specific rotation  $[\alpha]$ ; chirality and symmetry; symmetry, asymmetry and dissymmetry; elements of chirality and symmetry ( $C_n$ ,  $\sigma$ ,  $S_n$ )
2. Projections of a 3D molecule to 2D (Wedge-head, saw-horse, Newman & Fischer projections)
3. Stereochemical notations (+/-,  $d/l$ ,  $D/L$ ,  $R/S$ ,  $r/s$ ,  $aR/aS$ ,  $pR/pS$ ,  $M/P$ )
4. Conformational isomerism in mono-, di-, tri- and polysubstituted cyclohexanes; conformations of *cis* / *trans* decalene systems
5. Calculating the absolute configuration through CIP and modified CIP rule
6. Configurational isomers with 3 asymmetric centres and no asymmetric centre (allenes, spiranes, biphenyls etc.), mutarotation
7. Study of conformational and configurational isomers through spectroscopic methods
8. Stereocontrol in addition, elimination and aliphatic nucleophilic substitution (on C, Si and Sn) reactions on acyclic molecules
9. Stereoselective (introductory Cram's rule, Prelog's rule and Felkin-Anh's model) and stereospecific syntheses
10. Elucidating the configuration of a chiral molecule through ORD / CD.
11. Introduction to racemization and resolution

### Recommended Texts

1. Eliel, E. L. Wilen S. H., & Mander, L. N. (1994). *Stereochemistry of organic compounds*. New York: John Wiley & Sons.
2. Morris, D. G. (2001). *Stereochemistry*. Cambridge, UK: RSC.
3. North, M. (1998). *Principles and applications of stereochemistry*. Cheltenham, UK: Stanley Thornes Publishers Ltd.

### Suggested Readings

1. Nasipuri, D. (2012). *Stereochemistry of organic compounds: principles and applications*. New Delhi: New Age International Ltd.
2. Gal, J. (2011). *Stereochemical vocabulary for structure; Chirality*. 23, 647-659 (A review article).

This course is designed for the students opting Physical Chemistry as Minor Subject along with their field of specialization to provide comprehensive knowledge about the kinetics of homogeneous and heterogeneous reactions. Course include detailed discussion about liquids and gaseous systems of inorganic and organic reactions, single systems, double systems, reactions on solid surfaces, kinetics of single reacting gas, retardation by reaction products, kinetics of two reacting gases, retardation by reactants, reactions in solution, influence of solvents involving ions, primary and secondary salt effect on kinetics of the reactions and comparison between homogeneous and heterogeneous kinetics. Course is designed to make the students capable of understanding the dynamics and phenomena of homogeneous and heterogeneous kinetics. As catalysis is backbone of any synthesis. To control the reaction rate and develop new interfaces suitable for reaction catalysis, students will be trained along with solid foundation of physical chemistry. Kinetics equations dealing different cases of homogeneous and heterogeneous reactions will be guiding torch to make them understand.

#### *Contents*

Introduction of adsorption, Liquids and gaseous systems of inorganic and organic reactions, Single systems, Double systems, Study of reactions on solid surfaces, Kinetics of Single reacting gas, retardation by reaction products, Kinetics of two reacting gases, Retardation by reactants, Adsorb-heterogeneous reaction, Theory of absolute reaction rate, Reactions in solution, Influence of solvents involving ions, primary and secondary salt effect on kinetics of the reactions, Comparison between homogeneous and heterogeneous kinetics

#### *Kinetics of Heterogeneous Reactions Lab*

1. Determination of equilibrium constant of reversible reaction  $I_2 + I^- \rightleftharpoons I_3^-$  and to evaluate  $\Delta G^\circ$ .
2. Determination of molecular mass of polymer by viscosity method.
3. Determination of distribution coefficient of  $I_2$  between  $H_2O$  and  $CCl_4$ .
4. Determination of Molar extinction coefficient.
5. Verification of Beer–Lambert’s law by using spectrophotometer
6. Determination of  $\lambda_{max}$  and unknown concentration of  $KMnO_4$  solution by colorimeter
7. Determination of  $\lambda_{max}$  and unknown concentration of  $K_2Cr_2O_7$  solution using spectrophotometer

#### *Recommended Texts*

1. Kontogeorgis, G. M. & Kiil, S. (2016). *Introduction to applied colloid and surface chemistry*. John Wiley & Sons Inc.
2. Thomas, J. M. & Thomas, W. J. (2015). *Principles and practice of heterogeneous catalysis*. Germany: Wiley-VCH Verlag GmbH.

#### *Suggested Readings*

1. Somorjai, G. A. , Yimin, L. (2010). *Introduction to surface chemistry and catalysis*. John Wiley & Sons Inc.
2. Cosgrove, T. (2010). *Colloid science: principles, methods and application*. John Wiley & Sons Inc.
3. Pashley, R.. & Karaman, M. (2004). *Applied colloid and surface chemistry*. John Wiley & Sons Inc.

The objective of this course is to make the students enable to understand the process of polymerization and to know the approaches by which polymerization may be achieved. Additionally, a deep insight of photochemical reactions and laws of photochemistry is also incorporated in this course. The course includes the kinetics of polymerization occurring through different approaches e.g. condensation, addition and copolymerization along with the knowledge of photochemical reactions. Fluorescence and phosphorescence and relevant information is also a part of this course. A knowledge of polymer chemistry enables the students to know about natural and synthetic polymers. Natural and semi-synthetic polymers find their uses in almost every field of science ranging from drug delivery to common sensors and biosensors. Photochemistry enables students to know how UV/Visible light is absorbed or emitted during a physical or chemical change. The basic knowledge of photochemistry is applied in the field of carbon Nano-dots because of their unique optical properties which is applied in imaging the biological process.

#### *Contents*

Polymers: Introduction of Polymers, basic concepts of Kinetic chain length, average molecular weight of polymer & polydispersity, Classification of polymers, Kinetics of condensation polymerization, Kinetics of free radical addition polymerization, Kinetics of Anionic addition polymerization, Kinetics of Cationic addition polymerization, Kinetics of co-polymerization reactions, Molecular mass determination by different methods

Photochemistry: Laws of photochemistry (Grotthuss–Draper law, Stark-Einstein law, Beer-Lambert Law), Deviations of Laws of Photochemistry, Quantum efficiency, Methods to determine quantum yield and quantum efficiency, Photochemical reactions, Photosensitized reactions, Phosphorescence, Fluorescence, Joblonski Diagram, Chemiluminescence, LASERS.

#### *Recommended Texts*

1. Turro, N. J., Ramamurthy, V. & Scaiano, J.C. (2009). *Principles of molecular photochemistry: an introduction*. USA: University Science Books.
2. Rawe, A. (2000). *Principles of polymer chemistry*. (2<sup>nd</sup> ed.). New York, USA: Plenum publishers.

#### *Suggested Readings*

1. Allen, N. S. (2010). *Photochemistry and photophysics of polymeric materials*. John Wiley & Sons Inc.
2. Albini, A. & Protti, S. (2019). *Photochemistry: Volume 47*. Cambridge, UK: Royal Society of Chemistry.
3. Wardle, B. (2010). *Principles and applications of photochemistry*. John Wiley & Sons Inc.
4. Neckers, D. C., Jenks, W. S. & Wolff, T. (2005). *Advances in photochemistry*. John Wiley & Sons Inc.

This course is designed to have a comprehensive knowledge about nuclear energy and nuclear reactions. It gives understanding about the principles, kinetics and mechanism of nuclear reactions. It gives an intensive sight of tracers and their applications. Course content makes the students enable to understand the mechanism of radioactive decay and energy associated. Important portion related with reaction, mechanism, kinetics and radiolytic and radioactive reactions, fission and fusion. It gives brief understanding of radiation hazard and radiation dose as well. A knowledge of radiation chemistry enables students to know how radiations interact with living organism bodies and with different materials. Students may apply their knowledge in the field of research for isotope production as cancer treatment.

#### *Contents*

Atom & Nucleus, Nuclear Models, Radioactivity and Radioisotopes, Method of detection of radioactivity, Measurement of radioactivity, Radioactive Decay, Kinetics of radioactive decay, Half-life and Decay Constant, Nuclear Fission, Nuclear Fusion, Nuclear Fusion and Stellar Energy, The Atomic Bomb, The Hydrogen Bomb, Nuclear Reactor, Charged Particles accelerators, Radiation Dose, Radiation Hazards and safety measures, Applications of tracers

#### *Recommended Texts*

1. Choppin, G. R., Liljenzin, J. O., Jan Rydberg, J. & Ekberg, C. (2013). Radiochemistry and nuclear chemistry. Elsevier Science Publishing Co. Inc.
2. Walter D. Loveland, W. D. Morrissey, D. J. & Seaborg, G. T. (2017). Modern Nuclear Chemistry. John Wiley & Sons Inc.

#### *Suggested Readings*

1. Koskinen, A. N. (2009). Nuclear chemistry: new research, Nova Science Publishers Inc.