UNIVERSITY OF THE PUNJAB

NOTIFICATION

In continuation of this office notification No. D/5584/Acad., dated 02-08-2019 regarding approval of the Syllabi and Courses of Reading for BS Chemistry (04 year Program) for the School of Chemistry w.e.f. the Academic Session, 2019-2020. The same will be implemented to the Affiliated Colleges form the session, 2022.

Sd/-
Tasleem Kamran
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/ 274 /Acad. **Dated: 31- 01 /2023.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. Dean, Faculty of Sciences.
2. Head, School of Chemistry.
3. Principals of Affiliated Colleges
4. Controller of Examinations
5. Director, IT for placement at the website
6. Admin Officer (Statutes)
7. Secretary to the Vice-Chancellor.
8. PS to the Registrar.
9. Assistant Syllabus.

Assistant Registrar (Academic)
for Registrar

Item 2.40
R/850/Acad
7-8-19

UNIVERSITY OF THE PUNJAB

NOTIFICATION

No. D/5584/Acad. dated 02-08-2019. The Syndicate at its meeting held on 04-05-2019 has approved the recommendations of the Academic Council made at its meeting dated 20-12-2018 regarding approval of Syllabi & Courses of Reading of BS Chemistry (4-Years Program), under Semester System w.e.f. the Academic Session 2019-2020.

Syllabi & Courses of Reading BS Chemistry (4-Years Program) is attached herewith, as Annexure 'A'.

Sd/-
Dr. Muhammad Khalid Khan
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

Copy of the above is forwarded to the following for information and further necessary action: -

1. The Dean, Faculty of Sciences
2. The Director, Institute of Chemistry
3. The Controller of Examinations
4. The Director, Quality Enhancement Cell
5. The Secretary to the Vice-Chancellor
6. The Secretary to the Registrar
7. Assistant (Statutes)
8. Assistant Syllabus

Assistant Registrar (Academic)
for Registrar

Curricula/Syllabi of Degree Program

Program Title: BS Chemistry Four Year

Department: School of Chemistry of Chemistry

Faculty: Science

1. Department Mission

Chemistry is truly the central science and underpins much of the efforts of scientists and engineers to improve life for humankind. Institute of Chemistry is taking a leading role in discovering new chemical synthesis, catalysis, smart chemical sensors, creating sustainable energy, theoretical and experimental understanding of chemistry at its most fundamental level, unraveling the biochemical complexities of natural systems, improving the environment, detecting and curing disease, developing materials of new properties and nanoscience.

2. Introduction

This Institute is imparting knowledge of chemistry in subcontinent for more than 85 years. A large number of our illumine are holding very eminent and responsible positions in multinational organizations and international scientific organizations throughout the world.

You will find excellent teachers and researchers, qualified administration and services staff, and all the equipment and tools needed to understand and explore your studies. By choosing this institute, you have decided to study at one of the top higher education establishments in Pakistan and also at one of the leading universities of Asia. I hope the years you spend with us here at university will be filled with intense experiences you will remember fondly in the years to come. Both my team and I are at your disposal for anything you may need to make your stay here even better.

We offer an educational and research experience in chemistry that is rich with challenges and opportunities for undergraduate, graduate and postgraduate students.

3. Program Introduction

The mission of the programme is 'to prepare graduates who can perform the jobs of an educator, analyst, and a chemist within sphere of academia, research, development and production. Graduates of the programme will be able to useful personal and technical skills needed to work independently as well as in a team.

4. Program Course Objectives

1. Graduates will demonstrate a foundational knowledge of principles and concepts of chemistry and be able to apply this knowledge to the solution of problems both experimental and theoretical.

2. Graduate of the programme will acquire enough knowledge and skills to pursue higher education and conduct research activities with the help of mentors.

3. Graduates of this programme would be able to conduct qualitative and quantitative chemical analysis using modern instrumental techniques in laboratories for quality and/or process control.

4. Graduate of this programine will be able to generate, evaluate and interpret and communicate scientific data in different formats using modern IT tools.

5. The programme will enable students to conduct meaningful research independently and communicate its outcomes effectively using different platforms.

5. Admission Eligibility Criteria

- Years of Study completed 12 years
- Study Program/Subject F.Sc. Pre-medical (Chemistry, Biology, Physics)
  F.Sc. Pre-Engineering (Physics, Chemistry, Mathematics/Computer Science)
- Percentage/CGPA -----
- Entry Test (if applicable) with minimum requirement No
- Any other (if applicable)

6. Duration of the Program

Semesters/Years/ Credit hours 8/4/------

7. Categorization of Courses as per HEC Recommendation and Difference

Compulsory requirements (The students have no choice)		**General Course to be chosen from other departments**		**Discipline Specific foundation Course**	
Subject	**Cr. Hr.**	**Subject**	**Cr. Hr.**	**Subject**	**Cr. Hr.**
1.English-I (Functional English) 2.English-II (Communication Skills) 3.English-III (Technical Report Writing & presentation skills) 4. English-VI* 5. Pakistan Studies 6. Islamic Studies / Ethics 7. Elementry Mathematics 8. Introduction to Sociology 9. Introduction to computer 10. Translation of Holy Quran 11. Biology	3 3 3 3 2 2 6 2 3 4	1. General Course-I *** 2. General Course-II*** 3. General Course-III *** 4. General Course-IV *** 5. General Course-V *** 6. General Course-VI *** 7. General Course-VII *** 8. General Course-VIII***	3 3 3 3 3 3 3 3	1. Physical Chemistry 2. Inorganic Chemistry 3. Organic Chemistry 4. General Chemistry	4 4 4 4
	31		**24**		**16**

Compulsory courses		**Elective Courses within the major**	
Subject	**Cr. Hr.**	**Subject**	**Cr. Hr.**
1. Major Elective (i) Physical Chemistry (ii) Inorganic Chemistry (iii) Organic Chemistry (iv) Analytical Chemistry / Applied Chemistry / Bio Chemistry	 10 10 10 10	**1. Minor Elective** Physical Chemistry / Inorganic Chemistry / Organic Chemistry / Analytical Chemistry / Applied Chemistry / Bio Chemistry 1. Elective-I Research Project / Internship/ *Optional 2. Elective-II University Option	22 8
	40		**30**
HEC Guidelines	YES		
Difference (HEC) & PU	Lists of Readings Books have been updated and course objectives have been revised. Nevertheless, all the subjects offered strictly follow the HEC Curriculum. However, the HEC recommended syllabus has been adopted.		

**Core: Compulsory, Basic: Foundation, Major Electives: Professional Minor Electives: Specialization*

Note: The course/column heads are customizable according to nature and level of the program.

8. Scheme of Studies / Semester-wise workload

1. Type of course may be core (compulsory), basic (foundation), major elective (professional), minor elective (specialization) etc.
2. There are two combinations
   - Combination – I for Pre – Medical students
   - Combination – II for Pre – Engineering students

Research Thesis / Project /Internship

Details (credit hours, semesters etc.)

9. Award of Degree

Degree awarding criteria stating:

i. Minimum duration 4 Years
ii. Total number of Credit hours (Flexible from 130-141)
iii. Semester duration 16-18 weeks
iv. Semesters 8
v. Course Load per Semester 12-18 Cr hrs
vi. Number of courses per semester 4-6
vii. CGPA percentage required to Qualify
viii. Thesis /Project/Internship

10. NOC from Professional Councils (if applicable)

Provide the status of NOC from the concerned Professional Council(s), if applicable, depending on nature of the program being propose

11. Faculty Strength

Degree	Area/Specialization	Total
PhD	1. Analytical 2. Applied 3. Bio 4. Inorganic 5. Organic 6. Physical	6 5 3 4 5 4
MS/MPhil	1. Physical 2. ……. 3. …….	1
Total		**28**

12. Present Student Teacher Ratio in the Department

STR : 16.5

13. Course Outlines separately for each course.

Checklist for a New Academic Program

Parameters	
1. Department Mission and Introduction	☐
2. Program Introduction	☐
3. Program Alignment with University Mission	☐
4. Program Course Objectivess	☐
5. Market Need/ Rationale	☐
6. Admission Eligibility Criteria	☐
7. Duration of the Program	☐
8. Assessment Criteria	☐
9. Courses Categorization as per HEC Recommendation	☐
10. Curriculum Difference	☐
11. Study Scheme / Semester-wise Workload	☐
12. Award of Degree	☐
13. Faculty Strength	☐
14. NOC from Professional Councils (if applicable)	☐

Program Co-ordinator

Head, School of Chemistry, PU Lahore

BS (Chemistry) 4 years Programme (Combination I)

BS (Chemistry) 4 years Programme is held on Semester System comprising of eight (08) semesters. The Scheme of Study of (1-8 semesters) is given below:

Semester – I

Course Code	Subjects	Course Type	Credit Hours
Eng -101	English – I (Functional English)	Compulsory	3
Ise -101	Islamic Studies	Compulsory	2
Comp -101	Introduction to Computer	Compulsory	3
HQ-001	Translation of Holy Quran	Compulsory	0
Chem-101 & 102	Inorganic Chemistry	Foundation	3 + 1
Bot-101 & 102	Plant Diversity	General	2 + 1
Zool-101 & 102	Invertebrate Diversity	General	2 + 1
Semester Credit Hours			**18**

Semester – II

Course Code	Subjects	Course Type	Credit Hours
Eng-102	English – II (Communication Skills)	Compulsory	3
Pst-101	Pakistan Studies	Compulsory	2
Math-111	Elementary Mathematics-I	Compulsory	3
HQ-002	Translation of Holy Quran	Compulsory	1
Chem-103 & 104	Organic Chemistry	Foundation	3 + 1
Zool-103 & 104	Chordates Diversity	General	2 + 1
Bot-103 & 104	Plant Taxonomy, Anatomy and Development	General	2 + 1
Semester Credit Hours			**19**

Semester – III

Course Code	Subjects	Course Type	Credit Hours
Eng-201	English – III (Technical Report Writing & Presentation Skills)	Compulsory	3
Math-211	Elementary Mathematics-II	Compulsory	3
HQ-003	Translation of Holy Quran	Compulsory	0
Chem-201 & 202	Physical Chemistry	Foundation	3 + 1
Zool-201 & 202	Animal Form & Function–I	General	2 + 1
Bot-201 & 202	Cell Biology, Genetics and Evolution	General	2 + 1
Semester Credit Hours			**16**

Semester – IV

Course Code	Subjects	Course Type	Credit Hours
Eng-202	English – IV (English for Practical Aims)	Compulsory	3
Chem-203 & 204	General Chemistry	Foundation	3 + 1
HQ-004	Translation of Holy Quran	Compulsory	1 + 0
Zool-203 & 204	Animal Form & Function-II	General	2 + 1
Bot-203 & 204	Biodiversity and Conservation	General	2 + 1
Soc-201	Sociology	General	2+0
Semester Credit Hours			**13**

BS (Chemistry) 4 years Program (Combination II)

BS (Chemistry) 4 years Programme is held on Semester System comprising of eight (08) semesters. The Scheme of Study of (1-8 semesters) is given below:

Semester – I

Course Code	Subjects	Course Type	Credit Hours
Eng -101	English – I	Compulsory	3

Ise -101	Islamic Studies	Compulsory	2
Comp -101	Introduction to Computer	Compulsory	3
HQ-001	Translation of Holy Quran	Compulsory	0
Chem-101 & 102	Inorganic Chemistry	Foundation	3 + 1
Phy-101 & 102	Mechanics & Optics	General	2 + 1
Mathematics-101	Calculus – I	General	2 + 1
Semester Credit Hours			**18**

Semester – II

Course Code	Subjects	Course Type	Credit Hours
Eng-102	English – II	Compulsory	3
Pst-101	Pakistan Studies	Compulsory	2
Bio-111	Cell Biology and Biotechnology	Compulsory	3
HQ-002	Translation of Holy Quran	Compulsory	1
Chem-103 & 104	Organic Chemistry	Foundation	3 + 1
Phy-103 & 104	Waves & Oscillation	General	2 + 1
Mathematics-102	Plane curves & Analytic Geometry	General	2 + 1
Semester Credit Hours			**19**

Semester – III

Course Code	Subjects	Course Type	Credit Hours
Eng-201	English – III	Compulsory	3
Bio-211	Evolution, Biodiversity & Ecology	Compulsory	3
HQ-003	Translation of Holy Quran	Compulsory	0
Chem-201 & 202	Physical Chemistry	Foundation	3 + 1
Phy-201 & 202	Electricity & Magnetism	General	2 + 1
Mathematics-201	Linear Algebra	General	2 + 1
Semester Credit Hours			**16**

Semester – IV

Course Code	Subjects	Course Type	Credit Hours
Chem-203 & 204	General Chemistry	Foundation	3 + 1
HQ-004	Translation of Holy Quran	Compulsory	1 + 0
Phy-203 & 204	Concepts of Modern Physics	General	2 + 1
Mathematics-203	Ordinary Differential Equations	General	2 + 1
Soc-201	Introduction to Sociology	General	2+0
Semester Credit Hours			**13**

Common Courses (Combination I & II)

Semester – V

Course Code	Subjects	Course Type	Credit Hours
HQ-005	Translation of Holy Quran	Compulsory	0
Chem-301	Physical Chemistry-I (Electrochemistry)	Compulsory	2
Chem-302	Physical Chemistry-II (Quantum Chemistry)	Compulsory	2
Chem-303	Physical Chemistry Lab	Compulsory	1
Chem-304	Inorganic Chemistry-I (Pi-Acceptor Ligands)	Compulsory	2
Chem-305	Inorganic Chemistry-II (Chemical Bonding Theories)	Compulsory	2
Chem-306	Inorganic Chemistry Lab	Compulsory	1
Chem-307	Organic Chemistry-I (Fundamental Concepts)	Compulsory	2
Chem-308	Organic Chemistry-II (Named Reactions)	Compulsory	2
Chem-309	Organic Chemistry Lab	Compulsory	1
One of the following three optional			
Chem-310	Analytical Chemistry-I (Analytical Data Handling)	Optional	2
Chem-311	Analytical Chemistry-II (Chromatography)	Optional	2
Chem-312	Analytical Chemistry Lab	Optional	1
	Or		
Chem-313	Applied Chemistry-I (Unit Operations & Chemicals)	Optional	2

Chem-314	Applied Chemistry-II (Allied Chemical Industries)	Optional	2
Chem-315	Applied Chemistry Lab	Optional	1
	Or		
Chem-316	Bio Chemistry-I (Carbohydrates)	Optional	2
Chem-317	Bio Chemistry-II (General Biochemistry)	Optional	2
Chem-318	Bio Chemistry Lab	Optional	1

Semester Credit Hours **20**

Semester – VI

Course Code	Subjects	Course Type	Credit Hours
HQ-006	Translation of Holy Quran	Compulsory	1
Chem-319	Physical Chemistry-I (Chemical Kinetics)	Compulsory	2
Chem-320	Physical Chemistry-II (Thermodynamics)	Compulsory	2
Chem-321	Physical Chemistry Lab	Compulsory	1
Chem-322	Inorganic Chemistry-I (Coordination Chemistry)	Compulsory	2
Chem-323	Inorganic Chemistry-II (f-block elements)	Compulsory	2
Chem-324	Inorganic Chemistry Lab	Compulsory	1
Chem-325	Organic Chemistry-I (Reaction Mechanisms-I)	Compulsory	2
Chem-326	Organic Chemistry-II (Spectroscopy)	Compulsory	2
Chem-327	Organic Chemistry Lab	Compulsory	1
Chem-328	Analytical Chemistry-I(Separation Techniques)	Optional	2
Chem-329	Analytical Chemistry-II (Molecular Spectroscopy)	Optional	2
Chem-330	Analytical Chemistry Lab	Optional	1
	Or	**Or**	
Chem-331	Applied Chemistry-I (Water Treatment & Cleansers)	Optional	2
Chem-332	Applied Chemistry-II (Unit Processes & Chemical-I)	Optional	2
Chem-333	Applied Chemistry Lab	Optional	1
	Or	**Or**	
Chem-334	Bio Chemistry-I (Proteins)	Optional	2
Chem-335	Bio Chemistry-II (Nutrition)	Optional	2
Chem-336	Bio Chemistry Lab	Optional	1

Semester Credit Hours **21**

Semester – VII

Course Code	Subjects	Course Type	Credit Hours
HQ-007	Translation of Holy Quran	Compulsory	0
Chem-400	Research / Thesis	Compulsory	4
Chem-401	Physical Chemistry-I (Colloids)	Elective	2
Chem-402	Physical Chemistry Lab – I	Elective	1
Chem-403	Physical Chemistry-II (Surface Chemistry)	Elective	2
Chem-404	Physical Chemistry Lab – II	Elective	1
Chem-405	Physical Chemistry-III (Molecular Spectroscopy)	Elective	2
Chem-406	Physical Chemistry Lab - III	Elective	1
Chem-407	Physical Chemistry-IV (Solution Chemistry)		
	Or		
Chem-408	Inorganic Chemistry-I (Periodicity)	Elective	2
Chem-409	Inorganic Chemistry Lab - I	Elective	1
Chem-410	Inorganic Chemistry-II (Reagents and Solvents)	Elective	2
Chem-411	Inorganic Chemistry Lab - II	Elective	1
Chem-412	Inorganic Chemistry-III (Kinetic & Thermodynamic)	Elective	2
Chem-413	Inorganic Chemistry Lab - III	Elective	1
Chem-414	Inorganic Chemistry-IV (Environmental Aspects)	Elective	2

	Or		
Chem-415	Organic Chemistry-I (Reaction Mechanism-II)	Elective	2
Chem-416	Organic Chemistry Lab - I	Elective	1
Chem-417	Organic Chemistry-II (Oxidation & Reduction)	Elective	2
Chem-418	Organic Chemistry Lab - II	Elective	1
Chem-419	Organic Chemistry-III (Reaction Mechanism-III)	Elective	2
Chem-420	Organic Chemistry Lab - III	Elective	1
Chem-421	Organic Chemistry-IV (NMR Spectroscopy)	Elective	2
	Or		
Chem-422	Analytical Chemistry-I (Electroanalysis Method-I)	Elective	2
Chem-423	Analytical Chemistry Lab – I	Elective	1
Chem-424	Analytical Chemistry-II (Atomic Spectroscopy)	Elective	2
Chem-425	Analytical Chemistry Lab – II	Elective	1
Chem-426	Analytical Chemistry-III (Advance Chromatography)	Elective	2
Chem-427	Analytical Chemistry Lab – III	Elective	1
Chem-428	Analytical Chemistry-IV (Environmental Chemistry)	Elective	2
Chem-429	Applied Chemistry-I (Fuel Chemistry)	Elective	2
Chem-430	Applied Chemistry Lab – I	Elective	1
Chem-431	Applied Chemistry-II (Steel & Metal Finishing)	Elective	2
Chem-432	Applied Chemistry Lab – II	Elective	1
Chem-433	Applied Chemistry-III (Analytical Techniques)	Elective	2
Chem-434	Applied Chemistry Lab – III	Elective	1
Chem-435	Applied Chemistry-IV (Processing Industries)	Elective	2
Chem-436	Bio Chemistry-I (Nucleic Acids)	Elective	2
Chem-437	Bio Chemistry Lab – I	Elective	1
Chem-438	Bio Chemistry-II (Human Physiology)	Elective	2
Chem-439	Bio Chemistry Lab - II	Elective	1
Chem-440	Bio Chemistry-III (Enzymology)	Elective	2
Chem-441	Bio Chemistry Lab – III	Elective	1
Chem-442	Bio Chemistry-IV (Immunochemistry)	Elective	2
Semester Credit Hours			**15**

Semester – VIII

Course Code	Subjects	Course Type	Credit Hours
HQ-008	Translation of Holy Quran	Compulsory	1
Chem-400	Research / Thesis	Compulsory	4
Chem-443	Physical Chemistry-I (Polymer Chemistry)	Elective	2
Chem-444	Physical Chemistry Lab – I	Elective	1
Chem-445	Physical Chemistry-II (UV & Raman Spectroscopy)	Elective	2
Chem-446	Physical Chemistry Lab – II	Elective	1
Chem-447	Physical Chemistry-III (Photochemistry)	Elective	2
Chem-448	Physical Chemistry Lab – II	Elective	1
Chem-449	Physical Chemistry-IV (Nuclear Chemistry)	Elective	2
Chem-450	Inorganic Chemistry-I (Radioactivity)	Elective	2
Chem-451	Inorganic Chemistry Lab – I	Elective	1
Chem-452	Inorganic Chemistry-II (Bio-inorganic Chemistry)	Elective	2
Chem-453	Inorganic Chemistry Lab – II	Elective	1
Chem-454	Inorganic Chemistry-III (Organometallic Chemistry)	Elective	2
Chem-455	Inorganic Chemistry Lab - III	Elective	1
Chem-456	Inorganic Chemistry-IV (Inorganic Polymers)	Elective	2
	Or		
Chem-457	Organic Chemistry-I (Natural Products)	Elective	2

Chem-458	Organic Chemistry Lab – I	Elective	1
Chem-459	Organic Chemistry-II (Organic Synthesis)	Elective	2
Chem-460	Organic Chemistry Lab – II	Elective	1
Chem-461	Organic Chemistry-III (Heterocyclic Chemistry)	Elective	2
Chem-462	Organic Chemistry Lab – III	Elective	1
Chem-463	Organic Chemistry-IV (Reaction Mechanism-IV)	Elective	2
	Or		
Chem-464	Analytical Chemistry-I (Electroanalysis Method-II)	Elective	2
Chem-465	Analytical Chemistry Lab – I	Elective	1
Chem-466	Analytical Chemistry-II (Compound Analysis)	Elective	2
Chem-467	Analytical Chemistry Lab – II	Elective	1
Chem-468	Analytical Chemistry-III (Thermoanalysis Method)	Elective	2
Chem-469	Analytical Chemistry Lab – III	Elective	1
Chem-470	Analytical Chemistry-IV (Conducto/Oscillometry)	Elective	2
	Or		
Chem-471	Applied Chemistry-I (Polymers)	Elective	2
Chem-472	Applied Chemistry Lab – I	Elective	1
Chem-473	Applied Chemistry-II (Agro-industries)	Elective	2
Chem-474	Applied Chemistry Lab – II	Elective	1
Chem-475	Applied Chemistry-III (Textile Industries)	Elective	2
Chem-476	Applied Chemistry Lab – III	Elective	1
Chem-477	Applied Chemistry-IV (Environmental Chemistry)	Elective	2
	Or		
Chem-478	Bio Chemistry-I (Lipids)	Elective	2
Chem-479	Bio Chemistry Lab – I	Elective	1
Chem-480	Bio Chemistry-II (Molecular Biology)	Elective	2
Chem-481	Bio Chemistry Lab – II	Elective	1
Chem-492	Bio Chemistry-III (Microbiology & Drug Metabolism)	Elective	2
Chem-483	Bio Chemistry Lab - III	Elective	1
Chem-484	Bio Chemistry-IV (Biochemical Techniques)	Elective	2

Semester Credit Hours **16**

Combination – I (Pre – Medical Group)
Semester – I

Module Code: Eng - 101
Module title: English-I (Functional English)
Name of Scheme: BS Chemistry (4 Years)
Semester : 1st
Module Type: Compulsory
Module Rating: 3 Credits

1. Introduction of the Course:

The main purpose of this course is to guide students in their first year of learning and impart basic study skills. It is designed with the view to enable them to take immediate control of their learning. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies.

2. Course Objectives

The course aims to:

1. Enhance language skills through grammar, phrases and sentence making.
2. Develop skills for English writing and translation.
3. Enhance listening and speaking skills for wider use

3. Course Contents

Basics of Grammar: Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified

sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verb, Punctuation and spelling.

Comprehension: Answers to questions on a given text.

Discussion: General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students).

Listening: To be improved by showing documentaries/films carefully selected by subject teachers.

Translation skills: Urdu to English

Paragraph writing: Topics to be chosen at the discretion of the teacher.

Presentation skills: Introduction to presentations and deliberations.

Note: *Extensive reading is required for vocabulary building.*

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the Basics of Grammar including Parts of speech and use of articles, Sentence structure, Active and passive voice etc.
2. They will learn about the basic rules of paragraph writing and presentation skills.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Thomson, A.J., Martinet, A.V. 1997. Practical English Grammar and Exercises 3rd Ed. Oxford University Press.
2. Boutin, M-C., Brinand, S., Grellet, F. 1993. Writing. Intermediate and Supplementary Skills. Oxford Fourth Impression.
3. Tomlinson, B., Ellis, R. 1992. Reading. Upper Intermediate. Oxford Supplementary Skills. Third Impression.

Module Code:	Ise - 101
Module title:	Islamic Studies
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Compulsory
Module Rating:	2 Credits

1. Introduction of the Course:

This course will provide basic information about Islamic Studies and will enhance understanding of the students regarding Islamic Civilization

2. Course Objectives:

This course aims to:

1. Provide Basic information about Islamic Studies.
2. Enhance understanding of the students regarding Islamic Civilization.
3. Improve Students skill to perform prayers and other worships.
4. Enhance the skill of the students for understanding of issues related to faith and religious life.

3. **Course Contents:**

Introduction to Quranic Studies: Basic Concepts of Quran: History of Quran; Uloom-ul –Quran.
Seerat of Holy Prophet (S.A.W) I: Life of Muhammad Bin Abdullah (Before Prophet Hood); Life of Holy Prophet (S.A.W) in Makkah; Important Lessons Derived from the life of Holy Prophet in Makkah.

Seerat of Holy Prophet (S.A.W) II: Life of Holy Prophet (S.A.W) in Madina: Important Events of Life Holy Prophet in Madina; Important Lessons Derived from the life of Holy Prophet in Madina.

Introduction to Sunnah: Basic Concepts of Hadith; History of Hadith; Kinds of Hadith; Uloom –ul-Hadith; Sunnah & Hadith; Legal Position of Sunnah.

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence: Basic Concepts of Islamic Law & Jurisprudence; History & Importance of Islamic Law & Jurisprudence; Sources of Islamic Law & Jurisprudence; Nature of Differences in Islamic Law; Islam and Sectarianism.

Islamic Culture & Civilization: Basic Concepts of Islamic Culture & Civilization; Historical Development of Islamic Culture & Civilization; Characteristics of Islamic Culture & Civilization; Islamic Culture & Civilization and Contemporary Issues.

Islam & Science: Basic Concepts of Islam & Science; Contributions of Muslims in the Development of Science; Quran & Science.

Islamic Economic System: Basic Concepts of Islamic Economic System; Means of Distribution of wealth in Islamic Economics; Islamic Concept of Riba; Islamic Ways of Trade & Commerce

Political System of Islam: Basic Concepts of Islamic Political System; Islamic Concept of Sovereignty; Basic Institutions of Govt. in Islam.

Islamic History: Period of Khlaft-E-Rashida**;** Period of Ummayyads**;** Period of Abbasids

Social System of Islam; Basic Concepts of Social System of Islam**;** Elements of Family; Ethical Values of Islam.

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcome:**
   1. Students are expected to get familiarized with the basic Concepts of Quran and History of Quran.
   2. They will learn about the basic concepts of Islam & Science and Contributions of Muslims in the Development of Science**.**

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. **Recommended Readings:**

1. Hameedullah M, “Emergence of Islam”, IRI, Islamabad
2. Hameedullah M, “Muslim Conduct of State”
3. Hameedullah M. ‘Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,”
5. Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.
6. Hasan A.1993. Principles of Islamic Jurisprudence. Islamic Research Institute, International Islamic University,

Islamabad.
7. Waliullah, M.1982. Muslim Jurisprudence and the Quranic Law of Crimes. Islamic Book Service.
8. Bhatia, H.S.1989. Studies in Islamic Law, Religion and Society. Deep & Deep Publications New Delhi
9. Zia-ul-Haq M.2001. Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad.

Module Code:	Comp - 101
Module title:	Introduction to Computer
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

This course is designed in view of the application of computers in wide range of areas. This course would familiarize students with basics of computer and will cover introduction to computer softwares.

2. Course Objectives:

The course is designed:

1. To provide an adequate knowledge about basics of computer.
2. To increase the understanding of the students about the use of different softwares.

3. Course Contents

Contents:

Introduction to Computers

- History of Computer
- Development Uses and Limitations
- Basic Units of Personal Computers

Introduction to Windows

- Why Windows?
- Basic features of Windows Starting up
- Using Applications
- Managing Files and Folders
- Managing the Desktop
- Change Settings

Introduction to MS Word

- Basic features of MS Word
- Typing, editing, formatting text
- Saving and printing
- Making Tables in Word

Introduction to MS Excel

- Basic features Everyday
- Worksheet Tasks
- Creating and Formatting
- Charts Printing Worksheet

Introduction to Power Point

- Basic Features
- Preparing presentations using Power Point

Using Computer for online Literature Search

- E-books
- E-journals
- Data Bases.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic Concepts of computer.
2. They will learn about different softwares.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Maran, R. (1995). Windows 95 simplified. Foster City, C.A: IDG Books World Wide, Inc.
2. Maran, R., & Wing, K. (1997). Teach yourself word 97, Foster City, C.A: IDG Books worldwide, Inc.
3. Nelson, K.Y. (1996). Windows 95 is driving me crazy. Berkeley, CA: Peach Pit Press.
4. Person, R. (1993). Using Excel Version 5 for windows. Indianapolis: Que Corporation.

Module Code:	Bot - 101
Module title:	Botany-I (**Plant diversity**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	General
Module Rating:	2 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about different plant groups with their representatives along with their Taxonomy, Morphology and life cycle patterns. It is generally aimed to familiarize students with the morphological and systematic knowledge of different plant groups, their evolution and Economic importance.

2. Course Objectives

The course is designed:

1. To provide an adequate knowledge about basic concepts of different plant groups and their morphological/anatomical characteristics.
2. To increase the understanding of the students about the diversity of plants, their classification, structure and growth.

3. Course Contents

Contents:

1. General account including morphology, habitat, reproduction and economic signification of: -
   a. Viruses**:** RNA and DNA types with special reference to Tobacco Mosaic Virus (TMV)
   b. Bacteria and Cyanobacteria**:** *Nostoc*, *Oscillatoria*
   c. Algae: *Chlamydomonas, Spirogyra*, *Chara, Pinnularia, Ectocarpus* and *Polysiphonia*
   d. Fungi: *Mucor*, *Penicillium, Phyllactinia, Ustilago, Puccinia* and *Agaricus*, their effects on crop production and industrial applications.
   e. Lichens: *Physcia*
   f. Bryophytes: *Riccia, Anthoceros, Funaria*
   g. Pteridophytes: Fossils and Fossilization, Major Groups and their Affinities, Psilopsida (*Psilotum*), Lycopsida (*Selaginella*), Sphenopsida (*Equisetum*), Pteropsida (*Marsilea*).
   h. Gymnosperms: *Cycas, Pinus* and *Ephedra*
   i. Angiosperms: Dicots and Monocots
2. Seed Habit
3. Fossil and Fossilization

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the morphological and systematic knowledge about different plant groups.
2. They will learn about the general characters, structure, life history, classification and Economic importance of different plant groups.
3. The obtained knowledge will enable students to know the earlier plants, their vegetative and reproductive structures and their importance.
4. This will enable them qualify for basic to moderate level jobs involving knowledge of plants and their environment.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Agrios, G.N. (2004). *Plant Pathology*. (8th Ed.), Academic Press London.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology.* (4th Ed.) John Wiley and Sons, UK.
3. Biswas, C, and Johri, B.M. (1999). *The Gymnosperms.* Narosa Publishing House. New Delhi and London.
4. Lee, E. R. (2007). *Phycology*. (4th Ed.) Cambridge University Press U.K.
5. Mauseth. J.D. (2003). *Botany: An Introduction to Plant Biology.* (3rd Ed.) Jones & Bartlett Pub.UK.
6. Prescott, L.M., Harley, J.P. and Klein, A.D. (2004). *Microbiology*, (3rd Ed.) WM. C. Brown Publishers.
7. Sambamurty, A.V.S.S. (2005). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany.* I.K. International Pvt. Ltd. New Delhi, Banglore, Mumbai. 573 pp.

Module Code:	Bot - 102
Module title:	Botany-I (Botany Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about different plant groups with their representatives along with their Taxonomy, Morphology and life cycle patterns. It is generally aimed to familiarize students with the morphological and systematic knowledge of different plant groups, their evolution and Economic importance.

2. Course Objectives

The course is designed:

1. To provide an adequate knowledge about basic concepts of different plant groups and their morphological/anatomical characteristics.
2. To increase the understanding of the students about the diversity of plants, their classification, structure and growth

3. Course Contents

1. Culturing and staining of microbial types.
2. Maintenance and preservation of cultures of microbes (Bacteria / Cyanobacteria / Algae / Fungi)
3. Identification of various types mentioned in the syllabus from fresh / preserved specimens and prepared slides.
4. Study of morphology and reproductive structures of the types mentioned in theory (Specimens/prepared slides)

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the morphological and systematic knowledge about different plant groups.
2. They will learn about the general characters, structure, life history, classification and Economic importance of different plant groups.

3. The obtained knowledge will enable students to know the earlier plants, their vegetative and reproductive structures and their importance.
4. This will enable them qualify for basic to moderate level jobs involving knowledge of plants and their environment.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. Agrios, G.N. (2004). *Plant Pathology*. (8th Ed.), Academic Press London.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). *Introductory Mycology*. (4th Ed.) John Wiley and Sons, UK.
3. Biswas, C, and Johri, B.M. (1999). *The Gymnosperms*. Narosa Publishing House. New Delhi and London.
4. Lee, E. R. (2007). *Phycology*. (4th Ed.) Cambridge University Press U.K.
5. Mauseth. J.D. (2003). *Botany: An Introduction to Plant Biology.* (3rd Ed.) Jones & Bartlett Pub.UK.
6. Prescott, L.M., Harley, J.P. and Klein, A.D. (2004). *Microbiology*, (3rd Ed.) WM. C. Brown Publishers.
7. Sambamurty, A.V.S.S. (2005). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany.* I.K. International Pvt. Ltd. New Delhi, Banglore, Mumbai. 573 pp.

Module Code:	Chem - 101
Module title:	Chemistry-I (Inorganic Chemistry)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Foundation
Module Rating:	3 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about periodicity, chemical bonding and general concepts of acids and bases.

2. Course Objectives

The course is designed:

1. To introduce students about the key introductory concepts of atomic structure and chemical bonding.
2. To introduce theories of acids and bases.

3. Course Contents

1. **Periodicity**
   Diagonal and vertical relationships of first row elements; Electro negativity of elements (Pauling and Mullikan scales); Polarizability and polarizing power of ions; Periodicity in the properties of outer transition and inner transition elements.
2. **Chemical Bonding**
   Types of chemical Bonding, theories of chemical bonding, and prediction of molecular shapes using valence shell electron pair repulsion (VSEPER) Model, Molecular orbital theory applied to diatomic molecules, bonding in electron deficient compounds.
3. **Acid-Base Concept:**
   General concept of acids and bases, detail of Lewis concept of acids and bases, Soft and Hard acid-base (SHAB) concept and its application, relative strength of acids and bases based on PKa value, Leveling effect, reaction of acids and bases, relationship between redox reactions and acid base reaction, Indicators and theory of indicators.
4. **Chemistry of d- Block Element:**
   Electronic configuration and oxidation states of transition elements, Nomenclature & theories of coordination compounds, Valence Bond Theory (VBT), Molecular Orbital Theory (MOT), and Crystal Field Theory (CFT) for octahedral complexes, Chelates, Applications of Coordination compounds.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion

3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get acquire the basic knowledge of determining molecular shapes.
2. They will be able to understand the concepts of acids and bases and use them efficiently.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Cotton, F, Albert, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3rd Edition (1995).
2. Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, "Vogel's text book of Quantitative Chemical analysis", 5th Education, Benjamin Cummings, (1989).
3. Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991).
4. Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th Edition (1996).
5. Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
6. Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992).
7. Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2nd Edition (1996).

Module Code:	Chem - 102
Module title:	Chemistry - I (Inorganic Chemistry Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Foundation
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about periodicity, chemical bonding and general concepts of acids and bases.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of atomic structure and chemical bonding.
2. To introduce theories of acids and bases.

3. Course Contents:

- Basic Introduction to preparation of different types of Solutions.

ARGENTOMETRY

MOHR,S Method

- Determine the % purity of NaCl.
- Determine the amount of Cl^{-1} in given sample solution.

REDOX TITRATIONS

- Determine the amount/dm^3 of $FeSO_4.7H_2O$ hydrate using potassium dichromate.
- Determine of % of Iron in ferric Alum using $K_2Cr_2O_7$.
- Determination of no. of water molecules in $FeSO4.xH_2O$ using $K_2Cr_2O_7$.

ACID BASE TITRATIONS

- Determine the strength of given acid/base solution.

SALT ANALYSIS

- Separation and identification of two acid and two basic radicals from a mixture of two salts.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion

3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get acquire the basic knowledge of determining molecular shapes.
2. They will be able to understand the concepts of acids and bases and use them efficiently.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Cotton, F, Albert, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3rd Edition (1995).
2. Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, "Vogel's text book of Quantitave Chemical analysis", 5th Education, Benjamin Cummings, (1989).
3. Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991).
4. Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th Edition (1996).
5. Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
6. Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992).
7. Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2nd Edition (1996).

Module Code:	Zool - 101
Module title:	Zoology-I (**Invertebrate Diversity**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	General
Module Rating:	2 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of classification of organisms and their evolutionary relationships.

3. Course Contents

INVERTEBRATE DIVERSITY:

Classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization. Biodiversity.

Animal-Like Protists: The Protozoa:

Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; symbiotic ciliates; further phylogenetic considerations.

Multicellular and Tissue Levels of Organization:

Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera:
cell types, and skeletons; body forms; maintenance functions. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class.
Phylum ctenophora; further phylogenetic considerations.

The Triploblastic, Acoelomate Body Plan:

Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations.

The Pseudocoelomate Body Plan: Aschelminths:

Evolutionary perspective; general characteristics; classification up to phyla; Some important nematode parasites of humans; further phylogenetic considerations.

Molluscan Success:

Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. Diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations.

Annelida: The Metameric Body Form:

Evolutionary perspective: metamerism and tagmatization; classification up to class. External structure and locomotion, feeding.

The Arthropods:

Evolutionary perspective: classification and relationships to other animals; classification up to class.

The Hexapods and Myriapods:

Insect and humans; further phylogenetic considerations.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

Students are expected to get acquire the basic knowledge of classification of organisms and their evolutionary relationships.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Campbell, N.A., 2002. Biology 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
2. Hickman, C.P., Roberts, L.S. and Larson, A., 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Kent, G.C. and Miller, S., 2001. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
4. Miller, S.A. and Harley, J.B., 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
5. Pechenik, J.A., 2000. Biology of Invertebrates, 4th Edition (International). Singapore: McGraw Hill.

Module Code:	Zool - 102
Module title:	Zoology – I (Zoology Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of classification of organisms and their evolutionary relationships.

3. Course Contents:

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, Paramecium as representative of animal like protists. (Prepared slides).
2. Study of sponges and their various body forms.
3. Study of principal representative classes of phylum Coelentrata.
4. Study of principal representative classes of phylum Platyhelminthes.
5. Study of representative of phylum Rotifera, phylum Nematoda.

6. Study of principal representative classes of phylum Mollusca.
7. Study of principal representative classes of phylum Annelida.
8. Study of principal representative classes of groups of phylum Arthropoda.
9. Brief notes on medical/economic importance of the following: Silkworm, Citrus butterfly.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get acquire the basic knowledge of classification of organisms and their evolutionary relationships.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Campbell, N.A., 2002. Biology 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
2. Hickman, C.P., Roberts, L.S. and Larson, A., 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Kent, G.C. and Miller, S., 2001. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
4. Miller, S.A. and Harley, J.B., 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
5. Pechenik, J.A., 2000. Biology of Invertebrates, 4th Edition (International). Singapore: McGraw Hill.

Semester – II

Module Code:	Eng - 103
Module title:	ENGLISH – II (Communicatio Skills)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

The main purpose of this course is to guide students in their first year of learning and impart basic study skills. It is designed with the view to enable them to take immediate control of their learning. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies.

2. Course Objectives:

The course aims to:

1. Enable the students to meet their real-life communication needs.

3. Course Contents:

Paragraph writing: Practice in writing a good, unified and coherent paragraph.
Essay writing: Introduction.
CV and job application: Translation skills; Urdu to English.
Study skills: Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension.
Academic skills: Letter/memo writing, minutes of meetings, use of library and internet.
Presentation skills: Personality development (emphasis on content, style and pronunciation).
Note: documentaries to be shown for discussion and review.

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the Basics of Grammar including Parts of speech and use of articles, Sentence structure, Active and passive voice etc.
2. They will learn about the basic rules of paragraph writing and presentation skills.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Boutin, Marie-Christine, Brinandm, S., Grellet, F. 1993. Writing: Intermediate. Oxford Supplementary Skills. Fourth Impression.
2. Langan, J. Reading and Study Skills by RichardYork.
3. Nolasco, R. 1992. Writing: Upper-Intermediate. Oxford Supplementary Skills. Fourth Impression (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
4. Thomson, A.J., Martinet, A.V. 1986. Practical English Grammar Exercises 2. 3rd Ed. Oxford University Press.
5. Tomlinson, B., Ellis, R. 1991. Reading. Advanced Oxford Supplementary Skills. Third Impression.

Module Code:	Pk - 101
Module title:	Pakistan Studies
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Compulsory
Module Rating:	2 Credits

1. Introduction of the Course:

The main purpose of this course is to guide students about historical perspective, government, politics, contemporary Pakistan and ideological background of Pakistan.

2. Course Objectives:

The course aims to:

1. Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
2. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

3. Course Contents:

Historical Perspective: Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah; Factors leading to Muslim separatism; People and Land: Indus Civilization, Muslim advent, Location and geo-physical features.

Government and Politics in Pakistan: Political and constitutional phases: 1947-58; 1958-71; 1971-77; 1977-88; 1988-99; 1999onward.

Contemporary Pakistan: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the foreign policy of Pakistan and challenges and Futuristic outlook of Pakistan
2. They will learn about the Government and Politics in Pakistan.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Ansar, Z. 1980. History & Culture of Sindh. Karachi: Royal Book Company.
2. Aziz, K.K. 1976. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research.
3. Burke, S.M., Ziring L. 1993. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.
4. Javed, B. S. 1980. State and Society in Pakistan. The Macmillan Press Ltd.
5. Khalid Bin Sayeed. 1967. The Political System of Pakistan. Boston: Houghton Mifflin.
6. Lawrence, Z. 1980. Enigma of Political Development. Kent England: WmDawson & sons Ltd.
7. Noor ul Haq. 1993. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research.
8. Rafique A. M. 1998. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
9. Safdar, M. 1994. Pakistan Political Roots & Development. Lahore.
10. Safdar, M. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e- Islamia, Club Road.
11. Tahir, A. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
12. Wayne, W. 1972. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research.
13. Waseem, M. 1987. Pakistan Under Martial Law, Lahore: Vanguard.
14. Zaidi A.S. 2000. Issue in Pakistan's Economy. Karachi: Oxford University Press.

Module Code:	Chem - 103
Module title:	Chemistry – II (Organic Chemistry)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Foundation
Module Rating:	3 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about basic concepts in organic chemistry including chemistry of hydrocarbons and different functional groups.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of organic chemistry
2. To introduce about hydrocarbons and different functional groups.

3. Course Contents

1. Basic concept in Organic Chemistry

Localized and Delocalized bonding, conjugation and hyperconjugation; applications, resonance, resonance energy, rules of resonance, resonance hybrid, factor effecting the resonance, inductive effect and applications, steric effect and its applications, hydrogen bonding and its effect on various properties of organic compounds, tautomerism.

2. Chemistry of Hydrocarbons

Preparation of alkanes from coupling alkyl halide and alkyl boranes, corey house synthesis, Free radical reactions of alkenes with halogens with mechanism, comparison of reactivities of halogens.

Preparations of alkenes from Pyrolytic elimination reactions. Relative stability and reactivity of alkenes in terms of Hoffmann and Sytzeff rules, reaction of alkenes i.e.g simon-smith and Diels- Alder reactions.

Preparation of alkynes by alkylation of terminal alkynes, reaction of alkynes; hydroboration and hydration and

formation of metal acetylides with mechanism.

Aromaticity, criteria for aromaticity, poly aromatic hydrocarbons like; benzene, naphthalene, antharacene and phenantharene, their resonance structures and relative stabilities, synthesis of naphthalene, orientation and reactivity of naphthalene, electrophilic substitution of naphthalene, oxidation and reduction reaction of naphthalene.

3. Chemistry of Functional Groups

Alcohols: preparation of alcohols by reduction of carbonyl compounds, reaction of alcohol with metals, organic and inorganic acid, oxidation, difference between primary secondary and tertiary alcohols.

Phenols: synthesis of phenols, physical properties, reactions like; carbonation, formylation and diazo coupling

Ethers: preparation of ethers from alcohols, alkyl halides and alkenes, physical properties, reactions of ethers.

Carboxylic acids: Physical properties of acids, effect of various parameters on the strength of aliphatic and aromatic acids, chemical properties like: nucleophilic acyl substitution, decarboxylation, Hunsdicker reaction, substitution at α- carbon.

Acetoacetic and malonic ester synthesis.

Alkyl Halides: Preparation of alkyl halides from carboxylic acids, Nucleophilic substitution (SN1 & SN2) and elimination reactions (E1 & E2) of alkyl halides, effect of various parameters on rate of substitution and elimination reactions.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic concepts of organic chemistry.
2. They will learn about the fundamentals of hydrocarbons and different functional groups.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. C.K. Ingold, “Structure and mechanism in organic chemsitry”, C.B.S.
2. I.L.Finar, “Organic Chemistry”, Vol. I, Pearson Education, L.P.E.
3. I.L.Finar, “Organic Chemistry”, Vol. II, 5th Edition, L.P.E.
4. Jerry March, “Advanced Organic Chemistry, Reaction, Mechanism and Structure”, 5th Edition, Wiley Inter Science.
5. Morison and Boyd, “Organic Chemistry”, 6th Edition, Prentice Hall.
6. Seyhan N. Ege, “Organic Chemistry Structure and Reactivity”, 3rd Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
7. Thomas H. Lowry, Kathleen Schueller Richardson “Mechanism and Theory in Organic Chemistry”, 3rd Edition, Harper and Row Publishers, New York.
8. Alder, Baker, Brown, “Mechanism in Organic Chemistry”, Wiley Publishers.
9. Atkins Carey, “Organic Chemistry”, A Brief Course, 2nd Edition.
10. Peter Sykes, “A guide book to mechanism in organic chemistry”, 6th Edition, Pearson Education, Singapore.

Module Code:	Chem - 104
Module title:	Chemistry – II (Organic Chemistry Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Foundation
Module Rating:	1 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about basic concepts in organic chemistry including chemistry of hydrocarbons and different functional groups.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of organic chemistry
2. To introduce about hydrocarbons and different functional groups.

3. Course Contents

Practicals:

1) Compound Analysis

Identification of organic compounds containing only one functional group with special emphasis on compounds containing following functional groups.

-COOH, -OH, C=O, -NH2, and –CONH2

2) Basic Experimental techniques used in organic chemistry

- Filtration
- Simple and fractional distillation
- Solvent extraction
- Sublimation
- Re-crystallization

3) Estimations (volumetric)

- Determination of molecular weight of a carboxylic acid.

Estimation of glucose.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic concepts of organic chemistry.
2. They will learn about the fundamentals of hydrocarbons and different functional groups.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. C.K. Ingold, “Structure and mechanism in organic chemsitry”, C.B.S.
2. I.L.Finar, “Organic Chemistry”, Vol. I, Pearson Education, L.P.E.
3. I.L.Finar, “Organic Chemistry”, Vol. II, 5th Edition, L.P.E.
4. Jerry March, “Advanced Organic Chemistry, Reaction, Mechanism and Structure”, 5th Edition, Wiley Inter Science.
5. Morison and Boyd, “Organic Chemistry”, 6th Edition, Prentice Hall.
6. Seyhan N. Ege, “Organic Chemistry Structure and Reactivity”, 3rd Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
7. Thomas H. Lowry, Kathleen Schueller Richardson “Mechanism and Theory in Organic Chemistry”, 3rd Edition, Harper and Row Publishers, New York.
8. Alder, Baker, Brown, “Mechanism in Organic Chemistry”, Wiley Publishers.
9. Atkins Carey, “Organic Chemistry”, A Brief Course, 2nd Edition.
10. Peter Sykes, “A guide book to mechanism in organic chemistry”, 6th Edition, Pearson Education, Singapore.

Module Code:	Bot - 103
Module title:	Botany – II (**Plant Taxonomy, Anatomy And Development**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd

Module Type: General
Module Rating: 2 Credits

1. Introduction of the Course:

The course is organized to provide an introduction to plant taxonomy, history of classification, introduction to nomenclature and International Code. It also includes morphological Study of plant families, anatomical study of cell wall and the Internal Structure (Tissues) of the Plant Body

2. Course Objectives:

The course is designed:

1. To provide an adequate knowledge about basic concepts of different plant groups and their morphological/anatomical characteristics.
2. To give an insight to the basic concepts of Plant taxonomy and its role in classification.

3. Course Contents

1. Taxonomy:

1.1. Introduction to Plant Taxonomy: Aims, Objectives and Importance.

1.2. Classification: Brief History of Various Systems of Classification (Artificial, Natural and Phylogenetic) withemphasis on Takhtajan's system of Classification.

1.3. Nomenclature: Introduction: Importance of Latin Names and Binomial Nomenclature with an Introduction to International Code of Botanical Nomenclature (ICBN), St. Louis Code.

1.4. Morphology: Brief Account of various morphological characters of root, stem, leaf, Inflorescence, Flower, Placentation and Fruit Types.

1.5. Diagnostic Characters: Economic Importance and Distribution Patterns of the following Families: Ranunculaceae, Brassicaceae, Fabaceae, Rosaceae, Euphorbiaceae, Cucurbitaceae, Solanaceae, Lamiaceae, Apiaceae, Asteraceae, Liliaceae, Poaceae.

2. Anatomy:

2.1. Cell Wall: Cell Wall Structure and Chemical Composition.

2.2. Simple Tissues: Parenchyma, Collenchyma, Sclerenchyma.

2.3. Epidermis: Epidermis and Epidermal Appendages including Stomata.

2.4. Complex Tissues: Xylem, Phloem.

2.5. Meristem: Types of Meristems, Stem and Root Apices, Secondary Meristem, Vascular Cambium and Periderm.

2.6. Structure and Development of Primary Root and Stem, Structure of Leaf.

3. Developmental Embryology:

Capsella bursa-pastoris: Structure of Anther, Microsporogenesis, Microgametophyte, Structure of Ovule, Megasporogenesis, Megagametophyte, Endosperm Formation.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the morphological and systematic knowledge about different plant groups.
2. They will be able to learn about the history of Plant Systematics and its role in classification.
1. The obtained knowledge shall also enable the students to make use of this knowledge for the identification and grouping of different plants based on the anatomy.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Esau, K. (1960). Anatomy of Seed Plants. John Wiley and Sons, New York.

2. Fahn, A. (1990). Plant Anatomy. Pergamum Press Oxford.
3. Foster, F. (2002). Practical Plant Anatomy. John Wiley and Sons, New York.
4. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens P.F. and Donoghue, M.J. (2015). Plant Systematics; A phylogenetic Approach, Sinauer, US.
5. Lawrence, G.H.M. (2007). *Taxonomy of Vascular Plants.* (2nd Ed.). MacMillan and Co. New York.
6. Maheshawari, P. (1971). Embryology of Angiosperms. McGraw Hill. New York.
7. Mauseth, J.D. (1998). An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Publisher. UK.
8. Moore, R.C., Clark, W.D. and Vodopich, D.S. (2003). *Botany.* McGraw Hill Company, U.S.A.
9. Panday, B.P. (2004). A Text Book of Botany (Angiosperms). S. Chand and Co. New Delhi.
10. Raven, P.H., Even, R.E. & Eichhom, S.E. (2010). *Biology of Plants.* W.H. Freeman and Company worth Publisher.
11. Raymond, F. and Eicbhorn, S.E. (2005). *Esau's Plant Anatomy. Meristematic cells and tissue of the plant body*, (3rd Ed.) John Wiley and Sons Inc. New York.
12. Simpson, M. G. (2018). Plant Systematics (3rd edition). Elsevier Academic Press, UK.
13. Singh, G. (2016). Plant Systematics; An Integrated Approach (3rd edition), University of Dehli, India.
14. Zahur, M.S. (1992). *The Taxonomy of Angiosperms.* Al-Hejaz Printers. Lahore.

Module Code:	Bot - 104
Module title:	Botany – II (Botany Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an introduction to plant taxonomy, history of classification, introduction to nomenclature and International Code. It also includes morphological Study of plant families, anatomical study of cell wall and the Internal Structure (Tissues) of the Plant Body.

2. Course Objectives

The course is designed:

1. To provide an adequate knowledge about basic concepts of different plant groups and their morphological/anatomical characteristics.
2. To give an insight to the basic concepts of Plant taxonomy and its role in classification.

3. Course Contents

Practicals:

1. Identification of Families with the help of keys
2. Description of Flowers (in technical terms) of following Families: Ranunculaceae, Brassicaceae, Fabaceae, Rosaceae, Euphorbiaceae, Cucurbitaceae, Solanaceae, Lamiaceae, Apiaceae, Asteraceae, Liliaceae and Poaceae.
3. Field tours shall be undertaken to study and collect local plants. Students are required to submit Forty (40) fully identified herbarium specimens.
4. Study of Epidermis, Stomata and Trichomes.
5. Study of Simple Tissues from fresh material and prepared slides as well.
6. Study of Complex Tissues (Xylem), Maceration and Study of Xylem from Macerated Material.
7. Study of a Transverse Section of Stem and Leaf of Angiosperm

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the morphological and systematic knowledge about different plant groups.
2. They will be able to learn about the history of Plant Systematics and its role in classification.
3. The obtained knowledge shall also enable the students to make use of this knowledge for the identification and grouping

of different plants based on the anatomy.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. Recommended Readings:
2. Esau, K. (1960). Anatomy of Seed Plants. John Wiley and Sons, New York.
3. Fahn, A. (1990). Plant Anatomy. Pergamum Press Oxford.
4. Foster, F. (2002). Practical Plant Anatomy. John Wiley and Sons, New York.
5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens P.F. and Donoghue, M.J. (2015). Plant Systematics; A phylogenetic Approach, Sinauer, US.
6. Lawrence, G.H.M. (2007). Taxonomy of Vascular Plants. (2nd Ed.). MacMillan and Co. New York.
7. Maheshawari, P. (1971). Embryology of Angiosperms. McGraw Hill. New York.
8. Mauseth, J.D. (1998). An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Publisher. UK.
9. Moore, R.C., Clark, W.D. and Vodopich, D.S. (2003). Botany. McGraw Hill Company, U.S.A.
10. Panday, B.P. (2004). A Text Book of Botany (Angiosperms). S. Chand and Co. New Delhi.
11. Raven, P.H., Even, R.E. & Eichhom, S.E. (2010). Biology of Plants. W.H. Freeman and Company worth Publisher.
12. Raymond, F. and Eicbhorn, S.E. (2005). Esau's Plant Anatomy. Meristematic cells and tissue of the plant body, (3rd Ed.) John Wiley and Sons Inc. New York.
13. Simpson, M. G. (2018). Plant Systematics (3rd edition). Elsevier Academic Press, UK.
14. Singh, G. (2016). Plant Systematics; An Integrated Approach (3rd edition), University of Dehli, India.
15. Zahur, M.S. (1992). The Taxonomy of Angiosperms. Al-Hejaz Printers. Lahore.

Module Code:	Math - 111
Module title:	Elementary Mathematics – I (Algebra)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

This course is designed in view of the algebra and Quadratic Equations. This course would familiarize students with basics of sequence and series.

2. Course Objectives

The course aims to:

1. Prepare the students with the essential tools of algebra.
2. Develop skills to apply the concepts and the techniques.

3. Course Contents

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.
Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.
Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.
Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.
Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.
Trigonometry: Fundamentals of trigonometry, trigonometric identities.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work

4. Seminar/ Workshop

5. **Learning Outcome:**
   1. Students are expected to get familiarized with the mathematical induction, binomial theorem with rational and irrational indices.
   2. They will learn about the fundamentals of trigonometry and trigonometric identities.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. **Recommended Readings:**
   1. Dolciani, M.P., Wooton, W., Beckenback, E.F., Sharron, S.1978. Algebra2 and Trigonometry, Houghton & Mifflin.
   2. Kaufmann, J.E., 1987. College Algebra and Trigonometry. PWS-Kent Company, Boston.
   3. Swokowski, E.W.1986. Fundamentals of Algebra and Trigonometry. 6th Ed., PWS-Kent

Module Code:	Zool - 103
Module title:	Zoology – II (Chordates Diversity)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	General
Module Rating:	2 Credits

1. **Introduction of the Course:**
   The course is organized to provide an adequate knowledge about chordates and their diversity.

2. **Course Objectives**
   The course is designed:
   1. To introduce students about the chordates and their evolutionary perspectives.
   2. To introduce about characters and classification of Chordates.

3. **Course Contents**

CHORDATES DIVERSITY:

Echinoderms:

Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, and chaetognaths.

Invertebrates, Hemichordates & Chordates: Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations.

Fishes: Vertebrate Success in Water:

Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; further phylogenetic considerations.

Amphibians: The First Terrestrial Vertebrates:

Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: further phylogenetic considerations.

Reptiles: The First Amniotes:

Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhynchocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, further phylogenetic considerations.

Birds: Feathers, Flight and Endothermy:

Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the migration and navigation.

Mammals: Specialized Teeth, Endothermy, Hair and Viviparity:

Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic concepts of chordates diversity.
2. They will learn about the fundamentals of characters and classification of different chordates.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Miller, S.A. and Harley, J.B., 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S. and Larson, A., 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Pechenik, J.A., 2000. Biology of Invertebrates, 4th Edition (International). Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S., 2001. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
5. Campbell, N.A., 2002. Biology Sixth Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc

Module Code:	Zool - 104
Module title:	Zoology – II (Zoology Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about chordates and their diversity.

2. Course Objectives

The course is designed:

1. To introduce students about the chordates and their evolutionary perspectives.
2. To introduce about characters and classification of Chordates.

3. Course Contents

Practicals:

Chordates Diversity:

1. Study of a representative of hemichordate and invertebrate chordate.
3. Study of representative groups of class fishes.
4. Study of representative groups of class Amphibia.
5. Study of representative groups of class Reptilia.
6. Study of representative groups of class Aves.
7. Study of representative groups of class Mammalia.
8. Field trips to study animal diversity in an ecosystem.

Developmental Biology-I

1. Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
2. Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
3. Study of preserved advanced stages of avian and mammalian development for amniotic membranes and placenta (Model).

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion

3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic concepts of chordates diversity.
2. They will learn about the fundamentals of characters and classification of different chordates.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Miller, S.A. and Harley, J.B., 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S. and Larson, A., 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Pechenik, J.A., 2000. Biology of Invertebrates, 4th Edition (International). Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S., 2001. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
5. Campbell, N.A., 2002. Biology Sixth Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc

Semester – III

Module Code:	Eng - 201
Module title:	**English – III (Technical Report Writing & Presentation Skills)**
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

The main purpose of this course is to guide students about presentation skills including essay writing. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies.

2. Course Objectives:

The course aims to:

1. Enhance language skills.
2. Develop critical thinking.

3. Course Contents:

Presentation skills: Essay writing: Descriptive, narrative, discursive, argumentative.
Academic writing: How to write a proposal for research paper/term paper How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency).
Technical Report writing Progress report writing
Note: Extensive reading is required for vocabulary building

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the Basics of presentation skills.
2. They will learn about the basic rules of paragraph writing and essay writing.

6. **Assessment Strategies**:
    1. Lecture Based Examination (Objective and Subjective)
    2. Assignments
    3. Class discussion
    4. Quiz
    5. Tests

7. Recommended Readings:

1. Kirszner. L.G., Mandell, S. R. Patterns of College Writing. 4th Ed. by St. Martin's Press.
2. Langan, J. 2004. College Writing Skills McGraw-Hill Higher Education.
3. Neulib, J., Cain, K. S., Ruffus, S., Scharton, M. (Editors). Reading. The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. (A reader that will give students exposure to the best of twentieth century literature).
4. White, R. 1992. Writing. Advanced. Oxford Supplementary Skills. Third Impression (particularly suitable for discursive, descriptive, argumentative and report writing).

Module Code:	Chem - 201
Module title:	**Chemistry – III (Physical Chemistry**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	Foundation
Module Rating:	3 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about basic concepts in Physical chemistry including thermodynamics, chemical kinetics etc.

2. Course Objectives:

The course is designed:

1. To introduce students about the key concepts of physical chemistry
2. To introduce about thermodynamics, chemical kinetics etc.

3. Course Contents

Theory

1. **Chemical Thermodynamic**

   Equation of states, ideal and real gases, the vander waals equation for real gases, critical phenomena and critical constants.

   Extensive and intensive properties, molar heat capacities, second law of thermodynamics, concept of entropy, entropy change in reversible and irreversible process, entropy change for an ideal gas, entropy change due to mixing of ideal gases, effect of temperature and pressure on entropy, concept of free energy, effect of temperature and pressure on free energy, relationship between standard free energy and equilibrium constants.

2. **Chemical Kinetics**

   Derivation of kinetics expression of zero order, first order, second order (with same and different concentrations), nuclear decay as first order reaction, derivations for determining rate constants and half life periods, measurement of order of the reaction with different methods, Arrhenius equation and determination of various Arrhenius parameters.

3. **Solutions and Colloids**

   Physical properties of liquids, surface tension, viscosity, refractive index etc.

   Osmotic pressure and its measurements, abnormal colligative properties (association and dissociation of solutes), fractional distillation and concept of azeotrops, concept of colloids, classification of colloids, dialysis, electro-dialysis, sedimentation, precipitation, ultra filtration, emulsions and gels, tyndall cone effect.

4. **Surface Chemistry**

   Interface, Adsorption, types of adsorption at liquid surface, adsorption isotherms (Freundlich and Langmuir), catalysis, and kinetics of enzyme catalysis.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion

3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

Students are expected to get familiarized with the with the basic concepts of Physical chemistry like chemical thermodynamics, solution chemistry and surface chemistry.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Adamson A. W. "Understanding Physical Chemistry" 3rd Ed., Benjamin Cummings Publishing Company Inc.
2. Akhtar M.N.& Ghulam Nabi, "Textbook of Physical Chemistry", ilmi Kutab Khana, Lahore. 3. Bhatti H.N. and K.Hussain, "Principles of Physical Chemistry"; Carwan Book House, Lahore.
3. Maron S.H. & B. Jerome, "Fundamentals of Physical Chemistry", Macruthan Publishing Co., Inc. New York. (Also published by National Book Foundation).
4. Atikins P.W.& M.J.Clugston, "Principles of Physical Chemistry" Pitman Publishing Company (1988).
5. Moore W.J. "Physical Chemistry", 5th Ed. Longmans Publishers.
6. Jones M. "Elements of Physical Chemistry" Addison-Sesky Publishing Company.
7. G.M.Barrow, International six Edition "Physical Chemistry".
8. IRA. N. Levine fourth edition "Physical Chemistry"
9. Alberty and Danials, "Physical Chemistry"
10. Castallon, "Physical Chemistry"
11. Laidler & Meiser "Physical Chemistry"
12. Friemental "Chemistry in Action"

16.

Module Code:	Chem - 202
Module title:	Chemistry – III (Physical Chemistry Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	Foundation
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about basic concepts in Physical chemistry including thermodynamics, chemical kinetics etc.

2. Course Objectives:

The course is designed:

1. To introduce students about the key concepts of physical chemistry
2. To introduce about thermodynamics, chemical kinetics etc.

3. Course Contents

Lab

1. Preparation of standard molar, normal, molal and percentage solutions.
2. Standardization of secondary standard acids and bases solutions by volumetric methods.
3. Determination of surface tension, parachor and percentage composition by surface tension measurement.
4. Determination of viscosity, rheochor and percentage composition by viscosity measurement.
5. Determination of refractive index, molar refractivity and percentage composition by refractive index method.
6. Conductometeric and potentiometric strong acid-base titrations using conductometer and pH meter respectively.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

Students are expected to get familiarized with the with the basic concepts of Physical chemistry like chemical thermodynamics, solution chemistry and surface chemistry.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. Adamson A. W. "Understanding Physical Chemistry" 3rd Ed., Benjamin Cummings Publishing Company Inc.
2. Akhtar M.N.& Ghulam Nabi, "Textbook of Physical Chemistry", ilmi Kutab Khana, Lahore. 3. Bhatti H.N. and K.Hussain, "Principles of Physical Chemistry"; Carwan Book House, Lahore.
3. Maron S.H. & B. Jerome, "Fundamentals of Physical Chemistry", Macruthan Publishing Co., Inc. New York. (Also published by National Book Foundation).
4. Atikins P.W.& M.J.Clugston, "Principles of Physical Chemistry" Pitman Publishing Company (1988).
5. Moore W.J. "Physical Chemistry", 5th Ed. Longmans Publishers.
6. Jones M. "Elements of Physical Chemistry" Addison-Sesky Publishing Company.
7. G.M.Barrow, International six Edition "Physical Chemistry".
8. IRA. N. Levine fourth edition "Physical Chemistry"
9. Alberty and Danials, "Physical Chemistry"
10. Castallon, "Physical Chemistry"
11. Laidler & Meiser "Physical Chemistry"
12. Friemental "Chemistry in Action"

Module Code:	Bot - 201
Module title:	Botany – III (**Cell Biology, Genetics and Evolution**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	General
Module Rating:	2 Credits

1. Introduction of the Course:

This course is planned to provide adequate knowledge about morphology and functioning of cell, cellular organelles and mechanisms of cell division, study of genes and their inheritance patterns and concept of evolution. It is generally aimed to familiarize students with the cell structure and its functioning along with basic concepts of genetics.

2. Course Objectives:

The course is designed:

1. To provide an adequate knowledge about basic concepts of different parts of cells and their morphological/anatomical characteristics along with their functions.
2. To provide basics of Genetics and Evolution.

3. Course Contents

1. Cell Biology:

1.1. Structures and brief description of biomolecules, carbohydrates, lipids, proteins, nucleic acids.

1.2. Cell: Physico-chemical nature of plasma membrane and cytoplasm.

1.3. Ultrastructure of plant cell with a brief description and functions of the following organelles: Endoplasmic

reticulum, Plastids, Mitochondria, Ribosomes, Dictyosomes, Vacuole, Microbodies (Glyoxysomes and Peroxisomes)

1.4 Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis;

1.5. Reproduction in somatic and embryogenic cell; Mitosis and meiosis; Cell cycle;

1.6. Chromosomal aberrations; Changes in the number of chromosomes, aneuploidy and euploidy; Changes in the structure of chromosomes, deletion, duplication, inversion and translocation, special types of chromosomes, Chromosome systems (parthenogenesis and apomixis).

2. Genetics and Evolution:

2.1. Introduction, scope and brief history of genetics.

2.2. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross; Dominance and incomplete dominance.

2.3. Sex linked inheritance, Sex Linkage in *Drosophila* and Man (Color blindness), XO, XY, WZ mechanisms, Sex limited and sex linked characters, Sex determination.

2.4. Linkage and crossing over; Linkage groups, Construction of linkage maps, Detection of linkage.

2.5. Recombination; DNA replication; Nature of gene, Genetic code; Transcription, Translation.

2.6. Regulation of gene expression (*e.g. lac* operon).

2.7. Transmission of genetic material in bacteria; conjugation and gene recombination in co-transduction and transformation;

2.8. Principles of genetic engineering, basic genetic engineering techniques;

2.9. The process and concept of evolution, theories of origin in life, historic idea of evolution, sources of variability, different mechanisms of gene change, role of gene mutation in evolution.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcomes:

1. Students are expected to get familiarized with the morphological and anatomical concepts about different cell parts.
2. They will be able to describe, apply and integrate the basic concepts of Cell Biology including Genetics and Evolution, Biochemistry, Physiology as well as Structure and Functions of different Organelles.
3. This will enable them qualify for basic to moderate level jobs involving general knowledge of Biology.
4. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to botany.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Bretscher, A. (2007). *Molecular Cell Biology.* W. H. Freeman and Company
2. Carroll, S. B., Grenier, J. K. and Velnerbee S. D. (2001). From DNA to Diversity—Molecular Genetics and the Evolution of Aminal Design. Blackwell Science.
3. Dyonsager, V. R. (2000). *Cytology and Genetics*. (3rd Ed.), TATA and McGraw Hill Publication Co. Ltd, New Delhi.
4. Gilmartin, P. M. and Bowler, C. (2002). *Molecular Plant Biology*. (Vol. 1 & 2). Oxford University Press. UK.
5. Griffiths, J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. and W. M. Gelbart (2010). *An Introduction to Genetic Analysis*. W.H. Freeman and Company.
6. Hoelzel, A. R. (2001). *Conservation Genetics*. Kluwer Academic Publishers.
7. Karp, G. (2002). *Cell and Molecular Biology*. Concepts and Experiments. (4th Ed.), John Wiley and Sons. New York.
8. Lodish, H. (2001). *Molecular Cell Biology*. W.H. Freeman and Company.
9. Sinha, U. and Sinha S. (2003). *Cytogenesis, Plant Breeding and Evolution.* Vini Educational Books, New Delhi.
10. Strickberger, M. V. (2003). *Genetics*. MacMillan Press Ltd., London.
11. Weaver, R. F. (2008). *Molecular Biology*. McGraw Hill, St. Louis.

Module Code:	Math - 211
Module title:	**Elementary Mathematics-II (Calculus)**
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	General
Module Rating:	3 Credits

1. Introduction of the Course:

The course provides information about Preliminaries, Limits and Continuity and Derivatives and their Applications.

2. Course Objectives:

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

3. Course Outline:

1. Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.
2. Limits and Continuity: Limit of a function, left-hand and righthand limits, continuity, continuous functions.
3. Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.
4. Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

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

Module Code:	Zool - 201
Module title:	Zoology – III (**Animal Form And Function- I**)

Name of Scheme: BS Chemistry (4 Years)
Semester : 3rd
Module Type: General
Module Rating: 2 Credits

1. Introduction of the Course:

The Objectives of the courses are:

1. To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

2.

Course Objectives:

The Objectives of the courses are:

1. To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

3.

Course Outline:

1. Protection, Support, and Movement:
- Protection: the integumentary system of invertebrates and vertebrates;
- Movement and support: the skeletal system of invertebrates and vertebrates;
- Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates

2. Communication I:
- Nerves: Neurons: structure and function.

3. Communication II:
- Senses: Sensory reception: baroreceptors,chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates
- Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

4. Communication III:
- The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action
- Hormones with principal function each of Porifera, Cnidarians, Platyhelminthes, Nemerteans, Nematodes, Molluscs, Annelids, Arthropods, and Echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

5. Circulation and Immunity:
- Internal transport and circulatory systems in invertebrates
- Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells
- transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response

4. Teaching-learning Strategies

1. Lectures

2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principlesof Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
3. Miller, S.A. and Harley, J.B. 2002. Zoology, 5th Ed. (International), Singapore: McGraw-Hill.
4. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California:Benjamin/Cummings Publishing
5. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. NewYork: McGraw-Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology. Singapore: McGraw-Hill.

Module Code:	Zool - 202
Module title:	Zoology – III (**Animal Form And Function- I**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2.

Course Objectives:

The Objectives of the courses are:

1. To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

3. Course Contents

Practicals:

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales,feathers and mammalian skin.
2. Study and notes of skeleton of Labeo (*Labeo rohita)*, Frog (*Hoplobatrachus tigerinus*), Varanus (*Varanus bengalensis)*, fowl*(Gallus gallus domesticus)* andrabbit (*Oryctolagus cuniculus)*.

Note: Exercises of notes on the adaptations of skeletons to their function must be done.

3. Earthworm or leech; cockroach, freshwater mussel, Channa or Catla catla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.
4. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7.

Books Recommended:

1. Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principlesof Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
3. Miller, S.A. and Harley, J.B. 2002. Zoology, 5th Ed. (International), Singapore: McGraw-Hill.
4. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California:Benjamin/Cummings Publishing
5. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. NewYork: McGraw-Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology. Singapore: McGraw-Hill.

Semester - IV

Module Code:	Eng – 202
Module title:	English IV (English for Practical Aims)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2. Course Objectives:

The course is designed:

To introduce students about the key introductory concepts of classification of organisms and their evolutionary relationships.

3. Course Contents

Professional Correspondence

- CV and covering letter.
- Follow up messages after the job interview.

Recommended Reading:

- Murphy, Herta A. Effective Business Communication. 7th Ed. New Delhi: Tata McGraw-Hill Publishing Company Limited, 2009 (Page 504-529, 540-548).

Advanced Reading and Comprehension II

- The students are required to read the given prose critically and answer the questions.
- Recommended Reading:
- (Rise. B. Axelrod. and Cooper, Charles R. The St. Martin's Guide to Writing New York: St. Martin's Press, 1985. Page 146-147, 152-155, 158-172).

Job Interviews

- The students should learn to handle job interviews through "mock interviews". Recommended Reading:
- Murphy, Herta A. Effective Business Communication. 7th Ed. New Delhi: Tata McGraw-Hill Publishing Company Limited, 2009. (Page 539-539).

Essay Writing

- The students should be able to compose essays of 4 to 6 paragraphs relying on what they have learnt in the previous semesters about paragraph writing. (Word Limitabout 500 words).

Vocabulary Building Skills

- WORD ROOT METHOD Unit 12-17. Page No. 116-131.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcomes:

1. Students are expected to get familiarized with the morphological and anatomical concepts about different cell parts.
2. They will be able to describe, apply and integrate the basic concepts of Cell Biology including Genetics and Evolution, Biochemistry, Physiology as well as Structure and Functions of different Organelles.
3. This will enable them qualify for basic to moderate level jobs involving general knowledge of Biology.
4. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to botany.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. RecommendedReading:Idrees, Muhammad. Guide for GAT General Test. Smart Brain GRE (General, Local). 2010-2011 ed. Lahore: Dogar Brother Publishers, 2010

Module Code:	Chem - 203
Module title:	Chemistry – IV (General Chemistry)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	Foundation

Module Rating: 3 Credits

1. **Introduction of the Course:**
   The course is organized to provide an adequate knowledge about basic concepts in General chemistry including spectroscopy, chemistry of biomolecules etc.

2. **Course Objectives:**
   The course is designed:
   1. To introduce students about the key concepts of general chemistry
   2. To introduce students about chemistry of biomolecules and their use in industries.

3. **Course Contents:**
   1. **Spectroscopy**
      Electromagnetic radiation and its interaction with matter, Development of spectroscopic analytical techniques employing various transitions, Basic introduction to atomic and molecular spectroscopic techniques include flame emission, spectrophotometry, UV/VIS and IR spectroscopies.
   2. **Chemical industries and Metallurgies**
      Raw materials, manufacturing process and flow sheet diagrams of; Glass, Sugar, Urea
      Metallurgies of; copper and iron.

   3. **Chemistry of Biomolecules**
      Basic introduction to Carbohydrates, lipids, proteins and nucleic acids, their classification, importance and different reactions..

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcomes:**
   1. Students are expected to get familiarized with the concepts of general chemistry.
   2. This will enable them qualify for basic to moderate level jobs involving general knowledge of Chemistry.
   3. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to chemistry.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. **Recommended Readings:**

   1. Adamson A. W. “Understanding Physical Chemistry” 3rd Ed. Benjamin Cummings publishing company Inc.
   2. Akhtar M.N. & Ghulam Nabi, “Textbook of Physical Chemistry” ilmi kutab khana, Lahore. 3. Bhatti H.N. and K. Hussain, “Principles of Physical Chemistry”; Carwan Book House, Lahore.
   3. Shriver, D.F., P.W. Atkins and C.H. Langford, “Inorganic Chemistry”; Oxford, 2nd Ed. (1996).
   4. Snarp, A.G. “Inorganic Chemistry”, Longman, 3rd Edition (1992).
   5. Rayner Canham, Gelof, “Descriptive Inorganic Chemistry” & Co. (1995).
   6. Daniel R. Pallers, “Experimental Organic Chemistry, John Willey & Sons” Inc., 2009.
   7. James A. Moore, “Experimental methods in Organic Chemistry” Holt-Saunders Int. 1983. 9. R.L. Shriner, R.C. Fuson, D.IV. Curtin and T.C. Morrill “The systematic Identification of organic compounds, 6th ed. John Willey & sons, 1979.

Module Code: Chem - 204
Module title: Chemistry – IV (General Chemistry Lab)

Name of Scheme: BS Chemistry (4 Years)
Semester : 4th
Module Type: Foundation
Module Rating: 1 Credits

1. **Introduction of the Course:**
The course is organized to provide an adequate knowledge about basic concepts in General chemistry including spectroscopy, chemistry of biomolecules etc.

2. **Course Objectives:**
The course is designed:
   1. To introduce students about the key concepts of general chemistry
   2. To introduce students about chemistry of biomolecules and their use in industries.

3. **Course Contents**
Practicals:
   1. Preparation of buffer solutions.
   2. Determine the lambda max of the given compounds spectrophotometrically. (i.e $KMNO_4$, $K_2Cr_2O_7$)
   3. Determine the concentration of unknown sample solution spectrophotometrically (i.e $KMNO_4$, $K_2Cr_2O_7$)
   4. Calibration of measuring apparatus e.g pipette, burette, measuring cylinder and measuring flask.
   5. Purification of the compounds using common ion effect.
   6. Separate the Given mixture of ink by paper chromatography.
   7. Qualitative and quantitative analysis of carbohydrates, lipids and proteins.

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcomes:**
   1. Students are expected to get familiarized with the concepts of general chemistry.
   2. This will enable them qualify for basic to moderate level jobs involving general knowledge of Chemistry.
   3. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to chemistry.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. **Recommended Readings:**

   1. Adamson A. W. “Understanding Physical Chemistry” 3rd Ed. Benjamin Cummings publishing company Inc.
   2. Akhtar M.N. & Ghulam Nabi, “Textbook of Physical Chemistry” ilmi kutab khana, Lahore. 3. Bhatti H.N. and K. Hussain, “Principles of Physical Chemistry”; Carwan Book House, Lahore.
   3. Shriver, D.F., P.W. Atkins and C.H. Langford, “Inorganic Chemistry”; Oxford, 2nd Ed. (1996).
   4. Snarp, A.G. “Inorganic Chemistry”, Longman, 3rd Edition (1992).
   5. Rayner Canham, Gelof, “Descriptive Inorganic Chemistry” & Co. (1995).
   6. Daniel R. Pallers, “Experimental Organic Chemistry, John Willey & Sons” Inc., 2009.
   7. James A. Moore, “Experimental methods in Organic Chemistry” Holt-Saunders Int. 1983. 9. R.L. Shriner, R.C. Fuson, D.IV. Curtin and T.C. Morrill “The systematic Identification of organic compounds, 6th ed. John Willey & sons, 1979.

Module Code: Bot - 203
Module title: Botany – IV (Plant Physiology And Ecology)
Name of Scheme: BS Chemistry (4 Years)
Semester : 4th

Module Type: General
Module Rating: 1 Credits

1. Introduction of the Course:

The course is organized to cover physiological processes involved in plant interaction with the environment, including water relations, gas exchange, photosynthesis, respiration, energy balance, mineral nutrition, responses to the environment and plant hormones. It is generally aimed to familiarize students with the ecological concepts focusing on biotic and abiotic factors involved in establishing plant communities.

2. Course Objectives:

The course is designed:

1. To provide an adequate knowledge about basic concepts of plant physiology.
2. To understand abiotic and biotic factors of the environment and interactions of plants with these factors

3. Course Contents

Practicals:

a) Plant Physiology:

1. Determination of Uptake of Water by Swelling Seeds when placed in Sodium Chloride Solution of Different Concentrations.
2. Determination of the Temperature at which Beet Root Cells lose their permeability.
3. Determination of the effects of environmental factors on the rate of transpiration of a Leafy shoot by means of a photometer by Cobalt Chloride Paper Method.
4. Extraction of Chlorophyll from the leaves and Separation of Component Pigments on a Paper Chromatogram.
5. Study of Absorption Spectra using Spectrophotometer.
6. Extraction of Amylase from Germinating Wheat Seeds and study of its effect on Starch Break Down.
7. Effect of Light and Temperature on Seed Germination.

b) Ecology:

1. Determination of Physical and Chemical Characteristics of Soil
2. Measurement of Light and Temperature
3. Measurement of Vegetation by Quadrat and Line Intercept Methods
4. Measurements of Wind Velocity
5. Field Trips to Ecologically Diverse Habitats.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students will be familiarized with the basic functioning of plants.
2. They will be able to conduct and interpret measurements using a variety of instruments and methods
3. They will be able to analyze and present quantitative results in graphs and tables**.**
4. This will enable them qualify for basic to moderate level jobs involving knowledge of plants and their environment.
5. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving environment.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

<u>Plant Physiology:</u>

1. Annual Review of Plant Biology (http://www.annualreviews.org/journal/arplant).
2. Buchanan, B. B., Gruissem, W. and Jones, R. L. (2015). *Biochemistry and Molecular Biology of Plants*. Wiley-Blackwell. ISBN: 978-0-470- 71421-8 1280pp

3. Current protocols in Plant Biology (http://www.currentprotocols.com/WileyCDA/Section/id-810246.html).
4. Grotewold, E., Chappell, J. and Kellogg, E. A. (2015). *Plant Genes, Genomes, and Genetics*. Wiley-Blackwell ISBN: 978-1-119-99888
5. Jones, R. L., Ougham, H., Thomas, H. and Waaland, S. (2012). The Molecular Life of Plants. Wiley Blackwell. ISBN: 978-0-470-87011-2012 766pp
6. Plant Physiology and Development (http://6e.plantphys.net/)
7. Plant Physiology (http://www.plantphysiol.org/).
8. Taiz, L., Zeiger, E., Møller, I.M. and Murphy A. (2015). *Plant Physiology and Development,* 6th Edition. Sinauer Associates Inc., Sunderland MA. ISBN: 0-87893-831-1,700pp
9. Teaching tools in Plant Biology (http://www.plantcell.org/content/teaching-tools-plant-biology).
10. The Arabidopsis Book (https://aspb.org/publications/other-aspb-publications/the arabidopsis-book/).
11. The Plant Cell (http://www.plantcell.org/site/teachingtools/).

Plant Ecology:

1. Barbour, M.O., Burke, H.J. and Pitts, D.W. (1999). *Terrestrial Plant Ecology*. The Benjamin, Cumming Publishing Co. California, USA.
2. Chapman, J. L. and Reiss, M. J. (1995). *Ecology; Principles and Applications*. Cambridge University Press. U.K.
3. Hussain, F. (1999). *Field and Laboratory Manual of Plant Ecology*. National Academy of Higher Education, Islamabad.
4. Krebs, C. J. (1997). *Ecology and Field Biology*. Addison Wesley Longman Inc, New York.
5. Odum, E.P. (1970). Basic Ecology. V/B. Saunders. Philadelphia.
6. Rick, R. E. (2000). *Ecology.* (1st Ed.). W.H. Freeman and Company, U.K.
7. Schultz, E. (2005). *Plant Ecology.* 2nd Ed. Springer-Verlag, Berlin.
8. Smith, R. L. (2002). *Ecology and Field Biology.* Harper and Row Publishers, New York.
9. Smith, R. L. (2000). *Elements of Ecology*. Harper and Row Publishers, New York.
10. Subrahmanyam, N.S. and Sambamurthy. A.V.S.S. (2000). *Ecology.* Narosa Publishing House, New Delhi.
11. Townsend, C.R., Harper, J.L. and Begon, M.E. (2000). *Essentials of Ecology*. Blackwell Scientific Publications, U.K...

Module Code:	Soc - 211
Module title:	Introduction to Sociology
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	General
Module Rating:	2 Credits

1. **Introduction of the Course:**
   The course is organized to provide an adequate knowledge about sociology and social interactions.
2. **Course Objectives:**
   The course is designed:
   To introduce students about the key introductory concepts of sociology, structuralism, social action, culture and socialization.

3. **Course Contents**

Introduction
- What is sociology
- Sociology & other social sciences
- Sociology & Common sense/Stereotypes
- Key terms – Social Problem/Sociological Issues
- Sociological Perspective

Structuralism
- Structural Functionalism
- Social Conflict

Social Action
- Symbolic Interactionism

Culture
- What is culture?
- Elements of Culture
- Cultural Diversity

Socialization
- Socialization & its importance

- Agents of Socialization
- Socialization through the life course
- C.H. Cooley
- George Herbert Mead

Social Interaction

- Social Structure
- Status
- Status Set
- Achieved & Ascribed
- Master Status
- Role
- Role Set
- Role Conflict
- Role Strain

Theories of Social Interaction (Brief)

- Social Construction of Reality
- Ethno methodology

Groups & Organizations

- Types of Groups
- Studies of Group Behaviour
- Bureaucracy & its Characteristics
- Deviance
- Deviance, Crime & Social Control
- Types of Crime

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcomes:

1. Students are expected to get familiarized with the structure of society.
2. They will be able to describe socialization, Social Interaction and Theories of Social Interaction.
3. This will enable them to understand Groups & Organizations

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Anderson, Margaret and Howard F. Taylor. (2001) Sociology the Essentials.Australia: Wadsworth.
2. Brown, Ken. (2004). Sociology. UK: Polity Press
3. idden, Anthony (2002). Introduction to Sociology. UK: Polity Press.
4. Macionis, John J. (2006). Sociology. 10 th ed. New Jersey: Prentice-Hall
5. Tischler, Henry L. (2002). Introduction to Sociology. 7th ed. New York:

Module Code:	Zool - 203
Module title:	Zoology – IV (**Animal Form And Function–II**)
Name of Scheme:	BS Chemistry (4 Years)

Semester : 4th
Module Type: General
Module Rating: 2 Credits

1. **Introduction of the Course:**
The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2. **Course Objectives**
Objectives of the courses are:
1. To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

3. **Course Contents**
Course Outline:
1. Nutrition and Digestion:
- Evolution of nutrition; the metabolic fates ofnutrients in heterotrophs; digestion
- Animal strategies for getting and usingfood, diversity in digestive structures of invertebrates.
- The mammalian digestive system: gastrointestinal motility and its control
- Oral cavity, pharynx and oesophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gall bladder in digestion.

2. Temperature and Body Fluid Regulation:
- Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals;
- Heat Production in Birds and Mammals
- Control of Water and Solutes (Osmoregulation and Excretion);
- Invertebrate and Vertebrate
- Excretory Systems; how vertebrates achieve osmoregulation; vertebrate kidney variations; mechanism in metanephric kidney functions. Reproduction and Development

3. Reproduction:
- Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction;
- Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes;
- The human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function;
- The human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function;hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.

4. **Teaching-learning Strategies**
1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. **Learning Outcome:**
1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.

5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International),Singapore: McGraw-Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principlesof Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
3. Miller, S.A., Harley, J.B. 2002. Zoology, 5th Ed. (International),Singapore: McGraw-Hill.
4. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
5. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. NewYork: McGraw-Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology. Singapore: McGraw-Hill.

Module Code:	Zool - 204
Module title:	Zoology – IV (Zoology Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2. Course Objectives

Objectives of the courses are:

1. To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

3. Course Contents

Practicals:

1. Study of excretory system in an invertebrate and avertebrate representative (Model).
2. Study of dissection system in invertebrate and a vertebrate representative (Dissection).
3. Dissection and study of male and female reproductive system in vertebraes and invertebrates.

Note: Prepared slides and preserved specimen and/or projection slidesand/or CD ROM computer projections may be used..

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International),Singapore: McGraw-Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principlesof Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
3. Miller, S.A., Harley, J.B. 2002. Zoology, 5th Ed. (International),Singapore: McGraw-Hill.
4. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
5. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. NewYork: McGraw-Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology. Singapore: McGraw-Hill..
7. Sinha, U. and Sinha S. (2003). *Cytogenesis, Plant Breeding and Evolution.* Vini Educational Books, New Delhi.

Combination – II (Pre – Engineering Gropup)

Semester - I

Module Code:	Eng - 101
Module title:	English-I (Functional English)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

The main purpose of this course is to guide students in their first year of learning and impart basic study skills. It is designed with the view to enable them to take immediate control of their learning. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies.

2. Course Objectives

The course aims to:

1. Enhance language skills through grammar, phrases and sentence making.
2. Develop skills for English writing and translation.
3. Enhance listening and speaking skills for wider use

3. Course Contents

Basics of Grammar: Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verb, Punctuation and spelling.

Comprehension: Answers to questions on a given text.

Discussion: General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping

in view the level of students).

Listening: To be improved by showing documentaries/films carefully selected by subject teachers.

Translation skills: Urdu to English

Paragraph writing: Topics to be chosen at the discretion of the teacher.

Presentation skills: Introduction to presentations and deliberations.

Note: *Extensive reading is required for vocabulary building.*

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the Basics of Grammar including Parts of speech and use of articles, Sentence structure, Active and passive voice etc.
2. They will learn about the basic rules of paragraph writing and presentation skills.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Thomson, A.J., Martinet, A.V. 1997. Practical English Grammar and Exercises 3rd Ed. Oxford University Press.
2. Boutin, M-C., Brinand, S., Grellet, F. 1993. Writing. Intermediate and Supplementary Skills. Oxford Fourth Impression.
3. Tomlinson, B., Ellis, R. 1992. Reading. Upper Intermediate. Oxford Supplementary Skills. Third Impression.

Module Code:	Ise - 101
Module title:	Islamic Studies
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Compulsory
Module Rating:	2 Credits

1. Introduction of the Course:

This course will provide basic information about Islamic Studies and will enhance understanding of the students regarding Islamic Civilization

2. Course Objectives:

This course aims to:

1. Provide Basic information about Islamic Studies.
2. Enhance understanding of the students regarding Islamic Civilization.
3. Improve Students skill to perform prayers and other worships.
4. Enhance the skill of the students for understanding of issues related to faith and religious life.

3. Course Contents:

Introduction to Quranic Studies: Basic Concepts of Quran: History of Quran; Uloom-ul –Quran.
Seerat of Holy Prophet (S.A.W) I: Life of Muhammad Bin Abdullah (Before Prophet Hood); Life of Holy Prophet (S.A.W) in Makkah; Important Lessons Derived from the life of Holy Prophet in Makkah.

Seerat of Holy Prophet (S.A.W) II: Life of Holy Prophet (S.A.W) in Madina: Important Events of Life Holy Prophet in Madina;

Important Lessons Derived from the life of Holy Prophet in Madina.

Introduction to Sunnah: Basic Concepts of Hadith; History of Hadith; Kinds of Hadith; Uloom –ul-Hadith; Sunnah & Hadith; Legal Position of Sunnah.

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence: Basic Concepts of Islamic Law & Jurisprudence; History & Importance of Islamic Law & Jurisprudence; Sources of Islamic Law & Jurisprudence; Nature of Differences in Islamic Law; Islam and Sectarianism.

Islamic Culture & Civilization: Basic Concepts of Islamic Culture & Civilization; Historical Development of Islamic Culture & Civilization; Characteristics of Islamic Culture & Civilization; Islamic Culture & Civilization and Contemporary Issues.

Islam & Science: Basic Concepts of Islam & Science; Contributions of Muslims in the Development of Science; Quran & Science.

Islamic Economic System: Basic Concepts of Islamic Economic System; Means of Distribution of wealth in Islamic Economics; Islamic Concept of Riba; Islamic Ways of Trade & Commerce

Political System of Islam: Basic Concepts of Islamic Political System; Islamic Concept of Sovereignty; Basic Institutions of Govt. in Islam.

Islamic History: Period of Khlaft-E-Rashida**;** Period of Ummayyads**;** Period of Abbasids
Social System of Islam; Basic Concepts of Social System of Islam**;** Elements of Family; Ethical Values of Islam.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic Concepts of Quran and History of Quran.
2. They will learn about the basic concepts of Islam & Science and Contributions of Muslims in the Development of Science**.**

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Hameedullah M, “Emergence of Islam”, IRI, Islamabad
2. Hameedullah M, “Muslim Conduct of State”
3. Hameedullah M. ‘Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,”
5. Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.
6. Hasan A.1993. Principles of Islamic Jurisprudence. Islamic Research Institute, International Islamic University, Islamabad.
7. Waliullah, M.1982. Muslim Jurisprudence and the Quranic Law of Crimes. Islamic Book Service.
8. Bhatia, H.S.1989. Studies in Islamic Law, Religion and Society. Deep & Deep Publications New Delhi
9. Zia-ul-Haq M.2001. Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad.

Module Code:	Comp - 101
Module title:	Introduction to Computer
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Compulsory
Module Rating:	3 Credits

1. **Introduction of the Course:**
   This course is designed in view of the application of computers in wide range of areas. This course would familiarize students with basics of computer and will cover introduction to computer softwares.
2. **Course Objectives:**
   The course is designed:
   1. To provide an adequate knowledge about basics of computer.
   2. To increase the understanding of the students about the use of different softwares.
3. **Course Contents**
   Contents:
   Introduction to Computers
   - History of Computer
   - Development Uses and Limitations
   - Basic Units of Personal Computers

   Introduction to Windows
   - Why Windows?
   - Basic features of Windows Starting up
   - Using Applications
   - Managing Files and Folders
   - Managing the Desktop
   - Change Settings

   Introduction to MS Word
   - Basic features of MS Word
   - Typing, editing, formatting text
   - Saving and printing
   - Making Tables in Word

   Introduction to MS Excel
   - Basic features Everyday
   - Worksheet Tasks
   - Creating and Formatting
   - Charts Printing Worksheet

   Introduction to Power Point
   - Basic Features
   - Preparing presentations using Power Point

   Using Computer for online Literature Search
   - E-books
   - E-journals
   - Data Bases.

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcome:**
   1. Students are expected to get familiarized with the basic Concepts of computer.
   2. They will learn about different softwares.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments

3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Maran, R. (1995). Windows 95 simplified. Foster City, C.A: IDG Books World Wide, Inc.
2. Maran, R., & Wing, K. (1997). Teach yourself word 97, Foster City, C.A: IDG Books worldwide, Inc.
3. Nelson, K.Y. (1996). Windows 95 is driving me crazy. Berkeley, CA: Peach Pit Press.
4. Person, R. (1993). Using Excel Version 5 for windows. Indianapolis: Que Corporation.

Module Code:	Math – 101
Module title:	Mathematics A-I (Calculus (I))
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	General
Module Rating:	3 Credits

1. Introduction of the Course:

The goal of this course is for students to gain proficiency in calculus computations. In calculus, we use three main tools for analyzing and describing the behavior of functions: limits, derivatives, and integrals. Students will use these tools to solve application problems in a variety of settings ranging from physics and biology to chemistry and economics.

2. Course Objectives

Upon successful completion of this course, students will be able to:

- Compute limits, derivatives, and integrals.
- Analyze functions using limits, derivatives, and integrals.

1. • Recognize the appropriate tools of calculus to solve applied problems.

3. Course Contents

1. Preliminaries

- Real numbers and the real line.
- Functions and their graphs.
- Shifting and scaling graphs.
- Solution of equations involving absolute values.
- Inequalities.
- Complex numbers system. Polar form of complex numbers, De Moivr's theorem.
- Circular function, hyperbolic functions, logarithmic.

2. Limit and Continuity

- Limit of a function, left hand and right hand limits, Theorems of limits.
- Continuity, Continuous functions.

3. Derivatives and its Applications.

- Differentiable functions.
- Differentiation of polynomial, rational and transcendental functions.
- Mean value theorems and applications.
- Higher derivatives, Leibniz's theorem.
- L'Hospitals Rule.
- Intermediate value theorem, Rolle's theorem.
- Taylor's and Maclaurin's theorem with their remainders.

4. Integration and Definite Integrals

- Techniques of evaluating indefinite integrals.
- Integration by substitutions, Integration by parts.
- Change of variable in indefinite integrals.
- Definite integrals, Fundamental theorem of calculus.
- Reduction formulas for algebraic and trigonometric integrands.
- Improper integrals, Gamma functions.

1.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion

3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Solve tangent and area problems using the concepts of limits, derivatives, and integrals.
2. Draw graphs of algebraic and transcendental functions considering limits, continuity, and differentiability at a point.
3. Determine whether a function is continuous and/or differentiable at a point using limits.
4. Use differentiation rules to differentiate algebraic and transcendental functions.
5. Identify appropriate calculus concepts and techniques to provide mathematical models of real-world situations and determine solutions to applied problems.
6. Evaluate definite integrals using the Fundamental Theorem of Calculus.
7. Demonstrate an understanding of the relationship between derivatives and integrals using the Fundamental Theorem of Calculus.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. Thomas, Calculus, 11 th Edition. Addison Wesley Publishing Company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition, John Wiley & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's outlines series, 4th Edition,1999.
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry, Prentice Hall, Inc. 1988.
6. E. W. Swokowski, Calculus and Analytic Geometry, PWS Publishers, Boston, Massachosetts, 1983.
7. Calculus: Concepts and Contexts, 4th edition, James Stewart, Brooks/Cole. ISBN 9781111027308.

Module Code:	Chem - 101
Module title:	Chemistry-I (Inorganic Chemistry)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Foundation
Module Rating:	3 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about periodicity, chemical bonding and general concepts of acids and bases.

2. Course Objectives

The course is designed:

1. To introduce students about the key introductory concepts of atomic structure and chemical bonding.
2. To introduce theories of acids and bases.

3. Course Contents

1. **Periodicity**
   Diagonal and vertical relationships of first row elements; Electro negativity of elements (Pauling and Mullikan scales); Polarizability and polarizing power of ions; Periodicity in the properties of outer transition and inner transition elements.
2. **Chemical Bonding**
   Types of chemical Bonding, theories of chemical bonding, and prediction of molecular shapes using valence shell electron pair repulsion (VSEPER) Model, Molecular orbital theory applied to diatomic molecules, bonding in electron deficient compounds.
3. **Acid-Base Concept:**

General concept of acids and bases, detail of Lewis concept of acids and bases, Soft and Hard acid-base (SHAB) concept and its application, relative strength of acids and bases based on PKa value, Leveling effect, reaction of acids and bases, relationship between redox reactions and acid base reaction, Indicators and theory of indicators.

4. **Chemistry of d- Block Element:**
   Electronic configuration and oxidation states of transition elements, Nomenclature & theories of coordination compounds, Valence Bond Theory (VBT), Molecular Orbital Theory (MOT), and Crystal Field Theory (CFT) for octahedral complexes, Chelates, Applications of Coordination compounds.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get acquire the basic knowledge of determining molecular shapes.
2. They will be able to understand the concepts of acids and bases and use them efficiently.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Cotton, F, Albert, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3rd Edition (1995).
2. Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, "Vogel's text book of Quantitative Chemical analysis", 5th Education, Benjamin Cummings, (1989).
3. Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991).
4. Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th Edition (1996).
5. Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
6. Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992).
7. Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2nd Edition (1996).

Module Code:	Chem - 102
Module title:	Chemistry - I (Inorganic Chemistry Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	Foundation
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about periodicity, chemical bonding and general concepts of acids and bases.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of atomic structure and chemical bonding.
2. To introduce theories of acids and bases.

3. Course Contents:

- Basic Introduction to preparation of different types of Solutions.

ARGENTOMETRY

MOHR,S Method

- Determine the % purity of NaCl.

- Determine the amount of Cl^{-1} in given sample solution.

REDOX TITRATIONS

- Determine the amount/dm^3 of $FeSO_4.7H_2O$ hydrate using potassium dichromate.
- Determine of % of Iron in ferric Alum using $K_2Cr_2O_7$.
- Determination of no. of water molecules in $FeSO4.xH_2O$ using $K_2Cr_2O_7$.

ACID BASE TITRATIONS

- Determine the strength of given acid/base solution.

SALT ANALYSIS

- Separation and identification of two acid and two basic radicals from a mixture of two salts.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get acquire the basic knowledge of determining molecular shapes.
2. They will be able to understand the concepts of acids and bases and use them efficiently.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Cotton, F, Albert, Goeffrey Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry", John, Wiley & Sons Ine, 3rd Edition (1995).
2. Jefferey, G.H., j. bassett, J.Mendham and R.C. Denney, "Vogel's text book of Quantitave Chemical analysis", 5th Education, Benjamin Cummings, (1989).
3. Jolly, William, L., "Modem Inorganic Chemistry", McGraw Hill, 2nd Edition (1991).
4. Lee, J.D., "Modem Inorganic Chemistry", Champan & Hall, 5th Edition (1996).
5. Rayner Canham, Geiof., "Descriptive Inorganic Chemistry" & Co. (1995).
6. Sharp, A.G. "Inorganic Chemistry", Longman, 3rd Edition (1992).
7. Shriver, D.F., P.W. Atkins and C.H. Langford, "Inorganic Chemistry", Oxford, 2nd Edition (1996).

Module Code:	Phy - 101
Module title:	Physics-I (**Mechanics & Optics**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	1st
Module Type:	General
Module Rating:	2 Credits

1. Introduction of the course:

This course is to provide the student a clear and a logical presentation of the basic concepts and principles of mechanics. Another aim of this course is associating the real world with physics to improve a better understanding of its concepts and principles, specially with the set of physical laws describing the motion of bodies under the action of a system of forces, the motion of macroscopic objects, from projectiles to parts of machinery, as well as astronomical objects, such as spacecraft, planets, stars and galaxies.

2. Course Objectives:

In this course, we study the physics of motion from the ground up – learning the basic principles of physical laws and their application to the behavior of objects. Mechanics studies statics, kinematics (motion), dynamics (forces), energy, and momentum developed prior to the 1900 from the physics of Galileo and Isaac Newton.

3. Course Contents

Mechanics Vector Operations

Vector in 3 dimensions; Vector derivatives and operation; Gradient, Divergence and Curl of a vector; Divergence Theorem; Stokes Theorem.

Particle Dynamic

Advanced application of Newton's laws Dynamics of Uniform motion; Equations of motion; Time dependent forces; Effect of drag forces on motion; Non inertial frames and pseudo forces; Non inertial frames and Pseudo forces; Limitations of Newton's Laws.

Work, Energy and Power

Work done by a constant force, work done by a variable force (1-dimensions); Work done by a variable (2-dimension) Work energy theorem, General proof of work energy theorem. Power: Reference Frames.

Conservation of Energy

Conservative, and non conservative forces; One dimensional conservative system; 2,3 dimensional conservative system; Conservation of energy in a system of particles system two practical system. Center of mass of solid object; Momentum changes in system of variable mass.

Collisions

Inelastic collision conservation of momentum during collision in center of Mass reference frame.

Rotational Dynamics

Angular momentum; angular velocity; Overview of rotational Dynamics; Parallel axis theorem; Determination of momentum of interstice of various shapes; Rotational dynamics of rigid bodies; combined rotational and transitional motion. Stability of spinning objects, the spinning Top.

Gravitation

Review of basic concepts of gravitation. Gravitational effect of a spherical mass distribution; Gravitational Potential Energy; Gravitational field & potential; Universal Gravitational Law.

Bulk Properties of Matters

Elastic Properties of Matter; Fluid Statistics; Fluid Dynamics; Bernoulli Equation; Viscosity.

Optic Topic

Nature of light; Light as an Electro magnetic wave; Interference; Adding of Electromagnetic wave using phasors; Interference from thin films; Michelson Interferometer; Fresnel Biprism and its use; Diffraction; Diffraction from multiple slits; Diffraction grating; Holography; Polarization; Description of polarization states; Rotation of plane of polarization.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Relative motion. Inertial and non inertial reference frames.
2. Parameters defining the motion of mechanical systems and their degrees of freedom.
3. Study of the interaction of forces between solids in mechanical systems.
4. Centre of mass and inertia tensor of mechanical systems.
5. Application of the vector theorems of mechanics and interpretation of their results.
6. Newton's laws of motion and conservation principles.
7. Introduction to analytical mechanics as a systematic tool for problem solving.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.
5. Physics for scientist and engineers by Serway and Jewelt, 6th Edition, Thomson Brooks/cole, 2004.

Module Code: Phy - 102

Module title: Physics – I (Physics Lab)
Name of Scheme: BS Chemistry (4 Years)
Semester : 1st
Module Type: General
Module Rating: 1 Credits

1. **Introduction of the course:**
This course is to provide the student a clear and a logical presentation of the basic concepts and principles of mechanics. Another aim of this course is associating the real world with physics to improve a better understanding of its concepts and principles, specially with the set of physical laws describing the motion of bodies under the action of a system of forces, the motion of macroscopic objects, from projectiles to parts of machinery, as well as astronomical objects, such as spacecraft, planets, stars and galaxies.
2. **Course Objectives:**
   1. To Study of bending behavior of beams and analyze the expression for young's modulus
   2. To understand the surface tension and viscosity of fluid
   3. To understand the dynamics and gravitation
   4. To Study the behavior of rigid body dynamics
   5. To understand the negative result of Michelson Morley experiment, Galilean and Lorentz transformation.

3. **Course Contents:**
   1. Surface tension by capillary rise.
   2. Study of compound pendulum and estimate of value of 'g'
   3. Elastic constants by spiral spring
   4. Modulus of rigidity by dynamic method and static method of Maxwell's Needle.
   5. Spring Constant by static and dynamic method.
   6. Modulus of rigidity by dynamic method.

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcome:**
The students would be able
   1. to explain bending behavior of beams and analyze the expression for young's modulus
   2. to describe the surface tension and viscosity of fluid
   3. to understand the dynamics and gravitation
   4. to explain the behavior of rigid body dynamics
   5. to understand the negative result of Michelson Morley experiment, Galilean and Lorentz transformation.
   6. to understand the definition for centre of gravity.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. **Recommended Readings:**
   1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
   2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
   3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA
   4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.
   5. Physics for scientist and engineers by Serway and Jewelt, 6th Edition, Thomson Brooks/cole, 2004.

Semester – II

Module Code: Eng - 103

Module title: ENGLISH – II (Communicatio Skills)
Name of Scheme: BS Chemistry (4 Years)
Semester : 2nd
Module Type: Compulsory
Module Rating: 3 Credits

1. **Introduction of the Course:**
The main purpose of this course is to guide students in their first year of learning and impart basic study skills. It is designed with the view to enable them to take immediate control of their learning. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies.

2. **Course Objectives:**
The course aims to:
1. Enable the students to meet their real-life communication needs.

3. **Course Contents:**
Paragraph writing: Practice in writing a good, unified and coherent paragraph.
Essay writing: Introduction.
CV and job application: Translation skills; Urdu to English.
Study skills: Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension.
Academic skills: Letter/memo writing, minutes of meetings, use of library and internet.
Presentation skills: Personality development (emphasis on content, style and pronunciation).
Note: documentaries to be shown for discussion and review.

4. **Teaching-learning Strategies**
1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. **Learning Outcome:**
1. Students are expected to get familiarized with the Basics of Grammar including Parts of speech and use of articles, Sentence structure, Active and passive voice etc.
2. They will learn about the basic rules of paragraph writing and presentation skills.

6. **Assessment Strategies**:
1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. **Recommended Readings:**
1. Boutin, Marie-Christine, Brinandm, S., Grellet, F. 1993. Writing: Intermediate. Oxford Supplementary Skills. Fourth Impression.
2. Langan, J. Reading and Study Skills by RichardYork.
3. Nolasco, R. 1992. Writing: Upper-Intermediate. Oxford Supplementary Skills. Fourth Impression (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
4. Thomson, A.J., Martinet, A.V. 1986. Practical English Grammar Exercises 2. 3rd Ed. Oxford University Press.
5. Tomlinson, B., Ellis, R. 1991. Reading. Advanced Oxford Supplementary Skills. Third Impression.

Module Code: Pst - 101
Module title: Pakistan Studies
Name of Scheme: BS Chemistry (4 Years)
Semester : 2nd
Module Type: Compulsory
Module Rating: 2 Credits

1. **Introduction of the Course:**
   The main purpose of this course is to guide students about historical perspective, government, politics, contemporary Pakistan and ideological background of Pakistan.

2. **Course Objectives:**
   The course aims to:
   1. Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
   2. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

3. **Course Contents:**
   Historical Perspective: Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah; Factors leading to Muslim separatism; People and Land: Indus Civilization, Muslim advent, Location and geo-physical features.
   Government and Politics in Pakistan: Political and constitutional phases: 1947-58; 1958-71; 1971-77; 1977-88; 1988-99; 1999onward.
   Contemporary Pakistan: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcome:**
   1. Students are expected to get familiarized with the foreign policy of Pakistan and challenges and Futuristic outlook of Pakistan
   2. They will learn about the Government and Politics in Pakistan.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. **Recommended Readings:**

   1. Ansar, Z. 1980. History & Culture of Sindh. Karachi: Royal Book Company.
   2. Aziz, K.K. 1976. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research.
   3. Burke, S.M., Ziring L. 1993. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.
   4. Javed, B. S. 1980. State and Society in Pakistan. The Macmillan Press Ltd.
   5. Khalid Bin Sayeed. 1967. The Political System of Pakistan. Boston: Houghton Mifflin.
   6. Lawrence, Z. 1980. Enigma of Political Development. Kent England: WmDawson & sons Ltd.
   7. Noor ul Haq. 1993. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research.
   8. Rafique A. M. 1998. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
   9. Safdar, M. 1994. Pakistan Political Roots & Development. Lahore.
   10. Safdar, M. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e- Islamia, Club Road.
   11. Tahir, A. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
   12. Wayne, W. 1972. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research.
   13. Waseem, M. 1987. Pakistan Under Martial Law, Lahore: Vanguard.
   14. Zaidi A.S. 2000. Issue in Pakistan's Economy. Karachi: Oxford University Press.

Module Code:	Chem - 103
Module title:	Chemistry – II (Organic Chemistry)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Foundation
Module Rating:	3 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about basic concepts in organic chemistry including chemistry of hydrocarbons and different functional groups.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of organic chemistry
2. To introduce about hydrocarbons and different functional groups.

3. Course Contents

1. Basic concept in Organic Chemistry

Localized and Delocalized bonding, conjugation and hyperconjugation; applications, resonance, resonance energy, rules of resonance, resonance hybrid, factor effecting the resonance, inductive effect and applications, steric effect and its applications, hydrogen bonding and its effect on various properties of organic compounds, tautomerism.

2. Chemistry of Hydrocarbons

Preparation of alkanes from coupling alkyl halide and alkyl boranes, corey house synthesis, Free radical reactions of alkenes with halogens with mechanism, comparison of reactivities of halogens.

Preparations of alkenes from Pyrolytic elimination reactions. Relative stability and reactivity of alkenes in terms of Hoffmann and Sytzeff rules, reaction of alkenes i.e.g simon-smith and Diels- Alder reactions.

Preparation of alkynes by alkylation of terminal alkynes, reaction of alkynes; hydroboration and hydration and formation of metal acetylides with mechanism.

Aromaticity, criteria for aromaticity, poly aromatic hydrocarbons like; benzene, naphthalene, antharacene and phenantharene, their resonance structures and relative stabilities, synthesis of naphthalene, orientation and reactivity of naphthalene, electrophilic substitution of naphthalene, oxidation and reduction reaction of naphthalene.

3. Chemistry of Functional Groups

Alcohols: preparation of alcohols by reduction of carbonyl compounds, reaction of alcohol with metals, organic and inorganic acid, oxidation, difference between primary secondary and tertiary alcohols.

Phenols: synthesis of phenols, physical properties, reactions like; carbonation, formylation and diazo coupling

Ethers: preparation of ethers from alcohols, alkyl halides and alkenes, physical properties, reactions of ethers.

Carboxylic acids: Physical properties of acids, effect of various parameters on the strength of aliphatic and aromatic acids, chemical properties like: nucleophilic acyl substitution, decarboxylation, Hunsdicker reaction, substitution at α- carbon.

Acetoacetic and malonic ester synthesis.

Alkyl Halides: Preparation of alkyl halides from carboxylic acids, Nucleophilic substitution (SN1 & SN2) and elimination reactions (E1 & E2) of alkyl halides, effect of various parameters on rate of substitution and elimination reactions.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic concepts of organic chemistry.
2. They will learn about the fundamentals of hydrocarbons and different functional groups.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion

4. Quiz
5. Tests

7. Recommended Readings:

1. C.K. Ingold, "Structure and mechanism in organic chemsitry", C.B.S.
2. I.L.Finar, "Organic Chemistry", Vol. I, Pearson Education, L.P.E.
3. I.L.Finar, "Organic Chemistry", Vol. II, 5th Edition, L.P.E.
4. Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 5th Edition, Wiley Inter Science.
5. Morison and Boyd, "Organic Chemistry", 6th Edition, Prentice Hall.
6. Seyhan N. Ege, "Organic Chemistry Structure and Reactivity", 3rd Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
7. Thomas H. Lowry, Kathleen Schueller Richardson "Mechanism and Theory in Organic Chemistry", 3rd Edition, Harper and Row Publishers, New York.
8. Alder, Baker, Brown, "Mechanism in Organic Chemistry", Wiley Publishers.
9. Atkins Carey, "Organic Chemistry", A Brief Course, 2nd Edition.
10. Peter Sykes, "A guide book to mechanism in organic chemistry", 6th Edition, Pearson Education, Singapore.

Module Code:	Chem - 104
Module title:	Chemistry – II (Organic Chemistry Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Foundation
Module Rating:	1 Credits

1. Introduction of the course:

The course is organized to provide an adequate knowledge about basic concepts in organic chemistry including chemistry of hydrocarbons and different functional groups.

2. Course Objectives:

The course is designed:

1. To introduce students about the key introductory concepts of organic chemistry
2. To introduce about hydrocarbons and different functional groups.

3. Course Contents

Practicals:

1) Compound Analysis

Identification of organic compounds containing only one functional group with special emphasis on compounds containing following functional groups.

-COOH, -OH, C=O, -NH2, and –CONH2

2) Basic Experimental techniques used in organic chemistry

- Filtration
- Simple and fractional distillation
- Solvent extraction
- Sublimation
- Re-crystallization

3) Estimations (volumetric)

- Determination of molecular weight of a carboxylic acid.

Estimation of glucose.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the basic concepts of organic chemistry.
2. They will learn about the fundamentals of hydrocarbons and different functional groups.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. C.K. Ingold, "Structure and mechanism in organic chemsitry", C.B.S.
2. I.L.Finar, "Organic Chemistry", Vol. I, Pearson Education, L.P.E.
3. I.L.Finar, "Organic Chemistry", Vol. II, 5th Edition, L.P.E.
4. Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 5th Edition, Wiley Inter Science.
5. Morison and Boyd, "Organic Chemistry", 6th Edition, Prentice Hall.
6. Seyhan N. Ege, "Organic Chemistry Structure and Reactivity", 3rd Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
7. Thomas H. Lowry, Kathleen Schueller Richardson "Mechanism and Theory in Organic Chemistry", 3rd Edition, Harper and Row Publishers, New York.
8. Alder, Baker, Brown, "Mechanism in Organic Chemistry", Wiley Publishers.
9. Atkins Carey, "Organic Chemistry", A Brief Course, 2nd Edition.
10. Peter Sykes, "A guide book to mechanism in organic chemistry", 6th Edition, Pearson Education, Singapore.

Module Code:	Math - 103
Module title:	Mathematics A – II (Plane curves & Analytic Geometry)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	General
Module Rating:	3 Credits

1. Introduction of the Course:

This is a beginning course in plane analytic geometry emphasizing the correspondence between geometric curves and algebraic equations. This correspondence makes it possible to reformulate problems in geometry as equivalent problems in algebra, and vice versa. Curves studied include straight lines, circles, parabolas, ellipses, and hyperbolas. Coordinate transformations, polar coordinates, and parametric equations are also studied. The course assumes a sound background in algebra, geometry, and trigonometry.

2. Course Objectives:

The course is designed:

1. To apply arithmetic, algebraic, geometric, higher-order thinking, and statistical methods to modeling and solving real-world situations.
2. To represent and evaluate basic mathematical information verbally, numerically, graphically, and symbolically.
3. To expand mathematical reasoning skills and formal logic to develop convincing mathematical arguments.
4. To use appropriate technology to enhance mathematical thinking and understanding and to solve mathematical problems and judge the reasonableness of the results.
5. To interpret mathematical models such as formulas, graphs, tables and schematics, and draw inferences from them.
6. To recognize the limitations of mathematical and statistical models.
7. To develop the view that mathematics is an evolving discipline, interrelated with human culture, and understand its connections to other disciplines.

3. Course Contents

1. Plane Analytics Geometry
   - Conic section and quadratic equations.
   - Classifying conic section by eccentricity.
   - Translation and rotation of axis.
   - Properties of circle, parabola, ellipse, hyperbola.
   - Polar coordinates, conic sections in polar coordinates.
   - Graphing in polar coordinates.
   - Tangents and normal, pedal equations, parametric representations of curves
2. Applications of Integration.

- Asymptotes.
  Relative extrema, points of inflection and concavity.
- Singular, points, tangents at the origin
- Graphing of Cartesian and polar curves.
- Area under the curve, area between two curves
- Arc length and intrinsic equations
- Curvature, radius and centre of curvature.
- Involute and evolute, envelope.

3. Analytic Geometry of Three Dimensions.
   - Rectangular coordinates system in a space.
   - Cylindrical and spherical coordinate system.
   - Direction ratios and direction cosines of a line.
   - Equation of straight lines and planes in three dimensions.
   - Shortest distance between skew lines.
   - Equation of sphere, cylinder, cone, ellipsoids, paraboloids, hyperboloids.
   - Quadric and ruled surfaces.
   - Spherical trigonometry. Direction of Qibla.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Solve problems involving lengths and distances in the plane, including midpoint and point-of-division formulas.
2. Demonstrate understanding of the notions of slope and inclination of lines, including angles between lines, parallel lines, and perpendicular lines.
3. Recognize the relationship between equations in two variables and graphs in the plane and use the equations to find pertinent information such as points of intersection, and intercepts.
4. Perform arithmetical and geometric operations involving vectors in the plane.
5. Use vectors to solve geometric and physical problems.
6. Sketch graphs of and discuss relevant features of curves in the plane determined by certain equations (including lines, circles, parabolas, ellipses, hyperbolas, polynomial functions, rational functions, and features such as slope, inclination, center, radius, vertices, foci, axes, eccentricity, intercepts, asymptotes).
7. Determine equations of curves when given information that determines the curves.
8. Perform translations and rotations of the coordinate axes to eliminate certain terms from equations.
9. Model real world situations with equations of conics.
10. Use the polar coordinate system, relate it to the rectangular coordinate system, and graph equations using polar coordinates.
11. Sketch graphs in the plane determined by parametric equations by direct sketching as well as elimination of the parameter to obtain a rectangular equation.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Thomas, Calculus, 11 th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8 th Edition, John Wiley & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's outlines series, 4th edition,
5. 1999.
6. C.H. Edward and E.D Penney, Calculus and Analytics Geometry Prentice.
7. Hall, Inc. 1988.
8. E. W. Swokowski, Calculus and Analytic Grometry PWS Publishers, Boston, Massachosetts, 1983.

9. Dennis G. Zill & Patric D. Shanahan, Complex Analysis, Jones & Barlett Publishers, 2003.

Module Code:	Bio - 111
Module title:	Biology – I (Cell and Biotechnology)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about the morphology and functioning of cell and cellular organelles. It is generally aimed to familiarize students with the cell cycle and systematic knowledge of genes, their inheritance pattern. Additionally, the concept of biotechnology and biodiversity has also been covered.

2. Course Objectives

The course is designed:

1. To give systemized knowledge of life.
2. To provide an adequate knowledge about basic concepts of cell biology.
3. To increase the understanding of the students about the mechanism of cell division, study of genes and their inheritance pattern.

3. Course Contents

1. Biological Methods, Principles of Cellular Life, Chemical Basis, Structure and Function, Principles of Metabolism, Energy Acquisition.
2. Principles of Inheritance, Mitosis and Meiosis, Chromosomes, Observable Inheritance Patterns, DNA Structure and Function, RNA and Proteins, Genes, Genetic, Engineering and Biotechnology, Biodiversity.
3. Fundamental Concept of Biodiversity, One or two examples of each of the following from commonly, found organism, Prions, Viruses, Bacteria, Protistans, Algae, Fungi, Plants, Crops, Animals, Invertebrates, Vertebrates.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students will be able to describe, apply, integrate the basic concept of cell biology.
2. They will learn about the cell cycle.
3. The obtained knowledge will enable students to know about genetics and biotechnology.
4. This will enable them qualify for basics of biodiversity.

6. Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall

Module Code:	Phy - 103
Module title:	Physics – II (Waves & Oscillation)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	General

Module Rating: 2 Credits

1. **Description and Objectives:**

This course provides students an insight of the principles of waves as carriers of energy including sound and optical waves mainly. This course also provides the students with a broad understanding of the physical principles of the oscillations, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments.

2. **Course Contents**

Harmonic Oscillations

|Simple harmonic oscillation (SHM); Application of S H M; SHM and uniform circular motion, combinations of Harmonic motion Damped Harmonic Motion.

Wave Topic:

Mechanical waves; Traveling waves; Waves speed; Waves equation; Power and intensity in wave motion; Principle of superposition. (Basic ideas);

Sound topic:

Beats Phenomenon; Doppler Effect.

Thermodynamics and Kinetic Theory of Gases:

Kinectic theory of the ideal gas, work done on an ideal gas internal energy of ana ideal gas intermolecular forces.

Statistical Mechanics:

Statistical, Distribution and Mean values; Distribution of molecular speeds; Brownian motion.

Heat:

Review of previous concepts; First law of Thermodynamics; Transfer of heat;

Entropy and Second law of Thermodynamics:

Reversible and irreversible process, Second law; Cycle; Carnot engines Thermodynamic temperature scale; Entropy; Joule-Thomson effect.

3. **Teaching-learning Strategies**

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

4. **Learning Outcome:**

After completion of this course, students will

1. Apply, knowledge of fluids, thermodynamics, sound waves, and light waves to explain natural physical processes and related technological advances.
2. Use an understanding of calculus along with physical principles to effectively solve problems encountered in everyday life, further study in science, and in the professional world.
3. Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies.
4. Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. **Recommended Readings:**

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA

4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Module Code:	Phy - 104
Module title:	Physics – II (Physics Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	2nd
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

Topics include concepts in fluid mechanics, waves, thermodynamics and optics.

2. Course Objectives

This is a calculus-based physics course required for students majoring in engineering, physics and chemistry. The course is transferable to other baccalaureate engineering programs. Students should be aware of the program requirements of the institutions to which they wish to transfer. This course conforms with the Oregon Block Transfer program.

3. Course Contents

1. Thermo-couple, Thermal e.m.f. and temperature diagram.
2. Determination of 'J' Electrical Method (Calendar and Barnes Method) with compensation for heat loss.
3. Velocity of Sound by Kundt's tube.
4. Frequency & A.C. mains by Sonometer.
5. Frequency & A.C. mains by Melde's Approvals.
6. Use of sextant and measurement of altitude with it.
7. Wavelengths of sodium D lines by Newton's biprism.
8. Wavelengths of light by Fresnel's biprism
9. Wavelength of light by diffraction gratting.
10. Measurement of the Rotation of the Plane of Polarization.
11. Resolving Power of diffraction gratting.
12. Determination of the radius of Lycopodium Particles.

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Apply knowledge of fluids, thermodynamics, sound waves, and light waves to explain natural physical processes and related technological advances.
2. Use an understanding of calculus along with physical principles to effectively solve problems encountered in everyday life, further study in science, and in the professional world.
3. Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies.
4. Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA

4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Semester – III

Module Code:	Eng - 201
Module title:	**English – III (Technical Report Writing & Presentation Skills)**
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

The main purpose of this course is to guide students about presentation skills including essay writing. The course will enable students to devise and follow "study systems" and equip them with the ability to think critically and adopt effective learning strategies.

2. Course Objectives:

The course aims to:

1. Enhance language skills.
2. Develop critical thinking.

3. Course Contents:

Presentation skills: Essay writing: Descriptive, narrative, discursive, argumentative.
Academic writing: How to write a proposal for research paper/term paper How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency).
Technical Report writing Progress report writing
Note: Extensive reading is required for vocabulary building

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the Basics of presentation skills.
2. They will learn about the basic rules of paragraph writing and essay writing.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Kirszner. L.G., Mandell, S. R. Patterns of College Writing. 4th Ed. by St. Martin's Press.
2. Langan, J. 2004. College Writing Skills McGraw-Hill Higher Education.
3. Neulib, J., Cain, K. S., Ruffus, S., Scharton, M. (Editors). Reading. The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. (A reader that will give students exposure to the best of twentieth century literature).
4. White, R. 1992. Writing. Advanced. Oxford Supplementary Skills. Third Impression (particularly suitable for discursive, descriptive, argumentative and report writing).

Module Code:	Chem - 201
Module title:	**Chemistry – III (Physical Chemistry**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd

Module Type: Foundation
Module Rating: 3 Credits

1. **Introduction of the Course:**
The course is organized to provide an adequate knowledge about basic concepts in Physical chemistry including thermodynamics, chemical kinetics etc.

2. **Course Objectives:**
The course is designed:
1. To introduce students about the key concepts of physical chemistry
2. To introduce about thermodynamics, chemical kinetics etc.

3. **Course Contents**
Theory
1. **Chemical Thermodynamic**
Equation of states, ideal and real gases, the vander waals equation for real gases, critical phenomena and critical constants.
Extensive and intensive properties, molar heat capacities, second law of thermodynamics, concept of entropy, entropy change in reversible and irreversible process, entropy change for an ideal gas, entropy change due to mixing of ideal gases, effect of temperature and pressure on entropy, concept of free energy, effect of temperature and pressure on free energy, relationship between standard free energy and equilibrium constants.
2. **Chemical Kinetics**
Derivation of kinetics expression of zero order, first order, second order (with same and different concentrations), nuclear decay as first order reaction, derivations for determining rate constants and half life periods, measurement of order of the reaction with different methods, Arrhenius equation and determination of various Arrhenius parameters.
3. **Solutions and Colloids**
Physical properties of liquids, surface tension, viscosity, refractive index etc.
Osmotic pressure and its measurements, abnormal colligative properties (association and dissociation of solutes), fractional distillation and concept of azeotrops, concept of colloids, classification of colloids, dialysis, electro-dialysis, sedimentation, precipitation, ultra filtration, emulsions and gels, tyndall cone effect.
4. **Surface Chemistry**
Interface, Adsorption, types of adsorption at liquid surface, adsorption isotherms (Freundlich and Langmuir), catalysis, and kinetics of enzyme catalysis.

4. **Teaching-learning Strategies**
1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. **Learning Outcome:**
Students are expected to get familiarized with the with the basic concepts of Physical chemistry like chemical thermodynamics, solution chemistry and surface chemistry.

6. **Assessment Strategies**:
1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. **Recommended Readings:**
1. Adamson A. W. "Understanding Physical Chemistry" 3rd Ed., Benjamin Cummings Publishing Company Inc.
2. Akhtar M.N.& Ghulam Nabi, "Textbook of Physical Chemistry", ilmi Kutab Khana, Lahore. 3. Bhatti H.N. and K.Hussain, "Principles of Physical Chemistry"; Carwan Book House, Lahore.
3. Maron S.H. & B. Jerome, "Fundamentals of Physical Chemistry", Macruthan Publishing Co., Inc. New York. (Also published by National Book Foundation).

4. Atikins P.W.& M.J.Clugston, "Principles of Physical Chemistry" Pitman Publishing Company (1988).
5. Moore W.J. "Physical Chemistry", 5th Ed. Longmans Publishers.
6. Jones M. "Elements of Physical Chemistry" Addison-Sesky Publishing Company.
7. G.M.Barrow, International six Edition "Physical Chemistry".
8. IRA. N. Levine fourth edition "Physical Chemistry"
9. Alberty and Danials, "Physical Chemistry"
10. Castallon, "Physical Chemistry"
11. Laidler & Meiser "Physical Chemistry"
12. Friemental "Chemistry in Action"

1.

Module Code:	Chem - 202
Module title:	Chemistry – III (Physical Chemistry Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	Foundation
Module Rating:	1 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about basic concepts in Physical chemistry including thermodynamics, chemical kinetics etc.

2. Course Objectives:

The course is designed:

1. To introduce students about the key concepts of physical chemistry
2. To introduce about thermodynamics, chemical kinetics etc.

3. Course Contents

Lab

1. Preparation of standard molar, normal, molal and percentage solutions.
2. Standardization of secondary standard acids and bases solutions by volumetric methods.
3. Determination of surface tension, parachor and percentage composition by surface tension measurement.
4. Determination of viscosity, rheochor and percentage composition by viscosity measurement.
5. Determination of refractive index, molar refractivity and percentage composition by refractive index method.
6. Conductometeric and potentiometric strong acid-base titrations using conductometer and pH meter respectively.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

Students are expected to get familiarized with the with the basic concepts of Physical chemistry like chemical thermodynamics, solution chemistry and surface chemistry.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Adamson A. W. "Understanding Physical Chemistry" 3rd Ed., Benjamin Cummings Publishing Company Inc.
2. Akhtar M.N.& Ghulam Nabi, "Textbook of Physical Chemistry", ilmi Kutab Khana, Lahore. 3. Bhatti H.N. and K.Hussain, "Principles of Physical Chemistry"; Carwan Book House, Lahore.
3. Maron S.H. & B. Jerome, "Fundamentals of Physical Chemistry", Macruthan Publishing Co., Inc. New York. (Also

published by National Book Foundation).
4. Atikins P.W.& M.J.Clugston, "Principles of Physical Chemistry" Pitman Publishing Company (1988).
5. Moore W.J. "Physical Chemistry", 5th Ed. Longmans Publishers.
6. Jones M. "Elements of Physical Chemistry" Addison-Sesky Publishing Company.
7. G.M.Barrow, International six Edition "Physical Chemistry".
8. IRA. N. Levine fourth edition "Physical Chemistry"
9. Alberty and Danials, "Physical Chemistry"
10. Castallon, "Physical Chemistry"
11. Laidler & Meiser "Physical Chemistry"
12. Friemental "Chemistry in Action"

Module Code:	Math - 201
Module title:	Mathematics A – III (Linear Algebra)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	General
Module Rating:	3 Credits

1. Introduction of the Course:

This course is planned to provide adequate knowledge about morphology and functioning of cell, cellular organelles and mechanisms of cell division, study of genes and their inheritance patterns and concept of evolution. It is generally aimed to familiarize students with the cell structure and its functioning along with basic concepts of genetics.

2. Course Objectives:

This course aims to make the students become familiar with the basic concepts of linear algebra with a thorough understanding of vector spaces, linear transformations and matrix operations enhancing the students' ability to reason mathematically and able to apply this knowledge to many fields in engineering, statistics and computer science.

3. Course Contents

1. Matrices, Determinants and System of Linear Equations
- Definition of matrix. various types of matrices.
- Algebra of matrices.
- Determinant of square matrix, cofactors and minors.
- Laplace expansion of determinants.
- Elementary matrices, adjoint and inverses of matrices.
- Rank of a matrix.
- Introduction to systems of linear equations.
- Cramer's rule, Guassian elimination and Gauss Jordan method.
- Solution of homologenous and non homogenous linear equations.
- Net work flow problems.

2. Vector Spaces
- Real vector spaces, subspaces.
- Linear combination and spanning set..
- Linear independence and linear dependence, basis and dimension, row space,.
- Colum space and Null space.

3. Linear Transformations.
- Introduction to linear transformation.
- Matrices of linear transformations.
- Rank and nullity.
- Eigen values and Eigen vectors.
- Diagonalization
- Orthogonal diagonalization.
- Orthogonal matrices, similar matrices.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcomes:

1. To make the students become familiar with the basic concepts of linear algebra.
2. To enhance the students' ability to reason mathematically.
3. To make the students aware of the crucial importance of linear algebra to many fields in engineering, statistics and computer science.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Howard Anton and Chris Rorres, Elementary Linear Algebra Applications
2. Version, John Wiley and Sons Inc. 9th Edition, 2005.
3. W. Keith Nicholoson, Elementary Linear Algebra, PWS-Kent Publishing Company, Boston, 2004.
4. Bernard Kolman, David R. Hill, Introduction Linear Algebra with Applications, Prentice Hall International, Inc. 7th Edition, 2001.
5. Stephen H. Friedberg Et al, Linear Algebra, Prentice Hall, Inc. 3rd Edition, 2000.
6. Seymour Lipschutz, Theory and Problems of Beginning Linear Algebra, Schaum's Outline Series, Mc-Graw Hill Company, New York, 1997.

Module Code:	Bio - 211
Module title:	Biology – II (Evolution & Ecology)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	Compulsory
Module Rating:	3 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about evolution, its myths and realities, and speciation. It is generally aimed to familiarize students with the biological organization and systematic knowledge of growth & development in plants and animals, and their reproduction as well. Moreover, ecology, human impacts on biosphere and environment conservation have been covered.

2. Course Objectives:

The course is designed:

1. To provide an adequate knowledge about evolution and speciation.
2. To increase the understanding of the students about the different level of organization.
3. To give systemized knowledge about growth & development and reproduction in plants and animals.
4. To familiarize the students about man and his environment

3. Course Outline:

1. Myths and Realities of Evolution, Microevolution, Speciation, Macroevolution, Level of Organization, Plants, Tissues, Nutrition and Transport, Reproduction.
2. Growth and Development Animals, Tissue, Organ System and Homeostasis, Information Flow and Neuron, Nervous System, Circulation and Immunity, Nutrition and Respiration, Reproduction and Development.
3. Ecology and Behavior, Ecosystems, Biosphere, Social Interactions, Community Interactions, Human Impact on Biosphere, Environment Conservation

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Students are expected to get familiarized with the evolution.
2. They will learn about the biological organization.
3. The obtained knowledge will enable students to know the growth & development along with reproduction in plants and animals.
4. This will enable them qualify for basic to moderate level jobs involving knowledge of living organisms and their environment.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall

Module Code:	Phy - 201
Module title:	Physics – III (Electricity & Magnetism)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	General
Module Rating:	2 Credits

1. Introduction of the Course:

To extend the scope of the student's understanding of electricity and magnetism, using the language of vector calculus

2.

Course Objectives:

Upon completion, successful students will be able to:

1. To explain an electrical current, circuits, construction and their use and network theorems
2. To study the electric field using coulombs Inverse Square law in electrostatics of current
3. To Analyze the chemical and heating effect of current, AC &DC
4. To analyze the relations between b, h and m and Biot-savarts law
5. To understand the faradays laws of electromagnetic induction
6. To Analyze the value of Maxwell equation- boundary conditions
7. Establish the foundation for higher-level courses in physics, chemistry, and engineering.

3.

Course Outline:

Electrostatics

Electric Charge; Conductors and Insulators; Vector form of coulomb's law.

Electric Field

Electric field of continuous charged stribution; Point charge in an electric field; Dipole in an electric field. Gauss's Law; Application of Gauss's Law (Integral Form).

Electric Potential

Calculating the field from the potential; Capacitors and dielectrics; Capacitor with dielectric.

Electric Current

Electric Current; Ohm's Law; Energy transfer in the electric circuit; Semiconductors; Super conductor.

DC Circuits

Calculating the current in a single loop, multiple loops; voltages at various elements of a loop; RC circuits.

Magnetism Magnetic Field Effects
Magnetic field, B. Magnetic force on a charged particle magnetic force on a charged particle magnetic force on a current; Torque on a current loop; Magnetic dipole.
Ampere's Law
Biot-Savart Law; Ampere's Law.
Faraday's Law of Electromagnetic Induction
Faraday's Law; Lenz's Law; Motional E.M.F. Induced electric fields.
Magnetic Properties of Matter
Gauss Law for Magnetism; Origin of Atomic and Nuclear magnetization; Magnetic Materials.
Inductance
Inductance; LR Circuits; Energy stored in magnetic field; Electromagnetic; Oscillation.
Alternating Current Circuits
Alternating Current; Single loop RLC circuit; Power in a.c. circuits; Transformer.
Maxwell's Equations
Summarizing ht electromagnetic equation; Induced magnetic fields & displacement current; Maxwell's equations.
Electromagnetic Waves
Generating an electromagnetic wave; Traveling waves and Maxwell's equation; Energy transport and the Poynting Vector.
Electronics
Semiconductor materials; Junction diode; Transistor; Transistor, biasing; Transistor as an amplifier; Amplification with feedback; Oscillators; Logic Gates

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Explain electrical current, circuits, construction and their use and network theorems.
2. Study the electric field using coulombs Inverse Square law in electrostatics of current .
3. Analyze the chemical and heating effect of current, AC &DC.
4. Analyze the relations between b, h and m and Biot- savarts law.
5. Understand the faradays laws of electromagnetic induction.
6. 6. Analyze the value of Maxwell equation- boundary conditions.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Module Code:	Phy - 202
Module title:	Physics – III (Physics Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	3rd
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

To extend the scope of the student's understanding of electricity and magnetism, using the language of vector calculus

2.

Course Objectives:

The Objectives of the courses are:

1. To explain an electrical current, circuits, construction and their use and network theorems
2. To study the electric field using coulombs Inverse Square law in electrostatics of current
3. To Analyze the chemical and heating effect of current, AC &DC
4. To analyze the relations between b, h and m and Biot-savarts law
5. To understand the faradays laws of electromagnetic induction
6. To Analyze the value of Maxwell equation- boundary conditions

3. Course Contents

1. Measurement of resistance using a neon flash bulb and condenser
2. I-H Curve by Magnetometer
3. Conversion of a Pointer Galvanometer into a voltmeter
4. Conversion of a Pointer Galvanometer into an ammeter
5. Calibration of a meter and voltmeter by potentiometer
6. Low resistance by Carey Foster bridge
7. Charge sensitivity of a ballistic galvanometer taking into account Logarithmic decrement
8. Comparison of capacities by ballistic galvanometer
9. Determination of temperature coefficient of a resistance
10. Measurement of magnetic field by fluxmeter or by search coil method.
11. Measurement of H by earth inductor.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

1. Explain electrical current, circuits, construction and their use and network theorems.
2. Study the electric field using coulombs Inverse Square law in electrostatics of current
3. Analyze the chemical and heating effect of current, AC &DC.
4. Analyze the relations between b, h and m and Biot- savarts law.
5. 5. Understand the faradays laws of electromagnetic induction.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Books Recommended:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Semester - IV

Module Code:	Eng – 202
Module title:	English IV (English for Practical Aims)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	Compulsory

Module Rating: 3 Credits

1. **Introduction of the course:**
The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.
2. **Course Objectives:**
The course is designed:
To introduce students about the key introductory concepts of classification of organisms and their evolutionary relationships.

3. **Course Contents**
Professional Correspondence
- CV and covering letter.
- Follow up messages after the job interview.

Recommended Reading:
- Murphy, Herta A. Effective Business Communication. 7th Ed. New Delhi: Tata McGraw-Hill Publishing Company Limited, 2009 (Page 504-529, 540-548).

Advanced Reading and Comprehension II
- The students are required to read the given prose critically and answer the questions.
- Recommended Reading:
- (Rise. B. Axelrod. and Cooper, Charles R. The St. Martin's Guide to Writing New York: St. Martin's Press, 1985. Page 146-147, 152-155, 158-172).

Job Interviews
- The students should learn to handle job interviews through "mock interviews". Recommended Reading:
- Murphy, Herta A. Effective Business Communication. 7th Ed. New Delhi: Tata McGraw-Hill Publishing Company Limited, 2009. (Page 539-539).

Essay Writing
- The students should be able to compose essays of 4 to 6 paragraphs relying on what they have learnt in the previous semesters about paragraph writing. (Word Limitabout 500 words).

Vocabulary Building Skills
- WORD ROOT METHOD Unit 12-17. Page No. 116-131.

4. **Teaching-learning Strategies**
1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. **Learning Outcomes:**
1. Students are expected to get familiarized with the morphological and anatomical concepts about different cell parts.
2. They will be able to describe, apply and integrate the basic concepts of Cell Biology including Genetics and Evolution, Biochemistry, Physiology as well as Structure and Functions of different Organelles.
3. This will enable them qualify for basic to moderate level jobs involving general knowledge of Biology.
4. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to botany.

6. **Assessment Strategies**:
1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. **Recommended Readings:**
1. RecommendedReading:Idrees, Muhammad. Guide for GAT General Test. Smart Brain GRE (General, Local). 2010-2011 ed. Lahore: Dogar Brother Publishers, 2010

Module Code: Chem - 203

Module title: Chemistry – IV (**General Chemistry**)
Name of Scheme: BS Chemistry (4 Years)
Semester : 4th
Module Type: Foundation
Module Rating: 3 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about basic concepts in General chemistry including spectroscopy, chemistry of biomolecules etc.

2. Course Objectives:

The course is designed:

1. To introduce students about the key concepts of general chemistry
2. To introduce students about chemistry of biomolecules and their use in industries.

3. Course Contents:

1. **Spectroscopy**
   Electromagnetic radiation and its interaction with matter, Development of spectroscopic analytical techniques employing various transitions, Basic introduction to atomic and molecular spectroscopic techniques include flame emission, spectrophotometry, UV/VIS and IR spectroscopies.
2. **Chemical industries and Metallurgies**
   Raw materials, manufacturing process and flow sheet diagrams of; Glass, Sugar, Urea
   Metallurgies of; copper and iron.
3. **Chemistry of Biomolecules**
   Basic introduction to Carbohydrates, lipids, proteins and nucleic acids, their classification, importance and different reactions..

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcomes:

1. Students are expected to get familiarized with the concepts of general chemistry.
2. This will enable them qualify for basic to moderate level jobs involving general knowledge of Chemistry.
3. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to chemistry.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Adamson A. W. “Understanding Physical Chemistry” 3rd Ed. Benjamin Cummings publishing company Inc.
2. Akhtar M.N. & Ghulam Nabi, “Textbook of Physical Chemistry” ilmi kutab khana, Lahore. 3. Bhatti H.N. and K. Hussain, “Principles of Physical Chemistry”; Carwan Book House, Lahore.
3. Shriver, D.F., P.W. Atkins and C.H. Langford, “Inorganic Chemistry”; Oxford, 2nd Ed. (1996).
4. Snarp, A.G. “Inorganic Chemistry”, Longman, 3rd Edition (1992).
5. Rayner Canham, Gelof, “Descriptive Inorganic Chemistry” & Co. (1995).
6. Daniel R. Pallers, “Experimental Organic Chemistry, John Willey & Sons” Inc., 2009.
7. James A. Moore, “Experimental methods in Organic Chemistry” Holt-Saunders Int. 1983. 9. R.L. Shriner, R.C. Fuson, D.IV. Curtin and T.C. Morrill “The systematic Identification of organic compounds, 6th ed. John Willey & sons, 1979.

Module Code:	Chem - 204
Module title:	Chemistry – IV (**General Chemistry**)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	Foundation
Module Rating:	1 Credits

1. **Introduction of the Course:**
The course is organized to provide an adequate knowledge about basic concepts in General chemistry including spectroscopy, chemistry of biomolecules etc.

2. **Course Objectives:**
The course is designed:
    1. To introduce students about the key concepts of general chemistry
    2. To introduce students about chemistry of biomolecules and their use in industries.

3. **Course Contents**
Practicals:
    1. Preparation of buffer solutions.
    2. Determine the lambda max of the given compounds spectrophotometrically. (i.e $KMNO_4$, $K_2Cr_2O_7$)
    3. Determine the concentration of unknown sample solution spectrophotometrically (i.e $KMNO_4$, $K_2Cr_2O_7$)
    4. Calibration of measuring apparatus e.g pipette, burette, measuring cylinder and measuring flask.
    5. Purification of the compounds using common ion effect.
    6. Separate the Given mixture of ink by paper chromatography.
    7. Qualitative and quantitative analysis of carbohydrates, lipids and proteins.
4. **Teaching-learning Strategies**
    1. Lectures
    2. Group Discussion
    3. Laboratory work
    4. Seminar/ Workshop

5. **Learning Outcomes:**
    1. Students are expected to get familiarized with the concepts of general chemistry.
    2. This will enable them qualify for basic to moderate level jobs involving general knowledge of Chemistry.
    3. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to chemistry.
6. **Assessment Strategies**:
    1. Lecture Based Examination (Objective and Subjective)
    2. Assignments
    3. Class discussion
    4. Quiz
    5. Tests

7. **Recommended Readings:**

    1. Adamson A. W. “Understanding Physical Chemistry” 3rd Ed. Benjamin Cummings publishing company Inc.
    2. Akhtar M.N. & Ghulam Nabi, “Textbook of Physical Chemistry” ilmi kutab khana, Lahore. 3. Bhatti H.N. and K. Hussain, “Principles of Physical Chemistry”; Carwan Book House, Lahore.
    3. Shriver, D.F., P.W. Atkins and C.H. Langford, “Inorganic Chemistry”; Oxford, 2nd Ed. (1996).
    4. Snarp, A.G. “Inorganic Chemistry”, Longman, 3rd Edition (1992).
    5. Rayner Canham, Gelof, “Descriptive Inorganic Chemistry” & Co. (1995).
    6. Daniel R. Pallers, “Experimental Organic Chemistry, John Willey & Sons” Inc., 2009.
    7. James A. Moore, “Experimental methods in Organic Chemistry” Holt-Saunders Int. 1983. 9. R.L. Shriner, R.C. Fuson, D.IV. Curtin and T.C. Morrill “The systematic Identification of organic compounds, 6th ed. John Willey & sons, 1979.

Module Code: Math - 203
Module title: Mathematics A – IV (Ordinary Differential Equations)
Name of Scheme: BS Chemistry (4 Years)
Semester : 4th
Module Type: General
Module Rating: 3 Credits

1. Introduction of the Course:

A study of the methods of solution and applications of ordinary differential equations. Topics include: first and second order equations, existence and uniqueness of solutions, separation of variables, exact equations, integrating factors, linear equations, undetermined coefficients, variation of parameters, transform methods, series solutions, systems of equations and elementary numerical methods.

2. Course Objectives:

To provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations.

3. Course Contents

1. Introduction to Differential Equations
   - Historical background and motivation.
   - Basic mathematical models: Directional fields.
   - Classification of differential equations.
2. First Order Differential Equations.
   - Separable equations.
   - Modeling with first order equations.
   - Differences between linear and nonlinear equations.
   - Exact equations and integrating factors.
3. Second Order Differential Equations
   - Homogenous equations.
   - Homogenous equations with constant coefficients.
   - Fundamental solutions of linear homogenous equations.
   - Linear independence and the wronskian.
   - Method of undetermined coefficients, Variation of parameters.
4. Higher Order Linear Equations
   - General theory of nth order linear equations.
   - Homogenous equations with constant coefficients.
   - The methods of undermined coefficients.
   - The method of variation of parameters.
5. Series Solution of Second Order Linear Equations and Special Functions
   - Series solution near an ordinary point, Legendr's equation.
   - Regular singular points, Series solution near a regular singular point.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

Students will be able to :

1. Effectively write mathematical solutions in a clear and concise manner. This may be assessed through class assignments, quizzes and tests, and a final exam.
2. Locate and use information to solve first and second order ordinary differential equations. This may be assessed through homework, class quizzes and tests and a final exam.
3. Demonstrate ability to think critically by determining and using appropriate techniques for solving a variety of differential equations. This may be assessed through tests and a final exam.
4. Demonstrate an intuitive and computational understanding of differential equations by solving a variety of application

problems arising from biology, chemistry, physics, engineering and mathematics. This may be assessed through homework, class quizzes and tests, and a final exam.

5. Demonstrate the ability to integrate knowledge and ideas of differential equations in a coherent and meaningful manner for solving real world problems. This may be assessed through homework, class quizzes and tests, and a final exam.
6. Demonstrate the ability to integrate knowledge and ideas of differential equations by analyzing their solution to explain the underlying physical processes. This may be assessed through tests and a final exam.
7. Demonstrate the ability to think critically by developing appropriate mathematical models of physical systems. This may be assessed through assignments, tests and a final exam.

6. **Assessment Strategies**:
   1. Lecture Based Examination (Objective and Subjective)
   2. Assignments
   3. Class discussion
   4. Quiz
   5. Tests

7. Recommended Readings:

1. W.E. Boyce and Diprima, Elementary Differential Equations, 8 th Edition, John Wiley & Sons, 2005.
2. Erwin, Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 2004.
3. Ross, S.L, Differential Equations, John Wiley & Sons, 2004.
4. Dennis G.Zill & Michael R. Cullen, Differential Equation With Boundary Value Problems, PWS Publihing Company, 2000.

Module Code:	Soc - 211
Module title:	Introduction to Sociology
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	Compulsory
Module Rating:	2 Credits

1. Introduction of the Course:

The course is organized to provide an adequate knowledge about classification of organisms; definition, concept, evolutionary relationships and tree diagrams; patterns of organization and biodiversity.

2. Course Objectives:

The course is designed:

To introduce students about the key introductory concepts of classification of organisms and their evolutionary relationships.

3. Course Contents

Introduction
- What is sociology
- Sociology & other social sciences
- Sociology & Common sense/Stereotypes
- Key terms – Social Problem/Sociological Issues
- Sociological Perspective

Structuralism
- Structural Functionalism
- Social Conflict

Social Action
- Symbolic Interactionism

Culture
- What is culture?
- Elements of Culture
- Cultural Diversity

Socialization
- Socialization & its importance
- Agents of Socialization
- Socialization through the life course

- C.H. Cooley
- George Herbert Mead

Social Interaction

- Social Structure
- Status
- Status Set
- Achieved & Ascribed
- Master Status
- Role
- Role Set
- Role Conflict
- Role Strain

Theories of Social Interaction (Brief)

- Social Construction of Reality
- Ethno methodology

Groups & Organizations

- Types of Groups
- Studies of Group Behaviour
- Bureaucracy & its Characteristics
- Deviance
- Deviance, Crime & Social Control
- Types of Crime

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcomes:

1. Students are expected to get familiarized with the morphological and anatomical concepts about different cell parts.
2. They will be able to describe, apply and integrate the basic concepts of Cell Biology including Genetics and Evolution, Biochemistry, Physiology as well as Structure and Functions of different Organelles.
3. This will enable them qualify for basic to moderate level jobs involving general knowledge of Biology.
4. The obtained knowledge shall also enable the students to enter into various entrepreneurial activities involving general introduction to botany.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. <u>Recommended Readings</u>:

1. Anderson, Margaret and Howard F. Taylor. (2001) Sociology the Essentials.Australia: Wadsworth.
2. Brown, Ken. (2004). Sociology. UK: Polity Press
3. idden, Anthony (2002). Introduction to Sociology. UK: Polity Press.
4. Macionis, John J. (2006). Sociology. 10 th ed. New Jersey: Prentice-Hall
5. Tischler, Henry L. (2002). Introduction to Sociology. 7th ed. New York:

Module Code: Phy - 203
Module title: Physics – IV (**Concepts of Modern Physics**)

Name of Scheme: BS Chemistry (4 Years)
Semester : 4th
Module Type: General
Module Rating: 2 Credits

1. **Introduction of the Course:**
Special relativity, atomic physics, and quantum mechanics. Theoretical and experimental studies to understand observable properties of matter in terms of microscopic constituents. Emphasis on the use of quantitative reasoning to solve modern physics problems. Writing and scientific ethics assignments based on laboratory experiences. Lecture and laboratory.

2. **Course Objectives**
Objectives of the courses are:
   1. This course covers certain conceptual courses of physics by virtue of which the students will be able to understand some concepts of Quantum Mechanics, Atomic Physics and Nuclear Physics.
   2. It also imparts the basic principles of Quantum mechanics, Schrodinger equation and its applications
   3. To introduce students to the fundamentals of atomic physics and nuclear physics.
   4. To introduce them to the basic Laser principles and Properties.

3. **Course Contents**
Quantum Physics:
Thermal Radiations (Black body radiation); The quantization of Energy; The Photoelectric effect; Einstein's photon theory; The Compton effect; Line Spectra.
Wave Nature of Matter:
Wave behavior of particles; Testing De Broglie's hypothesis; Waves, Wave packets and particles; Heisenberg's uncertainty principle (HUP); Wave Function; Schrödinger Equation.
States and Energy Levels:
Trapped Particles and Probability; Densities; The correspondence principles; Dual nature of matter (waves & particles)
Atomic and Nuclear Physics Atomic Structure of Hydrogen:
Bohr's Theory; Angular Momentum of Electrons; Electron Spin; X-ray Spectrum; X-Ray & Atomic number; Development of periodic table; Laser.
Nuclear Physics:
Discovering the nucleus; Some nuclear properties; Radioactive decay; Alpha decay; Beta decay; Measuring ionizing radiation (Units); Natural Radioactive; Nuclear Reactions; Energy from the nucleus; Nuclear fission; Nuclear Reactors; Thermonuclear Fusion (T.N.F.); Controlled Thermonuclear Fusion.
Practical Paper:
Mechanics, Thermodynamics, Sound, Optics and Electricity or Magnetism:
Special theory of Relativity:
Trouble with classical Mechanics; Postulates of Relativity; The Lorentz Transformation inverse transformation Consequences of Lorentz transformation; Relativistic momentum; Relativistic energy.

4. **Teaching-learning Strategies**
   1. Lectures
   2. Group Discussion
   3. Laboratory work
   4. Seminar/ Workshop

5. **Learning Outcome:**

Upon successful completion of this course, students will be able to:

1. Understand and explain the differences between classical and quantum mechanics.
2. Solve Schrodinger equation for simple potentials.
3. Assess whether a solution to a given problem is physically reasonable.
4. Identify properties of the nucleus and other sub-atomic particles.
5. Describe theories explaining the structure of atoms and the origin of the observed spectra.
6. Explain different Laser used and make a comparison between them

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA.
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA

Module Code:	Phy - 204
Module title:	Physics – IV (Physics Lab)
Name of Scheme:	BS Chemistry (4 Years)
Semester :	4th
Module Type:	General
Module Rating:	1 Credits

1. Introduction of the Course:

Special relativity, atomic physics, and quantum mechanics. Theoretical and experimental studies to understand observable properties of matter in terms of microscopic constituents. Emphasis on the use of quantitative reasoning to solve modern physics problems. Writing and scientific ethics assignments based on laboratory experiences. Lecture and laboratory.

2. Course Objectives

Objectives of the courses are:

Students successfully completing this course will demonstrate knowledge of fundamental concepts in modern physics including special relativity and quantum mechanics and will be able to apply this knowledge to solve problems. Students will also demonstrate a working knowledge of physics-related technical and laboratory skills including data analysis.

3. Course Contents

1. Variation of photo-electric current with the intensity of light
2. Measurement of Planck's constant using spectrometer.
3. Determination of e.m. of electron by deflection method.
4. Determination of ionization potential of mercury.
5. Acceptor circuit.
6. Rejecter circuit.
7. Characteristic curves of G.M. Counter.
8. Setting up half and full wave rectifiers and the study of the waveshape on oscilloscope effect of smoothing circuit on ripple voltage.
9. To set up a transistor as an oscillator and to measure its frequency by an oscilloscope.
10. Triode valve as a single stage voltage amplifier and measurement of its gain by an oscilloscope.
11. To draw the characteristics of a semi-conductor diode.
12. Setting up a single stage transistor amplifier and measurement of voltage gain.
13. Determination of range of Alpha Particles.
14. Stopping power for alpha particles in air equivalent of Mica, Ag, Cu and Al.
15. Absorption coefficient of Beta-particles, using and End-on-Geiger Counter.
16. To study the voltage current characteristics of an electric Discharge in gases at low pressures.
17. Production of vacuum and its rought measurement with a monometer.
18. Production of X-rays and the demonstration of their effect on a fluorescent screen.
19. To set up a High-Frequency Oscillator and measure its frequency, with a wave meter.

4. Teaching-learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

5. Learning Outcome:

Students successfully completing this course will demonstrate knowledge of fundamental concepts in modern physics including special relativity and quantum mechanics and will be able to apply this knowledge to solve problems. Students will also demonstrate a working knowledge of physics-related technical and laboratory skills including data analysis.

6. **Assessment Strategies**:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

7. Recommended Readings:

5. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York
6. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
7. University Physics 8th Edition by Sears, Zemansky and Young, Addison – Wesley, Reading (MA), USA.
8. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA

Common Courses (Combination – I & II)
Semester – V

Module Code:	**Chem-301**
Module title:	**Physical Chemistry – I Electrochemistry**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 credits**

OBJECTIVES

This course will help in understanding basic principles of electrochemistry. Students will be able to use fundamental principles of electrochemistry in development of electrochemical devices like batteries and fuel cells.

SYLLABUS OUTLINES

Basics of electrochemistry, Idea of conductance of electrolytes and its determination, Debye-Huckle equation for all types of solution and limiting law, ionic strength, weak electrolyte and Debye-Huckle theory, Activity and activity coefficients of electrolytic solution, determination of activities, concentration cells, Types of concentration cells, derivation of E.M.F of electrode and electrolyte concentration cells with and without transference, basics of Fuel cells, classification of fuel cells: Alkaline fuel cells, molten carbonate fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, Proton exchange membrane fuel cells and hydrocarbon fuel cells.

RECOMMENDED BOOKS

1. Electrochemical Methods and applications by bard, A. and Faulkner, L.R., John Wiley, New York, 1980.
2. Arun Bahl, B S Bahl & G D Tuli, Essential of Physical Chemistry, S. Chand Publishing New Dehli, 2000.
3. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House Lahore, (2014).
4. Physical Chemistry, Samuel Glasstone, 1995. Macmillan and Co. Ltd. St. marlins Street, London.
5. Principles of Physical chemistry, Maron and Prutton, 1965 the Macmillan Company, Collier Macmillan Ltd. London.
6. Physical Chemistry, Barrow, 1973, McGraw Hill, Tokyo.
7. Physical Chemistry, Moore, 1972, Rentice Hall, Englewood cliffs, Jersey.
8. Physical Chemistry, Alberty and Daniels, 1962, McGraw Hill Book Company Ltd London.
9. Physical chemistry, Atkins, 1989, Oxford University Press, Walton Street, Oxford.
10. Physical Chemistry, Castallan, 1972, Addison Westey Publishing Company, Menla Park, California, London.

PHYSICAL CHEMISTRY (BS CHEMISTRY 5th Semester)

Module Code:	**Chem-302**
Module title:	**Physical Chemistry – II Quantum Chemistry**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 credits**

OBJECTIVES

This course will help in understanding basic principles of kinetic theory of gases and quantum chemistry. This will assist students in calculating bond energies and bond length on the basis of quantum approach.

SYLLABUS OUTLINES

Postulates of quantum theory, Eigen functions, operators, Schrödinger's wave equation, particle in one dimensional box, Normalized wave function and orthogonality, Quantum mechanical tunneling, motion of particle in three dimensional box and idea of degeneracy, separation of variables and derivation of quantum numbers, Mathematical treatment of rigid rotator and calculation of bond length of simple molecules, harmonic oscillator and calculation of bond length of simple molecules, harmonic oscillator and calculation of vibrational frequencies, formation of covalent bond, Mathematical treatment of He_2^+ and H_2 molecules, discussion of overlapping integrals, molecular orbital theory and formation of H_2 and O_2 molecules.

The van der walls equation, Maxwell distribution of molecular velocities and energies, Derivation of average velocity and most probable velocity, Barometric formula, Maxwell-Boltzmann's law of energy distribution

RECOMMENDED BOOKS

1. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).
2. Physical Chemistry, Samuel Glasstone, 1995. Macmillan and Co. Ltd. St. marlins Street, London.
3. Principles of Physical chemistry, Maron and Prutton, 1965 the Macmillan Company, Collier Macmillan Ltd. London.
4. Physical Chemistry, Barrow, 1973, McGraw Hill, Tokyo.
5. Physical Chemistry, Moore, 1972, Rentice Hall, Englewood cliffs, Jersey.
6. Physical Chemistry, Alberty and Daniels, 1962, McGraw Hill Book Company Ltd London.
7. Physical chemistry, Atkins, 1989, Oxford University Press, Walton Street, Oxford.
8. Physical Chemistry, Castallan, 1972, Addson Westey Publishing Company, Menla Park, California, London.

Module Code:	**Chem-303**
Module title:	**Physical Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**1 credit**

OBJECTIVES

The course will provide the practical grounds for the verification of fundamental principles of physical chemistry and applications of these principles. In addition it will enable the students to apply these practical methods in other branches of chemistry. Students will also learn the electrochemical measurements for determination of various physical constants like cell constant and dissociation constant etc. The course will be helpful for students to use conductometry in chemical analysis.

SYLLABUS OUTLINES

1. Preparation of standard molar and Normal solutions and percentage compositions of different substances.
2. Preparation of buffer solution (CH_3COOH and CH_3COONa) of a certain pH.
3. Determination of the equivalence conductance of solution of weak electrolyte at various dilutions at room temperature to verify Oswald's law.
4. Determination of the strength of given base by titrating it against standard Acetic acid solution and HCl solution using conductivity meter.
5. To determine the strength of HCl and CH_3COOH in the given mixture of both by titrating it against NaOH conductometrically.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker.

Module Code:	**Chem-304**
Module title:	**Inorganic Chemistry – I Pi- Acceptor Ligands**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 credits**

OBJECTIVES

This course will help in understanding basic principles of Pi-Acceptor Ligands, Chemical Bonding and Coordination Compounds. This will assist students in understanding the chemistry of Pi-Acceptor Ligands.

SYLLABUS OUTLINE:

1. Metal carbonyls:

Transition metal carbonyls (Mononuclear, Binuclear, Poylnuclear), Effective atomic number rule or the 18 electron rule, Synthesis and bonding situation based on spectroscopic evidences; Theoretical rationalization of molecular structures, Synthesis. Characteristics and reactivity of derivatives of metal carbonyls (carbonylate anions, carbonyl hydrides and carbonyl halides).

2. Metal nitrosyls

Transition metal nitrosyls including halonitrosyl and their derivatives, chemistry of nitroso ferrous sulphate, sodium nitroprusside, Applications of carbonyls and nitrosyls in industry and synthetic chemistry.

RECOMMENDED BOOKS:

1. Inorganic Chemistry by James E. Huheey 1983 Harper International London.
2. Pi-Acceptor Ligands by Zafar Iqbal 1982 U.G.C. Islamabad.
3. Coordination Compounds by S.F.A. Kettle, 1971, Nelson, (Nauohi Kenya).
4. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.

Module Code:	**Chem-305**
Module title:	**Inorganic Chemistry – II Chemical Bonding Theories**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 credits**

OBJECTIVES

This course will help in understanding basic principles of chemical Bonding and Coordination Compounds. This will assist students in understanding the structural chemistry of metal complexes and inorganic molecules.

SYLLABUS OUTLINE:

Theoretical aspects of inorganic compounds:

(a) VSEPR model followed by VB theory (Hybridization, Resonance etc.,) explanation of the structure of AB_2, AB_3, AB_2E, AB_4, AB_3E, AB_2E_2, AB_5, AB_3E_3, AB_6, AB_5E, AB_4E_2, AB_7, AB_6E, AB_8 and AB_9 type molecules.

(b) Discussion of molecular orbitals and molecular structures of homo nuclear molecules and ions, hetero nuclear diatomic and polyatomic molecules and ions.

(c) Bent bond, bridge bond, four electrons-three centre bond.

(d) Shielding effect and effective nuclear charge, Factors affecting the magnitude of σ and $\mathbf{Z_{eff}}$ and their variation in the period table, Applications of Slater's rules, Polarization of ions, Fajan's rules and its applications.

(e) Correlation diagram for triatomic and tetraatomic molecules.

(f) Metallic bond on the basis of band model, X-ray spectra and N(E) curves, n(E) curves. Binding energy in metals, conductors, semi-conductors and insulators. Effect of temperature and impurities on conductivity.

RECOMMENDED BOOKS:

1. Theoretical Principles of Inorganic Chemistry by Manko, G.S. 1980, McGraw Hill.
2. Coordination Chemistry by B.A. Basallo and R. Johnson 1972 W.A. Benhamen, London.
3. Coordination Compounds by S.F.A. Kettle, 1971, Nelson, (Nauohi Kenya).
4. Selected topics of Inorganic Chemistry by G.D Tuli.
5. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.
6. Stereochemistry and bonding in Inorganic Chemistry by by J.E. Ferguson 1974, Prentice Hall, New Jersy.
7. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkineon 1972, Interscience, Publishers, London.

Module Code:	**Chem-306**
Module title:	**Inorganic Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**1 credit**

OBJECTIVES

This course will help in understanding Aqueous Acid-base titration and Argentometric Titrations. This will assist students calculating aqueous acid base titration, estimation of oxalic acid, SO_2, SO_3 CO_2, H_2SO_4, Determination of %age purity of H_3BO_3 and Determine the %age composition of carbonate and bicarbonate in a mixture.

SYLLABUS OUTLINE:

1. Aqueous Acid-base Titrations:

a) Estimation of SO_2 and SO_3 in air and discharged from an industrial process.

b) Estimation of CO_2

c) Estimation of oxalic acid and H_2SO_4 in a mixture.

d) Determination of %age purity of H_3BO_3.

e) Determine the %age composition of carbonate and bicarbonate in a mixture.

2. Argentometric Titrations:

a) Mohr's Method

b) Volhard's Method

c) Adsorption Indicator Method (Fajan's Method)

RECOMMENDED BOOKS:

1. Vogel, I. (1724). A Text-Book Of Macro And Semimicro Qualitative Inorganic Analysis. Willam Clowes And Sons Limited; London; Bxccles.
2. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
3. Quantitative Analysis Chemistry, James S. Pritz, George H. Schenk, 1987 Alby and Becon Inc. London.
4. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
5. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
6. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006.
7.

Module Code:	**Chem-307**
Module title:	**Organic Chemistry – I Fundamental Concepts**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**

Module Type:	**Compulsory**
Module Rating:	**2 Credits**

Objectives

To develop understanding of the rules and basic principles working behind different properties and reactions of organic molecules. To gain knowledge about systematic naming of different types of organic compounds.

SYLLABUS OUTLINES

1. Basic Concepts

Electronic (Inductive and resonance) effects, steric and solvent effects, hyper-conjugation, hydrogen bonding, tautomerism, strength of acids and bases (pKa and Ka values), Influence of all these phenomena on the strength of acids and bases, aromaticity along with non- and anti-aromaticity.

2. Stereochemistry

Rotation around a single bond and the concept of conformational analysis in ethane, propane, butane, pentane, cyclo-pentane, cyclo-hexane, and cis/trans decalin system. Optical isomerism up to three chiral carbon atoms, enantiomers and diasteromers, racemates, racemization and resolution of racemates, epimerization, stereoisomerism of cyclic diphenyls.

Cis/Trans nomenclature, Z and E conventions, determination of configuration, geometrical isomerism in open chain and cyclic compounds, R/S system of nomenclature for isomers with more than one asymmetric carbon, Optical activity

RECOMMENDED BOOKS:

1. Organic Chemistry, (4th - 7th Ed) by Paula Yurkanis Bruice, Pearson Education (Singapore) Pvt. Ltd. 2004-2015.
2. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
3. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
4. A Text-Book of Organic Chemistry by M. Younas, ILMI, Pakistan.
5. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
6. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
7. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and r.K. Boyd, Benjamin Cummings, 1992.
8. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
9. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
10. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code:	**Chem-308**
Module title:	**Organic Chemistry – II Named Reactions**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 Credits**

OBJECTIVES

To acquire knowledge about mechanisms and applications of a set of classis and well known reactions in organic synthesis.

SYLLABOUS OUTLINES:

1. Active Methylene Compounds

Enols and enolates, Kinetic and thermodynamic enolates, alkylation, acylation and halogenation of active methylene compounds, acid and base catalyzed reactions of mono-functional and bi-functional active methylene compounds e.g. malonic ester, β-ketoester, cyanoester, malononitrile, and dinitro compounds etc. Cyclization and decarboxylation.

2. Named Reactions

Description, Conditions, mechanism and synthetic applications of the following named reactions; Aldol, Claisen, Diekmann, Perkin, Henry, Knoevenagel, Reformatsky, Darzen's (glycosidic ester synthesis), and Mannich reaction.

RECOMMENDED BOOKS:

1. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
2. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley,

2007.
3. A Text-Book of Organic Chemistry by M. Younas, ILMI, Pakistan.
4. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
5. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
6. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and R.K. Boyd, Benjamin Cummings, 1992.
7. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
8. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
9. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code:	**Chem-309**
Module title:	**Organic Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**1 Credit**

OBJECTIVES

To develop experimental skills for certain organic reactions, estimation of sugars and detections of functional groups.

SYLLABOUS OUTLINES:

1. **Organic Preparations**:
Benzoic acid from benzaldehyde (Cannizzaro) and from toluene ($KMnO_4$); ethyl benzene from acetophenone; benzilic acid from benzyl and benzyl from benzoin, Iodoform reaction etc.

2. **Quantitative and Qualitative Analysis of Organic compounds:**
Estimation of glucose, and number of acetyl groups, functional group allocation, etc.

RECOMMENDED BOOKS:

1. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
2. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
3. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
4. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
5. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code:	**Chem-310**
Module title:	**Analytical Chemistry – I Analytical Data Handling**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES:

This course will help the students in assessing the analytical data. The students will be able to apply various statistical tests to interpret their observations and the obtained data.

SYLLABUS OUTLINE:

1. **Introduction / Assessment of Analytical Data**
Introduction and scope of Analytical Chemistry: Analytical problems and their solutions; The nature of analytical methods; trends in analytical methods; Different units of concentration and their conversion; Definition and basic concepts: nature and origin of errors, Classification of errors; Accuracy and Precision; Limits of detection, Confidence limits; Deviation, Standard deviation, Application of statistical tests; Rounding off analytical data; Quality control charts; Computation of analytical data. Significance of sampling, weighing and measuring in Analytical chemistry.

RECOMMENDED BOOKS:

1. Analytical Chemistry by J.D. Dick, McGraw Hill, 1973, N.Y. also available in International students edition McGraw Hill, Mogakusha, 1973.
2. Instrumental Methods by W.Ewing, Mc Graw Hill Book Co. N.Y. (Third/Fourth Edition) also available in International students edition.

Module Code:	**Chem-311**
Module title:	**Analytical Chemistry – II Chromatography**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES:

This course will help the students in understanding basic chromatographic techniques. Involving separation of complex mixture. The students will be able to understand ion exchange methods. The students will also learn about the basic concepts of chromatography.

SYLLABUS OUTLINE:

1. **Basic Chromatographic Techniques**
   Basic principle of chromatography, Classifications of Chromatographic Techniques, Column, Paper and Thin Layer Chromatographic Techniques; their instrumentation, applications and limitations.

2. **Ion Exchange Chromatography:**
   Cation Exchange resin, Anion Exchange resin, Cross-linkage, Effect of pH on Amino Acids, Metal ions on Anions/Cations Exchange Columns, Applications of ion Exchange Chromatography.

RECOMMENDED BOOKS:

1. Chromatography by R.K Sharma , Gogel publishing home meerret
2. Introduction to chromatography by Nasir-ud-din, Published by author
3. Modern analytical chemistry by David Harvey, Roohani-art press, Islamabad
4. Principle and Practice of analytical chemistry by Fillfield, Blackwell Science Ltd
5. Fundamentals of Chromatography by H.G. Cassidy, Inter Science Publisher, London, N.Y.
6. Fundamentals of Analytical Chemistry by Doughlas Skoog and Donals M. W. West, Holt Reinchart and Inc, London.
7. Analytical Chemistry by G. D. Christian,

Module Code:	**Chem-312**
Module title:	**Analytical Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**1 credit**

OBJECTIVES:

This course will help the students in assessing the analytical data regarding calibration. The students will be able to apply various statistical tests to interpret their observations and the obtained data of analytical apparatus.

SYLLABUS OUTLINE:

1. **Calibration**
   Calibration of glassware (pipette, burette and flask) used for volumetric analysis. Use of analytical balance and calculation of standard

deviation. Calibration of pH meter and determination of pH of various acidic and basic solution.
Calibration of conductometer and determination of conductance of tap water, distilled water, conductivity water and canal water.
Calculation of dissociation constants of various acids.
Calculation of variance, mean, median, coefficient of variance of the data.

RECOMMENDED BOOKS:

1. Vogels, a text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman.
2. Introduction to chromatography by Nasir-ud-din, Published by author.
3. Paper chromatography by Dr. Friedrich Cramer, London Macmillan and Co Ltd.
4. Thin- layer chromatography by Marini, Elservier publisher.

Module Code:	**Chem-313**
Module title:	**Applied Chemistry – I Unit Operations & Chemicals**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES

This course will help the students in assessing the Unit Operations in Chemical Industry, Basic Chemical Industries and Cement Industries. The students will learn about the basic concepts of chemical industries.

SYLLABUS OUTLINE:

1. Unit Operations in Chemical Industry:
Introduction to chemical industry with reference to Pakistan, Chemistry vs Chemical Engineering, Flow sheet Diagrams, Brief Introduction of different unit operations used in chemical industry. Heat Flow, Convection, Conduction, Heat Exchangers, Distillation, Evaporation, Size Reduction and Size Separation and Filtration.

2. Basic Chemical Industries:
Raw materials; Chemical processes involved; flow sheet diagrams with all the important parameters concerned with the manufacturing of Phosphoric acid; caustic Soda; Calcium oxychloride; Phenol, Phthalic anhydride, Oxalic acid, Paracetamol, and Aspirin, Applications of these chemicals in industry.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Unit operations in Chemical Engineering, Chattopadhyay, Khanna Publishers, Delhi-6.(1993).
3. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers,
4. Small Industries Research Institute, New Delhi (1995)
5. Small Medium and large Scale Industries, A.K. Sirivastawa, Small Industries Research Institute, New Delhi (1996).
6. The Chemistry of Cement, H.F.W. Taylor, Academic Press, London, 1964.
7. Shereve's Chemical Process Industries, 5th Ed.1975 by G.T.Austin McGraw Hill Book Co. New York.
8. Industrial chemistry, B. K. Sharma Krishna Prakashan Media (P) Ltd., Ed-15 (2006).

Module Code:	**Chem-314**
Module title:	**Applied Chemistry – II Allied Chemical Industries**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES

It will help the students to understand the working in Allied Chemical Industries staring from raw material to end finished product.

SYLLABUS OUTLINE:

1. **Cement Industries:**
   Glossary of Cement Terms, Raw materials used for cement manufacturing, Dry process and Wet process, Semi-wet process, Types of Cement, Hydration of Cement, Properties of Cement, Testing of Cement, and Allied Cementing materials
2. **Glass and Ceramics:**
   Glass – Physical and Chemical properties of glass, types of glass, raw materials used for glass, manufacturing of special glass. Ceramics – Classification and properties of ceramics, raw materials, manufacturing of ceramics, application of colors to pottery, refractory.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Industrial Organic Chemicals, by H.A.Witcoff and B.J.Reuben, John Wiley & Sons Inc. New York.
3. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers,
4. The Chemistry of Cement, H.F.W. Taylor, Academic Press, London, 1964.
5. Shereve's Chemical Process Industries, 5th Ed.1975 by G.T.Austin McGraw Hill Book Co. New York.
6. Industrial chemistry, B. K. Sharma Krishna Prakashan Media (P) Ltd., Ed-15 (2006)
7. Chemistry of glass manufacturing, F.W.Hunter, Dower Publications, New York, 1950.

Module Code:	**Chem-315**
Module Title:	**Applied Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 5th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module type:	**Optional**
Module Rating:	**1 credit**

OBJECTIVES

This course content will increase the working skills of students regarding water testing labs and cosmetic industries.

SYLLABUS OUTLINE:

1. **Preparations:**

   Detergent and cosmetics (Cold cream, shampoo and vanishing cream)

2. **Titrimetery:**
   Estimation of water hardness by complexometery
   Estimation of TSS and TDS in water
   Determination of acidity, alkalinity, Free CO_2 in water
   Determine the %age purity of the Commercial sample of sodium chloride.

3. **Spectorphotometery:**

   Determination of the of $KMnO_4$, $K_2Cr_2O_7$ and $CoCl_2$ (λ_{max} and Beer's law verification)

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Unit operations in Chemical Engineering, Chattopadhyay, Khanna Publishers, Delhi-6.(1993).
3. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers,
4. Small Industries Research Institute, New Delhi (1995)
5. Small Medium and large Scale Industries, A.K. Sirivastawa, Small Industries Research Institute, New Delhi (1996).
6. The Chemistry of Cement, H.F.W. Taylor, Academic Press, London, 1964.
7. Shereve's Chemical Process Industries, 5th Ed.1975 by G.T.Austin McGraw Hill Book Co. New York.
8. Industrial chemistry, B. K. Sharma Krishna Prakashan Media (P) Ltd., Ed-15 (2006)

Module Code: **Chem-316**

Module title: **Bio Chemistry – I Carbohydrates**
Name of Scheme: **BS CHEMISTRY 5th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Optional**
Module Rating: **2 credits**

OBJECTIVES

This course will help students to understand major types of carbohydrates and their function in the human body. Students will be able to learn metabolism and metabolic pathways of carbohydrates. It will also help in understanding of ATP production in cell, normal level of blood sugar and its regulation.

SYLLABUS OUTLINES

Introduction, occurrence and importance of Carbohydrates in biosphere and life processes. classification of carbohydrates; chemistry, physical, chemical properties and biological significance of monosaccharide's, oligosaccharides and polysaccharides; Homo-polysaccharides and Hetro-polysaccharides with special emphasis on Glycosaminoglycans. Haworth configuration, D and L configuration of monosaccharides. Optical isomerism and mutarotation in glucose. Invert sugar. A brief discussion of digestion, absorption, and transport of Carbohydrates. Description about the Metabolism, biological importance and ATP production of carbohydrates; glycolysis, citric acid Cycle, HMP pathway, uronic acid pathway. gluconeogenesis, glycogenesis, glycogenolysis, electron transport chain, oxidative phosphorylation and uncoupler agents involved in oxidative phosphorylation.

RECOMMENDED BOOKS

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000
   Pub: worth Publishers
2. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
3. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
4. Lippincott's Biochemistry by Champ C; Harvey.R.A and Ferrie.D.R. 3rd Edition., Pub: J.B. Lippincott company

Module Code: **Chem-317**
Module title: **Bio Chemistry – II General Biochemistry**
Name of Scheme: **BS CHEMISTRY 5th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Optional**
Module Rating: **2 credits**

OBJECTIVES

This course will enable students to understand Fundamental principles of biochemistry. Students will also learn difference between prokaryotic and eukaryotic cells, organelles properties of water, buffers and their role in the human body.

SYLLABUS OUTLINES

Scope and molecular basis of Biochemistry in life. Introduction of living cells; Prokaryotes and Eukaryotes. A brief description on the isolation, structure and functions of cellular organelles. Water; structure, properties of water and aqueous solution. Colligative properties of water and its importance in life. Water interaction in aqueous system. Ionization of water, weak acids and weak bases. pH, Handerson- Hasselbalch equation and buffer systems. Different buffering agents and their importance in biological systems. Electrolytes and acid base balance in body.

RECOMMENDED BOOKS

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000 Pub: Worth Publishers
2. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
3. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.
4. Harpers Biochemistry, 27th Ed. (2006) McGraw Hills Inc.

Module Code: **Chem-318**
Module title: **Bio Chemistry Lab**
Name of Scheme: **BS CHEMISTRY 5th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Optional**
Module Rating: **1 credit**

OBJECTIVES

This course will provide the grounds for distinction between various carbohydrates. In addition, it will help students to apply these practical methods on sugar level determination of human's blood and urine.

SYLLABUS OUTLINES

- Awareness about the preparation of the laboratory solution and pH determination.
- Qualitative and Quantitative tests of various Carbohydrates; Distinction between pentoses and hexoses, aldoses and Ketoses, reducing and non-reducing sugars, mono and polysaccharides.
- Qualitative tests for polysaccharides; starch, glycogen and cellulose.
- Extraction of starch from plant source and its confirmatory tests.
- Acid and enzymatic hydrolysis of polysaccharide.
- Analysis of organic constituents in human urine.
- Determination of sugar level in blood and urine.
- Estimation of glucose in urine.

RECOMMENDED BOOKS

1. Practical clinical Biochemistry by Varley. Pub: C B S Publishers An
2. Introduction to Practical Biochemistry by D. T. Plummer Pub: McGrawHill
3. Varleys Practical Clinical Biochemistry 6th Edition (English, Hardcover, Alan H. Gowenlock)
4. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.

Semester - VI

Module Code: **Chem-319**
Module title: **Physical Chemistry – I Chemical Kinetics**
Name of Scheme: **BS CHEMISTRY 6th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Compulsory**
Module Rating: **2 credits**

OBJECTIVES

Students will acquire knowledge to enable themselves to understand the fundamental principles of chemical kinetics and laws of thermodynamics. Students will also be able to explore the insights of reactions occurring in solution phase and perform related calculations.

SYLLABUS OUTLINES

Chemical kinetics

Concept of rate law and order of reaction, Kinetics of 3rd order reaction with different concentrations and molecular identity, kinetics of opposing, parallel and consecutive reactions, basic experimental methods, Kinetics of thermally excited chain reactions like reaction of H_2 and Br_2, kinetics of thermal decomposition of ozone, N_2O_5 and CH_3CHO.
Effect of temperature on reaction rate, mathematical treatment of collision theory and transition state theory of bimolecular reactions, Comparison of collision theory and Transition state theory with Arrhenius theory, Calculation of entropy and enthalpy

by Eyring equation, effect of ionic strength, hydrostatic pressure on the rate of reaction in solution.

RECOMMENDED BOOKS

1. Atkin, P. and Paula, J. D., Atkin's Physical Chemistry, 2nd ed., Oxford University Press, (2002).
2. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).
3. Physical Chemistry by Kundu, N and Jain, S.K.,S. Chand and Company Ltd. 1984.
4. Fundamentals of Chemical kinetics by Logan, S.R., Longman Group Ltd. 1996.
5. Elementry reaction kinetics by Latham. J.L. and burgess, A.E., 3rd Ed., Butterworths, London, 1997.
6. Physical Chemistry by Atkins, P.W., 5th Ed., W.H. Freeman and Company, New Yark, 1994.
7. Physical Chemistry by Alberty, R.A. and Silbey, R.J., John Wiley, New York, 1995.
8. Physical Chemistry by Engel, T. and Ried, P., 1st Ed,. Pearson education, Inc. 2006.

Module Code:	**Chem-320**
Module title:	**Physical Chemistry – II Thermodynamics**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 credits**

OBJECTIVES

Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics. The course will be helpful for students for basic understanding of statistical thermodynamics. Students will also be able to explore the insights of reactions occurring in solution phase and perform related calculations.

SYLLABUS OUTLINES

Brief introduction of second law of thermodynamics, Clausius inequality, Nernst heat theorem and its applications, Nernst approximation, Maxwell's Relations, third law of thermodynamics, Experimental verification of third law of thermodynamics. Entropy change in solid/liquid and ideal gas, Adiabatic demagnetization.

Sterling's approximation, partition function (Q), its derivation and physical significance, Energy of system in terms of partition function, expression of thermodynamic functions (energy, enthalpy, entropy, heat capacity at constant pressure and volume and free energies) in terms of translational partition function (Q_t), rotational partition function (Q_r), vibrational partition function (Q_v) and electronic partition function (Q_e), Separation of partition functions, expression of free energy and equilibrium constant of reversible chemical reaction in terms of partition function. Entropy and probability.

RECOMMENDED BOOKS

1. Atkin, P. and Paula, J. D., Atkin's Physical Chemistry, 2nd ed., Oxford University Press, (2002).
2. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).
3. Physical Chemistry by Kundu, N and Jain, S.K.,S. Chand and Company Ltd. 1984.
4. Fundamentals of Chemical kinetics by Logan, S.R., Longman Group Ltd. 1996.
5. Elementry reaction kinetics by Latham. J.L. and burgess, A.E., 3rd Ed., Butterworths, London, 1997.
6. Physical Chemistry by Atkins, P.W., 5th Ed., W.H. Freeman and Company, New Yark, 1994.
7. Physical Chemistry by Alberty, R.A. and Silbey, R.J., John Wiley, New York, 1995.
8. Physical Chemistry by Engel, T. and Ried, P., 1st Ed,. Pearson education, Inc. 2006.
9. Principles of Physical Chemistry by Maron and Prutton, Macmillan and Co. Ltd. 1965.
10. Physical Chemistry by Glasstone, S. Macmillan and Co. Ltd., London, 195.
11. Elements of classical and statistical thermodynamics by Nash, L.K. Addison Wesley Co. Ltd., 1979

Module Code:	**Chem-321**
Module title:	**Physical Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**

Module Type: **Compulsory**
Module Rating: **1 credit**

OBJECTIVES

The course will be helpful for students in basic understanding of various physical methods of analysis like refractometry, cryoscopy, spectrophotometry and polarimetry.

SYLLABUS OUTLINES

1. Determination of the percentage composition of a binary solution by refractometry.
2. Determination of the molar mass of a substance by cryoscopic method.
3. Determination of concentration of given colored solution using spectrophotometer.
4. Determination of the eutectic point of a binary mixture (Naphthalene and diphenyl, urea and phenol, benzoic acid and naphthalene) system.
5. Determination of percentage composition of a solution of an optically active substance (Sucrose, glucose).

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker.

Module Code: **Chem-322**
Module title: **Inorganic Chemistry – I Coordination Chemistry**
Name of Scheme: **BS CHEMISTRY 6th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Compulsory**
Module Rating: **2 credits**

OBJECTIVES

This course will familiarize to students about the covalent bond, co-ordination compounds and lanthanides and actinides of chemistry. The students will get knowledge about the VB theory, molecular orbitals and molecular structures of homo nuclear molecules and ions, various kinds of bonds. This course will also assist the students to know about the coordination compounds such as preparative methods, techniques of studying complexes, stability constants, nomenclature, separation and electronic configuration, applications of Lanthanides and Actinides.

SYLLABUS OUTLINE:

Coordination Chemistry

1. Structure & Bonding

Development of coordination compounds, Rules of nomenclature of inorganic compounds. Hybridization in coordination compounds with coordination number from 2 to 9. MO diagrams for metal complexes of common geometry. Important features of CFT, d-orbitals splitting for various common geometries, measurement of 10 Dq., factors effecting 10 Dq. CFSE, factors influencing magnitude of variation in lattice and hydration energy for ions of first transition series.

2. Synthesis and properties

Preparative methods. Techniques of studying complexes, stability constants. The spectrochemical series and colour of metal complexes. Diamagnetism and Para magnetism, stereochemistry, John-Teller Theorem, Isomerism. Role of metal complexes in analytical chemistry, industry and nature.

RECOMMENDED BOOKS:

1. Coordination Chemistry by B.A. Basallo and R. Johnson 1972 W.A. Benhamen, London.
2. Selected topics of Inorganic Chemistry by G.D Tuli.
3. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.
4. R.D.Madan, Satya Prakash's Modern Inorganic Chemistry, S. Chand Company and Ltd, 2002.
5. J.D.Lee, Concise Inorganic Chemistry, 5th Edition.

Module Code: **Chem-323**
Module title: **Inorganic Chemistry – II f-block elements**
Name of Scheme: **BS CHEMISTRY 6th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Compulsory**
Module Rating: **2 credits**

OBJECTIVES

This course will familiarize to students about lanthanides and actinides chemistry. The students will get knowledge about their discovery, extraction, separation, electronic configuration and their applications

SYLLABUS OUTLINE:

1. **Chemistry of Lanthanides**
Types and shapes of 'f'-orbitals, Nomenclature, Position in periodic table, occurrence, Separation, and electronic configuration, oxidation States, Ionic radius, Complex Formation, Comparison of Lanthanides and Actinides, applications of Lanthanides. (Nuclear and Non Nuclear).

2. **Chemistry of Actinides**
Nomenclature, Position in periodic table, occurrence, Separation, and electronic configuration, oxidation States, Ionic radius, Complex Formation, Synthesis of transuranic elements, extraction of Uranium and Thorium, applications of Actinides (Nuclear and Non Nuclear).

RECOMMENDED BOOKS:

1. Inorganic Chemistry by James E. Huheey 1983 Harper International London.
2. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkineon 1972, Interscience, Publishers, London.
3. Selected topics of Inorganic Chemistry by G.D Tuli.
4. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.
5. J.D.Lee, Concise Inorganic Chemistry, 5th Edition.

Module Code: **Chem-324**
Module title: **Inorganic Chemistry Lab**
Name of Scheme: **BS CHEMISTRY 6th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Compulsory**
Module Rating: **1 credit**

OBJECTIVES

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students to determine the complexometric titrations, Redox titrations and preparations of some compounds.

SYLLABUS OUTLINE:

1 **Complexometric Tritrations:**
Estimation of Mg^{+2} , and Zn^{+2} with EDTA (Direct titration).
Estimation of Ni^{+2} with EDTA (Back titration).
Determination of Ca^{+2} and Mg^{+2} in a mixture
Determination of Co^{2+} and Pb^{+2} by using Xylenol Orange Indicator.

2 **Redox Titrations:**

(a) **Iodimetry**
Determine the amount of Iodine dissolved in water using $Na_2S_2O_3$

(b) **Use of potassium iodate for the determination of the followings:**

i) KI ii) Copper iii) H_2O_2 iv) Commercial Hypochlorite

RECOMMENDED BOOKS:

1. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
2. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
3. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
4. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006.

Module Code:	**Chem-325**
Module title:	**Organic Chemistry – I Reaction Mechanism-I**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 Credits**

OBJECTIVES:

To grasp ideas about the mechanisms, basic rules and principles working behind different types of electrophilic and nucleophilic substitutions and free radical reactions of organic compounds.

SYLLABUS OUTLINES:

1. Aromatic Substitution reactions

a. Electrophilic Aromatic Substitutions:
General mechanism (kinetic, isotopic and spectroscopic evidences), nitration, sulfonation, halogenation, Friedel-Crafts alkylation and acylation, orientation and reactivity; poly-substitution reactions of aromatic compounds.

b. Nucleophilic Aromatic Substitutions:
Addition and elimination mechanism, Benzyne mechanism, Radical mechanism, Sandmeyer reaction and its examples.

2. Free Radical Reactions
Introduction, generation methods, relative stability, structure, free radical reactions and industrial applications.:

RECOMMENDED BOOKS:

1. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
2. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
3. A Text-Book of Organic Chemistry by M. Younas, ILMI, Pakistan.
4. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
5. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
6. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and R.K. Boyd, Benjamin Cummings, 1992.
7. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
8. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
9. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code:	**Chem-326**
Module title:	**Organic Chemistry – II Spectroscopy**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**2 Credits**

OBJECTIVES:

To acquire knowledge of the instrumentation, working and applications of UV/Visible and IR spectroscopy and role of these techniques for the characterization of organic compounds.

SYLLABUS OUTLINES:

1. Spectroscopy

a. Infra-Red (IR) Spectroscopy

Electromagnetic radiations: IR; modes of vibration, sampling techniques, Vibration frequencies of different functional groups, factors influencing the vibration frequencies and applications of IR spectroscopy.

b. Ultra-Violet (UV) and Visible Spectroscopy

Ultraviolet (UV) or electronic spectroscopy: electronic transitions; factors influencing the $\lambda_{max.}$ values, Woodward-Fieser rules for calculations of λ_{max}. Applications of UV-Vis. Spectroscopy.

RECOMMENDED BOOKS:

1. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
2. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
3. A Text-Book of Organic Chemistry by M. Younas, ILMI, Pakistan.
4. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
5. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
6. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and R.K. Boyd, Benjamin Cummings, 1992.
7. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
8. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
9. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code:	**Chem-327**
Module title:	**Organic Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**1 Credit**

OBJECTIVES

To gain experimental skills for different organic transformations, separation and identification of two components in a mixture of unknown compounds via systematic physical and chemical tests.

SYLLABUS OUTLINES:

1. Organic Preparations

Synthesis of aromatic nitro, halogens, amines, carboxylic acid, aldehyde and related compounds. (Depending upon the availability of chemicals and reagents)

2. Quantitative and Qualitative Analysis of Organic compounds

Mixture Analysis

Physical/ Chemical separation of mixture containing two Compounds, identification, confirmation and derivatization.

RECOMMENDED BOOKS:

1. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
2. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
3. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
4. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
5. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code:	**Chem-328**
Module title:	**Analytical Chemistry – I Separation Techniques**

Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES:

The course will enable the students to understand the use and mechanism of separation techniques (solvent extraction and electrophoresis) and their application in sample preparation.

SYLLABUS OUTLINE:

1. **Solvent Extraction:**
   Basic principle of solvent extraction, The Distribution Coefficient, The Distribution Ratio, The Percent Extraction Ion, Solvent Extraction of Metals, Multiple Batch Extractions, Countercurrent Distribution

2. **Solid-Phase Extraction:**
   Basic Principle, Mechanism of Separation, Sample Characteristics, Properties of Sorbents, Elution process, SPME

3. **Electrophoresis:**
   Basic Principle, Types of Electrophoresis, Analytical Protocol, Application of Electrophoresis.

RECOMMENDED BOOKS:

1. Vogels, text book of Quantitative chemical analysis by J. Mendham, RCDenny, JDBarnes, MJ KTHomas, Pearson education Ltd.
2. Advances in electrophoresis by Andrea Chrmambach , Wiiley- VCH.
3. Solvent Extraction by Gorge H. & Morrison Hener, John Wiley and sons, London, N.Y.
4. Analytical Chemistry by G.D. Christian.

Module Code:	**Chem-329**
Module title:	**Analytical Chemistry – II Molecular Spectroscopy**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES:

The course will enable the students to understand the use and mechanism of separation techniques (solvent extraction and electrophoresis) and their application in sample preparation. In addition, the students will acquire knowledge about the useful atomic spectroscopic techniques like AES, ICP, AFS and AAS. The students will learn these techniques and their applications in chemical analysis

SYLLABUS OUTLINE:

1. **Introduction to Spectroscopy/Spectrophotometry**
   Introduction to Molecular spectroscopy, absorption in UV and Visible range; Basic principle of Spectrophotometry; Beer-Lambert's law; Deviations; Instrumentation and application.

2. **FTIR / Raman Spectroscopy:**
   Origin of Infra Red Spectra; Different vibrational modes, Normal coordinate and normal vibrations, Symmetry of normal vibrations and selection rule, Raman Spectroscopy,, Vibrational Spectra in gaseous phase and inert gas matrices; Comparison of raman with Infra Red spectroscopy; Applications for qualitative and quantitative chemical analysis; Instrumentation details and their function.

3. **UV / Vis Spectroscopy:**
   The Nature of Electromagnetic Radiation, The Electromagnetic Spectrum, Atomic Energy Levels, molecular Electronic Energy Levels, Instrumentation

Radiation Sources, Wavelength Selection, Cells and Sampling Devices, Detectors, Readout Modules and application.

RECOMMENDED BOOKS:

1. Chemical Application of Spectroscopy by West, Inter Science Publisher Inc. N.Y. London.
2. Kinetics in Analytical Chemistry by H.B. Mark Jr. & G.A. Rechnitz, Interscience N.Y. (1968).
3. Analytical Chemistry by Gary D. Christian, John Wiley and Sons (1977).
4. Automated Chemical Analysis by J.K. Forman Stockwell, John Wiley and Sons, N.Y. (1975).
5. Advances in Infrared Group Frequencies by L.J. Bellacy, Mathuen & Col. Amsterdam (1968).
6. Fundamentals of Molecular Spectroscopy by Banwell.

Module Code:	**Chem-330**
Module title:	**Analytical Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**1 credit**

OBJECTIVES:

Outline of this course covers latest analytical separation techniques involving different types of chromatography. It also finds its applications in various fields regarding organic and in organic separations.

SYLLABUS OUTLINE:

1. Molecular Spectrophotometry:

- Separation of ink components by paper chromatography
- Separation of amino acids by thin layer chromatography
- Separation of dyes by column chromatography
- Separation of mixtures by circular paper chromatography

RECOMMENDED BOOKS:

1. Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman
2. Introduction to chromatography by Nasir-ud-din, Published by author
3. Paper chromatography by Dr. Friedrich Cramer, London Macmilian and Co. Ltd
4. Thin-layer chromatography by Marini, Elservier publisher

Module Code:	**Chem-331**
Module title:	**Applied Chemistry – I Water Treatment and Cleansers**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES

This course content will help the students to understand the chemistry of water regarding its industrial use especially. It will also help them to learn about the operations and processes involved in manufacturing of soaps and detergents.

SYLLABUS OUTLINE:

1. Water For Industry:

Importance of Water in industry; Criteria of water quality for industrial use; Water hardness; softening of water by classical methods, Ion-exchange, Demineralization, Reverse osmosis and Distillation; Boiler Scaling, types, effects and mechanism; Removal of Boiler scales, Physical and Chemical methods.

2. Soaps, Detergents And Disinfectants:

Soaps – Introduction, types, raw materials, counter-current method for soap manufacturing, recovery glycerin from spent lye and sweet water, builders and Additives.

Detergents – Introduction, theory and working of detergents, cationic, anionic and non-ionic and amphoteric detergents, synthesis of typical anionic detergents, fabric softener (introduction and mechanism of action), Environmental impact of detergents.

Disinfectants – Introduction, types and applications.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Water Supply and Sewerage, T.J.McGhee, McGraw Hill Book Co. New York.(1991)
3. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers,
4. Shereve's Chemical Process Industries, 5th Ed.1975 by G.T.Austin McGraw Hill Book Co. New York.
5. Industrial chemistry, B. K. Sharma Krishna Prakashan Media (P) Ltd., Ed-15 (2006)

Module Code:	**Chem-332**
Module title:	**Applied Chemistry – II Unit Processes & Chemicals**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES

This course will help the students in assessing the Unit processes in Organic Industries. The students will learn about the basic raw materials and their applications in chemical industries.

SYLLABUS OUTLINE:

1. Unit Processes in Organic Synthesis:

Introduction, agents, mechanism, general procedure and application of Nitration; Halogenation; Sulphonation; Esterification and Oxidation.

2. Basic Industrial Raw Materials:

Origin/Source, Properties, Chemistry and industrial applications of Acetylene, propylene, Ethylene, BTX, Naphthalene, Butadiene and Styrene.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Shereve's Chemical Process Industries, 5th Ed.1975 by G.T.Austin, McGraw Hill Book Co. New York.
3. Industrial Organic Chemicals, by H.A.Witcoff and B.J.Reuben, John Wiley & Sons Inc. New York.
4. Riegal's handbook of Industrial Chemistry, Ed. J.A.Kent, CBS Publkishers and Distributors, New Delhi (1997).
5. Chemical Process Design, Robin Smith, McGraw Hill Book Co. New York. (1995).
6. Hand Book of Industrial Chemicals, by SIRI Board of Consultants and Engineers, Small Industries Research Institute, New Delhi (1995).
7. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).

Module Code:	**Chem-333**
Module Title:	**Applied Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module type:	**Optional**

Module Rating: **1 credit**

OBJECTIVES

It will the students to increase their working skills in labs, theory and working of Flamephotometery.

SYLLABUS OUTLINE:

1. **Preparations:**
   Dentifrice, Thermo and Thermosetting polymers

2. **Titrimetery:**
   Estimation of Residual and Available Chlorine
   Acidity of Vinegar
   Acidity of Sulphuric acid
   Analysis of Soap (Free and Combined alkalinity)

3. **Flamephotometery:**
   Determination of the Sodium in water
   Determination of Potassium in water
   Simultaneous determination of sodium and potassium in water

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Water Supply and Sewerage, T.J.McGhee, McGraw Hill Book Co. New York.(1991)
3. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers,
4. Shereve's Chemical Process Industries, 5th Ed.1975 by G.T.Austin McGraw Hill Book Co. New York.
5. Industrial chemistry, B. K. Sharma Krishna Prakashan Media (P) Ltd., Ed-15 (2006)

Module Code: **Chem-334**
Module title: **Bio Chemistry – I Proteins**
Name of Scheme: **BS CHEMISTRY 6th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Optional**
Module Rating: **2 credits**

OBJECTIVES:

After studying this course, students will be able to understand classification, properties and importance of amino acids. Students will also learn Structural classification and biological importance of proteins, dietary proteins and their digestion. It will also help to learn general pathways of amino acid catabolism and metabolism.

SYLLABUS OUTLINES

Amino acids: Structure, Chiral Center, stereoisomerism and optical activity. Classification of amino acids; chemical, nutritional, metabolic and R group. Acid base properties of amino acids, their titration curves and importance of titration curves. Biological significance of amino acids and peptides. Proteins: Covalent structure, classification, and biological significance of proteins

including Primary, Secondary, Tertiary and Quaternary structure of proteins, as Keratins, Collagens and elastin. Conformation, structure and function of Fibrous and globular proteins with special reference to Hemoglobin and Myoglobin. Digestion and Absorption of Proteins. Biosynthesis of essential amino acids and their degradation. Urea Cycle, decarboxylation, transamination and deamination reactions of amino acids and their importance. Synthesis and secretion of creatine and creatinine.

RECOMMENDED BOOKS:

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000

Pub: worth Publishers

2. Biochemistry by Lubert Stryer(2006) Pub: Freeman and Company
3. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
4. Lippincott's Biochemistry by champ c; Harvey.R. A and Ferrie. D .R. 3rd edition., Pub: J. B. Lippincott company

Module Code:	**Chem-335**
Module title:	**Bio Chemistry – II Nutrition**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**2 credits**

OBJECTIVES:

After studying this course student will be able to understand Importance of nutrition and Basal Metabolic Rate measurement. Students will also learn basics of Physiological function and requirement of micro and macro minerals. In addition, it will also help in better understanding of Vitamins, its types, physiological function, deficiency symptoms, and daily dietary requirements.

SYLLABUS OUTLINE:

Introduction and importance the science of nutrition: Brief introduction of nutrients, classification of nutrients and their Importance, Importance physiological function and requirement of micro and macro minerals for life and their deficiency symptoms. Introduction and history of vitamins. Classification of vitamins. A discussion of the occurrence, Chemistry, Physiological function, deficiency symptoms, and requirements of Vitamins A, B-Complex, C, D, E and K. Energy value and requirement of food under different living and physiological conditions. Basal metabolic rate (BMR), respiratory quotient and their measurements. Energy expenditure and its importance for health. Direct and Indirect calorimetry methods for the determination of energy expenditure. Thermogenic effect of food and Nutrition status of food in Pakistan.

RECOMMENDED BOOKS:

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000 Pub: worth Publishers
2. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
3. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
4. Advanced Nutrition and Human Metabolism - 6th Edition

Module Code:	**Chem-336**
Module title:	**Bio Chemistry Lab**
Name of Scheme:	**BS CHEMISTRY 6th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Optional**
Module Rating:	**1 credit**

OBJECTIVES:

This study will help students in understanding of practical grounds of different estimation tests of amino acids and proteins. It will also help in hydrolysis of proteins by various methods. Students will also be able to estimate different vitamins in food by chemical methods.

SYLLABUS OUTLINE:

- Qualitative tests and Quantitative tests of amino acids and proteins.
- Determination of isoelectric point.
- Isolation and solubilization of proteins from plant and animal origin.
- Hydrolysis and estimation of proteins by Kjeldahl and Lowry method.
- Estimation of Vitamin A, B1, B2, C and D in food materials by chemical methods and HPLC.
- Separation of different proteins in serum by Polyacrylamide gel electrophoresis (PAGE).

RECOMMENDED BOOKS:

1. Practical clinical Biochemistry by Varley. Pub: CBSpublisher
2. An Introduction to Practical Biochemistry By D. T. Plummer 3rd ed. (1987) Pub: Mc GrawHill
3. Varleys Practical Clinical Biochemistry 6th Edition (English, Hardcover, Alan H. Gowenlock)

Semester - VII

Module Code:	**Chem-400**
Module title:	**Research Thesis**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**4 credits**

OBJECTIVES

Students will acquire knowledge and understanding about the research methodology and report writing. A topic will be allotted to the students by the supervisor. The students will do the literature survey, design their research work and analyze the experimental data and then report their results in the form of thesis. In the end, they will be judged by the presentation and viva voce examination.

Module Code:	**Chem-401**
Module title:	**Physical Chemistry – I Colloids**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will acquire knowledge and understanding about the theoretical as well as application related aspects of various types of colloids and surfactants.

SYLLABUS OUTLINES

Colloids, Colloidal dispersions, sols and their preparation, properties of suspensions, Optional properties of sols, determination of particle size, kinetic properties of sols, sedimention of suspensions, electrical properties of sols, electrophoresis and electro osmosis, stability of suspensoids, precipitation of sols, associated colloids, macromolecular properties in solutions and molecular weight determinations.

Classification, Preparation and Characterization of emulsions, Emulsifiers and their properties, Gibbs surface excess, Micellization, Theories of emulsion type; Orientation wedge theory, kinetic theory. Emulsification and wetting, Stability of emulsions. Classification and properties of gels.

RECOMMENDED BOOKS

1. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
2. Fundamentals of chemical kinetics by Logan, S.R, Longman Group Ltd. 1996.
3. Elementry reaction kinetics by Latham.J.L. And Burgess, A.E.3rd Ed., Butterworths, London, 1977.
4. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).
5. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
6. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
7. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
8. Hand book of surface and Colloid Chemistry by Birdi, K.S., CRC Press, 1997.
9. Heterogeneous Catalysis: Principles and applications by Bond, G.C., 2nd Ed., Oxford, Clarendon press, 1987.
10. Surfactants and interfacial Phenomena by Rosen, Milton J., John Wiley, New York, 1978.

Module Code:	**Chem-402**
Module title:	**Physical Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Students will be trained to carry out laboratory work using various techniques including filtration, solvent extraction, spectrophotometric and conducto-metric methodologies.

SYLLABUS OUTLINES

1. Verification of Freundlich adsorption isotherm for Adsorption of acetic acid on active charcoal.
2. Determination of Critical micelle concentration of various ionic surfactants in water.
3. Determination of the partition coefficient of benzoic acid between organic solvent and water.
4. Determination of the partition coefficient of iodine between CCl_4 and H_2O.
5. Preparation of silver sol and its characterization by UV Visible spectroscopy.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker.

Module Code:	**Chem-403**
Module title:	**Physical Chemistry – II Surface Chemistry**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will acquire knowledge and understanding about the theoretical as well as application related aspects of surface chemistry. They will be able to explore adsorption and catalysis processes including autocatalysis and enzyme catalysis.

SYLLABUS OUTLINES

Adsorption, types of adsorption, Adsorption isotherms, single system, double system, catalytic reaction of a gas on solid surface, catalytic reaction of two gases on solid surface, the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism, Autocatalysis, enzyme catalysis and enzyme inhibition.

RECOMMENDED BOOKS

1. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
2. Fundamentals of chemical kinetics by Logan, S.R, Longman Group Ltd. 1996.
3. Elementry reaction kinetics by Latham.J.L. And Burgess, A.E.3rd Ed., Butterworths, London, 1977.
4. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
5. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
6. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
7. Hand book of surface and Colloid Chemistry by Birdi, K.S., CRC Press, 1997.
8. Heterogeneous Catalysis: Principles and applications by Bond, G.C., 2nd Ed., Oxford, Clarendon press, 1987.
9. Surfactants and interfacial Phenomena by Rosen, Milton J., John Wiley, New York, 1978.
10. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).

Module Code:	**Chem-404**
Module title:	**Physical Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Students will be able to learn spectrophotometric, potentiometric and polarimetric techniques and their use in various applications.

SYLLABUS OUTLINES

1. Determination of percentage composition of two coloured components in solution spectrophotometrically.
2. Study of kinetics of iodination of acetone using UV Visible Spectrophotometry.
3. Determination of concentration of HCl using standard solution of NaOH by potentiometric method.
4. Study of kinetics of inversion of cane sugar using polarimetry.
5. Study of kinetics of decomposition of benzene diazonium chloride.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker.

Module Code:	**Chem-405**
Module title:	**Physical Chemistry – III Molecular Spectroscopy**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will be able to learn fundamentals and applications of both vibrational and rotational spectroscopy. They will be able to analyze IR spectra of various organic molecules.

Special regions and classification of spectroscopy; Rotational energies of diatomic molecules, population of Rotational energy level. Rotational spectra of rigid linear molecules and determination of bond lengths. The Zeeman Effect and Stark effect in atom.

Vibrational spectroscopy: energy of an atomic molecule, harmonic and harmonic oscillator molecules, relative population of energy levels and intensities of transition, types of vibrational modes.

Vibrational of polyatomic molecules, interpretation of IR spectra of simple molecules, Fermi resonance, applications and sampling techniques.

RECOMMENDED BOOKS

1. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
2. Fundamentals of chemical kinetics by Logan, S.R, Longman Group Ltd. 1996.
3. Elementry reaction kinetics by Latham.J.L. And Burgess, A.E.3rd Ed., Butterworths, London, 1977.
4. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
5. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
6. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
7. Hand book of surface and Colloid Chemistry by Birdi, K.S., CRC Press, 1997.
8. Heterogeneous Catalysis: Principles and applications by Bond, G.C., 2nd Ed., Oxford, Clarendon press, 1987.
9. Surfactants and interfacial Phenomena by Rosen, Milton J., John Wiley, New York, 1978.

Module Code:	**Chem-406**
Module title:	**Physical Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

This lab course will be highly helpful for students to learn about optical activity of organic compounds, analysis of IR spectra of simple organic molecules and use of refractive index for different purposes.

SYLLABUS OUTLINES

1. Predicting normal modes of vibration for simple molecules and interpretation of their IR Spectra.
2. Determination of specific rotation and molar rotation of optically active substances (sucrose and glucose).
3. Determination of wavelength of maximum absorption of various colored substances.
4. Determination of Dissociation Constant of an Acid by Spectrophotometric Method.
5. Determination of specific refraction and molar refraction of binary solutions.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker.

Module Code:	**Chem-407**
Module title:	**Physical Chemistry – IV Solution Chemistry**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

This course will be helpful for students for their learning in fundamentals of solution chemistry.

SYLLABUS OUTLINES

The thermodynamic properties of solution. The solution process. Conditions of equilibrium between phases. Theoretical basis of Raoults equation. Deviation from ideal behavior. Compound formation and association. Separation of solid solutions. Semi Permeable membranes. The cause of semi-permeability. Mechanism of osmotic pressure. Dilute solutions and the Gas Laws. The Bombardment theory. Objections to the Bombardment theory. Review of the theories. Determination of the molecular weight by Osmometry.

RECOMMENDED BOOKS

1. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
2. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
3. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
4. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
5. Physical Chemistry, Samuel Glasstone, 1995. Macmillan and Co. Ltd. St. marlins Street, London.
6. Principles of Physical chemistry, Maron and Prutton, 1965 the Macmillan Company, Collier Macmillan Ltd. London.
7. Physical Chemistry, Barrow, 1973, McGraw Hill, Tokyo.

Module Code:	**Chem-408**
Module title:	**Inorganic Chemistry – I Periodicity**

Name of Scheme: **BS CHEMISTRY 7th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 credits**

OBJECTIVES:

The aim of this course is to provide the concepts for better understanding of advance study in inorganic chemistry and other interdisciplinary subject related to inorganic chemistry. The students will learn about stereochemistry and bonding in main group compounds, periodicity and organic reagents used in inorganic analysis.

SYLLABUS OUTLINE:

1. **Periodicity of s-Block block elements:**
   Introduction, Occurrence and Abundance, Extraction of these metals, Flame colours and spectra, Chemical Properties, Oxides, hydroxides, Sulfides, Hydrides, Oxosalts, Nitrates, Carbides, Halide, Biological importance.

2. **Periodicity of p-Block block elements:**
   Introduction, Occurrence and Abundance, 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 the non-metals and post-transition metals, $d\pi$-$P\pi$ bonds.

RECOMMENDED BOOKS:

1. Quantitative Analysis Chemistry, James S. Pritz, George H. Schenk, 1987 Alby and Becon Inc. London.
2. Inorganic Chemistry by James E. Huheey 1983 Harper International London.
3. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkineon 1972, Interscience, Publishers, London.
4. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.
5. R.D.Madan, Satya Prakash's Modern Inorganic Chemistry, S. Chand Company and Ltd, 2002.

Module Code: **Chem-409**
Module title: **Inorganic Chemistry Lab - I**
Name of Scheme: **BS CHEMISTRY 7th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **1 credit**

OBJECTIVES

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students, use of organic reagents for the estimation of various cations and anions.

SYLLABUS OUTLINE:

1. **Use of organic reagents for the estimation of various ions;**

   (At least any four of the following):

   (a) 8-Hydroxyquinoline (Al^{3+}, Ti^{3+}, Fe^{3+})
   (b) Pyrogallol (Bi^{3+})
   (c) Nitron (NO_3^{1-})
   (d) Salicyladoxime (Ni^{2+} in presence of Cu^{2+})
   (e) Anthranilic acid (Cd^{2+}, Zn^{2+}, Co^{2+})

RECOMMENDED BOOKS:

1. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
2. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
3. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
4. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006.

Module Code:	**Chem-410**
Module title:	**Inorganic Chemistry – II Reagents and Solvents**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

The aim of this course is to provide the concepts for better understanding of advance study in inorganic chemistry and other interdisciplinary subject related to inorganic chemistry. The students will learn about stereochemistry and bonding in main group compounds, periodicity and organic reagents used in inorganic analysis.

SYLLABUS OUTLINE:

1. **Organic Reagents:**
   Classification of organic reagents, their selectivity and specificity, methods of preparation of specific compounds and their studies with UV, Visible and IR. Typical reagents used in complexometric titrations involving the use of EDTA. Chelates, classification, stability, preparation and properties. Role of organic Reagents in different analytical techniques.

2. **Aqueous and non-aqueous solvents:**
   Classification of solvents, types of reactions, the dielectric constant, solubilities, electrode potential and electromotive forces. Reactions in water and molten salts. Reactions in non-aqueous solvents, i.e. ammonia, sulfur dioxide, brominetrifluoride and hydrofluoric acid.

RECOMMENDED BOOKS:

1. Hand Book of Organic reagents in Inorganic Analysis by ZAVIX Holzbecher and other 1976 Ellis Hurwod Limited, London.
2. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
3. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkineon 1972, Interscience, Publishers, London.
4. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.
5. Sisler, H.H. 1965. Chemistry in Non-Aqueous Solvents. Chapman & Hall Ltd.
6. House, J.E. 2010. Inorganic Chemistry. Academic Press, USA.

Module Code:	**Chem-411**
Module title:	**Inorganic Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students use of organic reagents for the estimation of various metal ions, instrumental methods of analysis.

SYLLABUS OUTLINE:

1. **Instrumental methods of analysis:**

   Colorimetry:

   - **i).** Micro determination of chromium bydiphenyl Carbazide.
   - **ii).** Determination of iron(II) by 1, 10 Phenanthroline.
   - **iii).** Determination of nickel (II) by DMG
   - **iv).** Determination of Pb (II) by Dithizone.

RECOMMENDED BOOKS:

1. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
2. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
3. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
4. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006

Module Code:	**Chem-412**
Module title:	**Inorganic Chemistry – III Kinetic & Thermodynamic**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

The aim of this course is to provide the concepts for better understanding of advance study in inorganic chemistry and other interdisciplinary subject related to inorganic chemistry. The students will learn about kinetics and mechanisms of reaction of coordination compounds, reactions in aqueous and non-aqueous solvents and radioactivity.

SYLLABUS OUTLINE:

1. **Kinetic aspects**

   Introduction of reaction rate law and mechanism of stationary state approximation. Type of reactions, nucleophilic displacements, effective collisions. Dis-placement in square planar complexes, trans-effect, replacement in octahedral complexes, inert and labile complexes, (VBT, CFT explanation), Inner and outer sphere exchange reactions.

2. **Thermodynamic aspects:**

   Thermodynamic and kinetic stability, Interpretation of stability, Role of thermodynamics in interpretative chemistry, The lattice energy as a criterion of bond type, Quantitative uses of the lattice energy, The Kapustunskii equations, The stabilization of high oxidation states by fluorine and oxygen, The stabilization of low oxidation states by large anions, Halogen exchange reaction, The stability of halides containing protonated bases.

RECOMMENDED BOOKS:

1. Coordination Chemistry by B.A. Basallo and R. Johnson 1972 W.A. Benhamen, London.
2. Haq Nawaz Bhatti and Rabia Rehman, Advanced Inorganic Chemistry", Carvan Book House Lahore.
3. Some Thermodynamic Aspects of Inorganic Chemistry By David Arthur Johnson.
4. Chemical thermodynamics: with special reference to inorganic chemistry by David J. G. Ives.

Module Code:	**Chem-413**
Module title:	**Inorganic chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

Objectives:

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students use of organic reagents for the estimation of various metal ions, instrumental methods of analysis. This student will also learn about the identify acid and basic radicals of given salt by chemical analysis.

SYLLABUS OUTLINE:

1. **Salt Analysis:**

Identify acid and basic radicals of given salt by chemical analysis.

2. Chromatographic Techniques

a) Separation of metal ions by paper chromatography and their identification with the help of locating agents and comparison of R_f values.

b) Separation of anions by paper chromatography and their identification.

RECOMMENDED BOOKS:

1. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
2. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
3. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
4. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006.

Module Code:	**Chem-414**
Module title:	**Inorganic Chemistry – IV Environmental Aspects**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

The aim of this course is to provide the concepts for better understanding of advance study in inorganic chemistry and other interdisciplinary subject related to inorganic chemistry. The students will learn about stereochemistry and bonding in main group compounds, periodicity and organic reagents used in inorganic analysis.

SYLLABUS OUTLINE:

1. Environmental aspects of inorganic compounds:

Introduction, environmental segments and their interrelation ships (Water Cycle, Oxygen Cycle, Nitrogen Cycle), Environmental quality standards (air, drinking water and wastewater), nature and composition of atmosphere,, common air pollutants and their sources, greenhouse effect and global warming, stratospheric ozone depletion, vehicular emissions, Acid rain and its impacts, Photochemical smog, Indoor air quality. Importance of water, criteria for water quality, BOD and COD, sources of water pollution (industrial, agricultural, municipal and natural), fertilizers, pesticides, detergents, heavy metals, bio-accumulation and bio-amplification, primary, secondary and advanced treatment of water.

RECOMMENDED BOOKS:

1. J.W. Moore & EM. Moore, Environmental Chemistry, Academic Press, New York.
2. Manahan, S. (2017). Environmental chemistry. CRC press.
3. Sharma, B. K. (2014). Environmental chemistry. Krishna Prakashan Media.

Module Code:	**Chem-415**
Module title:	**Organic Chemistry – I Reaction Mechanism-II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

To get ideas about the development of mechanisms and basic principles working behind different types of molecular rearrangement based reactions of organic compounds.

SYLLABUS OUTLINES:

1. Molecular Rearrangements

Classification of molecular rearrangements: mechanism of intramolecular 1,2-shifts involving migration of a group from carbon to carbon, carbon to nitrogen, and carbon to oxygen, mechanism and synthetic applications of Wagner-Meerwein, Pinacol-pinacolone, benzylic acid, Favorski, Wolff, Beckmann, Hoffmann, Curtius, Lossen and Schmidt; Baeyer-Villiger, Dakin and Fries rearrangements.

2. Determination of Reaction Mechanism

Determination of reaction mechanism, kinetics, stereochemical, intermediate formation, spectroscopic and isotopic labeling methods.

RECOMMENDED BOOKS:

1. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
2. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
3. A Text-Book of Organic Chemistry by M. Younas, ILMI, Pakistan.
4. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
5. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
6. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and r.K. Boyd, Benjamin Cummings, 1992.
7. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
8. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
9. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code:	**Chem-416**
Module title:	**Organic Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

To gain experimental skills for separation and identification of three components in a mixture of unknown compounds via systematic physical and chemical tests.

SYLLABUS OUTLINES:

1. Qualitative analysis

Three component organic mixture analysis (separation and identification of three unknown components). Recrystallization and Derivatizations

RECOMMENDED BOOKS:

1. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
2. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
3. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
4. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
5. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code:	**Chem-417**
Module title:	**Organic Chemistry – II Oxidation & Reduction**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

To achieve knowledge about the mechanisms and principles operative in different types of methods for oxidation and reduction of organic compounds.

SYLLABUS OUTLINES:

1. Oxidation Reactions

Introduction, oxidation of saturated hydrocarbons, olefinic double bonds, aromatic rings, systems containing oxygen such as phenols, alcohols, aldehydes, ketones, and dicarbonyl compounds, oxidative decarboxylation, of acids, oxidation of systems containing nitrogen such as amines, hydrazines and hydrazones.

2. Reduction Reactions

Introduction, reduction of cycloalkanes, alkenes, alkynes, and aromatic rings, hydrogenolysis, reduction of benzylic and allylic systems, aldehydes and ketones, alcohols, pinacols, epoxides, acids and their derivatives, Reduction of system containing nitrogen such as imines, oximes and nitro compounds.

RECOMMENDED BOOKS:

1. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
2. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
3. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
4. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
5. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and r.K. Boyd, Benjamin Cummings, 1992.
6. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
7. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
8. Heterocyclic Chemistry, (4th Ed.), by J.A. Joules, K. Mills, Blackwell Publishing, 2000.
9. Heterocyclic Chemistry, (3rd Ed.), by T.L. Gilchrist, Longman, 1997.
10. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code:	**Chem-418**
Module title:	**Organic Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

To gain experimental skills for separation, purification by chromatography (TLC, etc) and analysis of different organic compounds by spectroscopy (UV, IR).

SYLLABUS OUTLINES:

1. Chromatography and Spectroscopy

Separation of mixtures of different organic compounds and isomers (Nitroanilines, bromoanilines, nitro and bromophenols etc) by silica chromatography and identification by spectroscopy (UV-Vis. IR etc).

RECOMMENDED BOOKS:

1. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
2. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
3. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
4. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
5. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code:	**Chem-419**
Module title:	**Organic Chemistry – III Reaction Mechanism-III**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**

Module Type: **Elective**
Module Rating: **2 credits**

OBJECTIVES:

To grasp ideas about the mechanisms, basic rules and principles working behind different types of nucleophilic substitutions and elimination reactions.

SYLLABUS OUTLINES:

1. Aliphatic Nucleophilic Substitutions

Mechanism of S_N1, S_N2, S_Ni, S_N1', S_N2' and S_Ni' reactions, kinetics, stereochemical and other evidence; effects of other substrate structure, attacking nucleophile, leaving group and solvent; neighboring group participation (Anchimeric assistance).

2. Elimination Reactions

Mechanism of E_1, E_2, and E_1cB elimination reactions; kinetics and stereochemical studies; applications of thermodynamically and kinetically controlled reactions (Saytzeff and Hoffmann reactions), Effects of substrates, solvent, base, leaving group and temperature on kinetics, competition between elimination and substitution reactions. Pyrolytic eliminations.

RECOMMENDED BOOKS:

1. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
2. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
3. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
4. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
5. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and r.K. Boyd, Benjamin Cummings, 1992.
6. Modern Synthetic Reactions, (2nd Ed.) by H.O. House, W.A. Banjamin Inc., Menlo Park, CA.
7. Principals in Organic Synthesis, by R.O.C. Norman and M.J. Coxon, Chapman and Hall, 1993.
8. Heterocyclic Chemistry, (4th Ed.), by J.A. Joules, K. Mills, Blackwell Publishing, 2000.
9. Heterocyclic Chemistry, (3rd Ed.), by T.L. Gilchrist, Longman, 1997.
10. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code: **Chem-420**
Module title: **Organic Chemistry Lab - III**
Name of Scheme: **BS CHEMISTRY 7th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **1 credit**

OBJECTIVES:

To gain experimental skills for different organic transformations, workups, separation and identification of products obtained in a multistep synthesis.

SYLLABUS OUTLINES:

1. Multistep Organic Preparations

Conversion of carboxylic acid to ester, its reduction to alcohol; Conversion of alcohol to alkyl halide and carbonyl compounds; Protection and deprotections; Aniline to 4-nitro- and 4-bromoanilines *via* acetanilide etc

RECOMMENDED BOOKS:

1. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
2. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
3. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
4. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
5. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code: **Chem-421**

Module title: **Organic Chemistry – IV NMR Spectroscopy**
Name of Scheme: **BS CHEMISTRY 7th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 credits**

SYLLABUS OUTLINES:

1. Nuclear Magnetic Resonance (NMR) Spectroscopy

NMR: Basic principles, theory, spin flipping, nuclear precession and absorption of electromagnetic radiation, spin relaxation, basic introduction of 1-D (^{1}H and ^{13}C) NMR spectroscopy, chemical shifts and integration curve, instrumentation, spin-spin splitting and coupling constants. Structure elucidation of small and substituted aromatic compounds.

RECOMMENDED BOOKS:

1. Organic Spectroscopy and Chromatography, by M. Younas. Ilmi kitab khana, kabir street, urdu bazar, Lahore.
2. Organic Chemistry, (4th-7th Ed) by Paula Yurkanis Bruice, Pearson Education (Singapore) Pvt. Ltd. 2004-2015.
3. Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, (2nd – 5th Ed). Saunders Golden Sunburst Series, 1996-2018.
4. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
5. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
6. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
7. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.
8. Basic One and Two-Dimensional NMR Spectroscopy by Jack K. Becconsall (4th Ed). Wiley-VCH verlag GmbH & Co. KGaA, 2005.

Module Code: **Chem-422**
Module title: **Analytical Chemistry – II Electroanalysis Method-I**
Name of Scheme: **BS CHEMISTRY 7th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 credits**

OBJECTIVES:

This course deals with the advanced chromatographic techniques like HPLC and GC. The students will learn about the instrumentation, applications and the sensitivities etc of these techniques. Furthermore, basic principle and applications of Potentiometry along with the various electrodes will be studied. The role of thermal methods in the analysis of various samples will be studied.

SYLLABUS OUTLINE:

1. Potentiometry:
Nernst equation; Electrode Potentials; different reference electrodes including glass and calomel electrode; working of a potentiometer and its applications including pH measurements and potentiometric titrations; ion-selective electrode systems; ion-exchange membrane electrode; gas-sensinig electrode; solid-state membrane electrode and bio membrane electrode.

2. Conductometry:
Conductance in Solutions; Specific conductance; molar conductance; factors upon which the conductance of solution depends; Measurement of conductance/Instrumentation; cell constant; Analytical applications of conductance measurement.

RECOMMENDED BOOKS:

1. Electro Analytical Chemistry by J.J. Longane, Inter Science Publisher Inc. N.Y. London.
2. Vogels, text book of Quantitative chemical analysis by J.mendham, RCDenny, JDBarnes, MJ KTHomas, Pearson education Ltd.

Module Code: **Chem-423**

Module title:	**Analytical Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

This course will be helpful to students in understanding electroanalytical techniques. Its basic and advance applications in aqueous and non aqueous titerations.

SYLLABUS OUTLINE:

1. Conductometry:

Determine the amount of HCl conductometrically by using strong base NaOH.
Determine the amount of base NH_4OH conductometrically by using strong acid.
Determine the amount of NH_4OH by using weak acid CH_3COOH conductometrically.
Determine the amount of NaOH conductometrically by using weak acid CH_3COOH.

2. Potentiometry:

Determine the amount of HCl by using strong base (NaOH) potentiometrically.
Determine the amount of HCl by using weak base (NH4OH) potentiometrically.
Determine the amount of CH3COOH by using strong base (naoh).
Determine the amount of HCl & CH3COOh conductometrically by using strong base NaOH.
Simple acid base titrations using potentiometer.
Determination of "F" in water by using ion selective electrodes.

RECOMMENDED BOOKS:

1. Vogels, text book of Quantitative chemical analysis by J.mendham, RCDenny, JDBarnes, MJ KTHomas, Pearson education Ltd.

Module Code:	**Chem-424**
Module title:	**Analytical Chemistry – II Atomic Spectroscopy**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

In this course, the students ll be able to learn about Atomic emission, atomic absorption and atomic floresence spectroscopic techniques. Its application in advance analytical testing of organic and inorganic samples.

SYLLABUS OUTLINE:

1. Atomic Emission / Atomic Florescence Spectroscopy:

Basic principle of atomic emission spectroscopy; Source of atomization; Use of atomic spectra for detection and determination of elements; flame as a source of atomization and excitation; Instrumentation involved in FES; applications and limitations, Flame temperatures. Atomic Florescence Spectroscopy, Instrumentation, Applications, plasma sources and ICP-AES.

2. Atomic Absorption Spectroscopy:

Basic Principle of AAS; Flameless AA spectroscopy including graphite furnace and hydride generation.Interferences, Instrumentation and application and limitation.

RECOMMENDED BOOKS:

1. Chemical Application of Spectroscopy by West, Inter Science Publisher Inc. N.Y. London.
2. Kinetics in Analytical Chemistry by H.B. Mark Jr. & G.A. Rechnitz, Interscience N.Y. (1968).

3. Analytical Chemistry by Gary D. Christian, John Wiley and Sons (1977).
4. Automated Chemical Analysis by J.K. Forman Stockwell, John Wiley and Sons, N.Y. (1975).
5. Advances in Infrared Group Frequencies by L.J. Bellacy, Mathuen & Col. Amsterdam (1968).
6. Fundamentals of Molecular Spectroscopy by Banwell.

Module Code:	**Chem-425**
Module title:	**Analytical Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

The students will be able to prepare the solutions of various concentrations. They will understand the use of atomic spectroscopic techniques for the practical determination of various elements in the given samples. They will also learn how to use the molecular spectroscopy and obtaining the valuable information.

SYLLABUS OUTLINE:

1. Flame Emission / Spectrophotometry:

Determination of Sodium in tap water by using Flame Photometer.
Determination of Potassium in tap water by using Flame Photometer.
Find out the calcium in chalk sample by flame photometry.
Determination of Ba by flame photometry.
Estimation of purity of various compounds on the base of flame emission Spectrophotometry.
Indirect determination of various compounds by flame photometric techniques.

2. Atomic Absorption/ Spectrophotometry:

Determination of Fe, Pb, Cd, Zn and Cu in soil samples by AAS technique.
Preparation of standard calibration graphs of Pb, Cd, Zn and Fe by AAS.

RECOMMENDED BOOKS:

1. Vogels, s text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman

Module Code:	**Chem-426**
Module title:	**Analytical Chemistry – III Advance Chromatography**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

This course deals with the advanced chromatographic techniques like HPLC and GC. The students will learn about the instrumentation, applications and the sensitivities etc of these techniques. Furthermore, basic principle and applications of Potentiometry along with the various electrodes will be studied. The role of thermal methods in the analysis of various samples will be studied.

SYLLABUS OUTLINE:

1. Gas Liquid Chromatography / Gas Solid Chromatography:

Gas Chromatographs, Derivative Formation, Gas Chromatographic Columns, Liquid Phases and Column Selection, Detectors for Gas Chromatography, Optimization of Experimental Condition, Gas-Solid Chromatography, Interfacing Gas Chromatography with Mass Spectrometry, Interfacing Gas Chromatography with Infrared Spectrometry,

2. High Performance Liquid Chromatography:

Optimization of Column Performance, Gradient Elution and Related Procedures, Derivation, HPLC Instrumentation, Mobile-Phase Delivery System, Sample Introduction, Separation Columns, Detectors, Interfacing HPLC with Mass Spectrometry, Instrumentation, detectors, sensitivity, precisian, sample types and qualitative and quantitative analysis.

RECOMMENDED BOOKS:

1. Electroanalytical chemistry by J.J. Longane, Inter Science Publisher Inc. N.Y. London..

Module Code:	**Chem-427**
Module title:	**Analytical Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

This course will help the students in hands on training on HPLC and Gas Chromatographic advance instrumentation. This course finds its application in various inorganic and organic samples analysis at trace levels.

SYLLABUS OUTLINE:

- Analysis of some drug samples (for example, Paracetamol and Caffeine) by HPLC.
- Determination of inorganic ions by HPLC.
- Isolation of compounds from plant extracts by HPLC.
- Gas Chromatographic MS Analysis of volatile samples
- Gas Chromatographic MS Analysis of vegetable oils

RECOMMENDED BOOKS:

1. Vogels, s text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman
2. Anlaytical Chemistry by G.D. Christian.

Module Code:	**Chem-428**
Module title:	**Analytical Chemistry – IV Environmental Chemistry**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

This course will help the students to learn the significance of environmental degradation, impact of the modern life use of acid value, ester value, sponification value and iodine value of different vegetable oils, dissolved oxygen, biological oxygen n demand, chemical oxygen demand an industrial analysis. The student will also learn about industrial analysis and textile.

SYLLABUS OUTLINE:

1. Analytical Techniques for pollutant Analysis

Techniques for the analysis of emerging pollutants in aqueous system like PCB, PAH, THM, HAA.
Guidelines, Parameters, MCL and threshold values by US-EPA, ASTM, Pak-EPA.

2. Environmental Pollution

Introduction: Environmental pollution in the world and in Pakistan. Oxygen and ozone chemistry: Ozone depletion and its biochemical affect, sulfur dioxide, nitrogen oxide, chlorofluorocarbons, greenhouse effect. Hazards of pesticides: Hazards to man, soil, plant and animals. Water contamination through pesticides disposal, ground water contamination by herbicides. Effects of nitrogen fertilizer: Plant effluent discharges in soil, composition of fertilizer plant effluent discharges, effect and fate of nitrogen fertilizer effluent discharges in the soil ecosystem, suggestion for controlling adverse effects of fertilizer plant effluent

and conservation of soil, leaching of fertilizer into soil, factors affecting nitrate, sulphate phosphate accumulation, losses of methane and ammonia from paddyland production system, global sources of methane, or sinks of methane. Atmospheric changes and sources of ammonia. Public awareness: Improper disposal/dumping of hazardous waste of landfills.

RECOMMENDED BOOKS:

1. Kumar. Environmental Chemistry, Wiley Eastern, New Delhi.
2. J.W. Moore & EM. Moore, Environmental Chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental Chemistry, Prentice Hafl, Delhi.
4. K. Banerji, Environmental Chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental Chemistry, Brooks, California.
6. Neil, P.O. Environmental Chemistry, Chapmann, London.
7. Baird, C. Environmental Chemistry, Freeman, New York.
8. Hassol, K.A. 1992. Biochemistry of Pesticides. McMillan Publishing Co. Ltd. USA.
9. Kumar. 1987. Environmental Chemistry. Anmol Publication, New Dehli, India.
10. Evangelon, V. P. 1998. Environmental Soil and Water Chemistry. John Willey, USA.
11. McBride, M.B. 1994. Environmental Chemistry of Soils. Oxford University Press, UK.

Module Code:	**Chem-429**
Module title:	**Applied Chemistry – I Fuel Chemistry**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

The students will learn about the existing energy resources; their processing, refining and utilization.

SYLLABUS OUTLINE:

1. Processing of Crude Oil:

Brief description of origin of petroleum, Petroleum processing like Desalting, Fractional distillation; Refining, cracking; reforming, isomerization; alkylation and finishing processes (Doctor's Sweetening and Merox processes)

2. Coal Chemicals & Fuel Gases:

The destructive distillation of coal, coking of coal distillation of coal tar; Liquid Fuels: Hydrogenelysis Natural gas; Coal Gas: Water Gas; Liquefied Petroleum Gases; LNG; Producer gas.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Petroleum Refining Technology, Ram Parsad (2002).
3. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
4. Shereve's Chemical Process Industries, 5th Ed.1975, by G.T.Austin, McGraw Hill Book Co. New York.

Module Code:	**Chem-430**
Module title:	**Applied Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

It will increase the practical handling of fuels and their characterization. Also they will have some know how about the heavy metal load in industrial effluents.

SYLLABUS OUTLINE:

Determination of Diesel index, Aniline point and pour point of petroleum products
Proximate analysis of Coal
Heavy metal Analysis in Industrial Effluents

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Petroleum Refining Technology, Ram Parsad (2002).
3. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
4. Shereve's Chemical Process Industries, 5th Ed.1975, by G.T.Austin, McGraw Hill Book Co. New York.

Module Code:	**Chem-431**
Module title:	**Applied Chemistry – II Steel & Metal Finishing**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

The students will learn about the metallurgical operation regarding steel industry as well as classical and advance technologies to save iron from corrosion.

SYLLABUS OUTLINE:

1. Steel Industry:

Steel – Mechanical properties of materials and change with respect to temperature, phase diagram of Fe-C system, manufacturing of steel, classification of steel, heat treatment of steel, important alloys of iron and their applications. Types of Corrosion and passivation techniques

2. Metal Finishing Technology:

Introduction, need for surface treatment, different surface finishing processes, basics of electrodeposition, electroplating principles, electrochemistry applied to electroplating, mechanical preparation of surfaces - pickling, cleaning, rinsing, composition and conditions of plating bath, electroplating of metals-chromium, nickel, electroplating of plastics, electroplating waste treatment and metal recovery.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Chemistry of iron and Steel Manufacture, C. Bodsworth, Longman Press, London, 1963.
3. Graham's Electroplating Engineering Hand Book, Ed. L.J. Durney, CBS Publishers and Distributors, New Delhi. (1997).
4. Nickel and Chromium plating, J.K. Dennis & T.E. Such, Newness Butterworth, London (1972).

Module Code:	**Chem-432**
Module title:	**Applied Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Students will learn that how to apply the basic and instrumental techniques to determine metal ions in metallurgical samples.

SYLLABUS OUTLINE:

Analysis Iron in steel by titrimetry, Analysis of Nickel in steel by Gravimetry and Solvent Extraction, Analysis of Chromium in

steel by Spectrophotometry, Heavy metal analysis of steel by AAS, Analysis of dolomite, chromite and bauxite Ore by titration method.

RECOMMENDED BOOKS:

5. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
6. Chemistry of iron and Steel Manufacture, C. Bodsworth, Longman Press, London, 1963.
7. Graham's Electroplating Engineering Hand Book, Ed. L.J. Durney, CBS Publishers and Distributors, New Delhi. (1997).
8. Nickel and Chromium plating, J.K. Dennis & T.E. Such, Newness Butterworth, London (1972).

Module Code:	**Chem-433**
Module title:	**Applied Chemistry – III Analytical Techniques**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will learn about the principle, theory and working of basic analytical techniques

SYLLABUS OUTLINE:

1. Chromatography

a. Thin Layer Chromatography –

Basic principle, theory and mechanism, stationary and mobile phase selection, locating reagents, applications, introduction to HPTLC

b. High Performance Liquid Chromatography (HPLC) –

Basic principle, types, theory and mechanism, stationary and mobile phase selection and types, basic parts of HPLC including pump, column, injector, detector, thermostat etc. Explanation of typical chromatogram highlighting retention time, peak height and width, tailing factor, resolution, theoretical plates, Isocratic and gradient elution and its significance, HPLC detectors such as Refractive Index, UV/Vis, photodiode array and fluorescence detector, Applications of HPLC

c. Gas Chromatography Mass Spectrometry (GCMS) –

Basic principle, theory and mechanism, stationary and mobile phase selection and types, basic parts of typical gas chromatography including sample injection port, gas reservoir, column and detectors. Nature of samples to be analyzed by GCMS, temperature selection, packed and capillary columns, Mass analyzers, quaderpole mass analyzers, Time of flight analyzer Applications of GCMS

2. Spectroscopy

Introduction, Basic Principle, Theory and Applications of Flame emission spectroscopy (FES), Flame atomic absorption spectroscopy (FAAS), continuous and line sources, construction of hollow cathode lamp, types of flames and their appropriate use, sensitivity and detection limits, Optical, Chemical, Physical and Ionization interferences and their possible solutions, Introduction, Basic Principle, Theory and Applications of UV/Vis spectroscopy and Thermal Analysis Techniques.

RECOMMENDED BOOKS:

9. T. B. of Quantitative Inorganic Analysis, Vogal's Ed-4th, Longman Group Limited (1978).
10. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
11. Instrumental Analysis, Gary D. Christain, 1978, Introduction to Instrumental Analysis by Braun, McGraw-Hill Book company, 1987.
12. Instrumental Analysis by B.K. Sharma

Module Code:	**Chem-434**
Module title:	**Applied Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Student will apply the analytical techniques for characterization of Industrial samples.

SYLLABUS OUTLINE:

Spectrophotometric analysis of iron in pharmaceutical tablets, Chlorides in water, phosphates in fertilizers, Chromium in Tannery wastewater, Recovery of chromium from tannery waste water, Application of AAS on analysis of heavy metals of various industrial effluents.

RECOMMENDED BOOKS:

1. T. B. of Quantitative Inorganic Analysis, Vogal's Ed-4th, Longman Group Limited (1978).
2. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
3. Instrumental Analysis, Gary D. Christain, 1978, Introduction to Instrumental Analysis by Braun, McGraw-Hill Book company, 1987.
4. Instrumental Analysis by B.K. Sharma

Module Code:	**Chem-435**
Module title:	**Applied Chemistry – IV Processing Industries**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will understand and learn about the operation and processes involved in Paper, Leather and Oils/Fats industries. Starting from raw material to end product.

SYLLABUS OUTLINE:

1. **Paper & Leather Industry**
   Paper – History, Survey of Raw materials, Production of Pulp by Soda process, Sulphite process, Kraft (Sulphate) process, Recovery of cooking liquor, manufacturing of paper, Environmental aspects of paper Industry.
   Leather – Introduction, Types of Skin, Theory of Tanning, Beamhouse Operations, Vegetable and Chrome tanning, Finishing processes, Waste Disposal and Pollution Aspects.

2. **Oils And Fats**
   Classification of oils and fats, vegetable oils, essential oils, various methods of extraction of oils, refining and hydrogenation of oils, Industrial applications of oils in resins, surfactants, lubricants and paints.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Pulp and Paper Technology, Testing and Applications, K.P. Rao (2003), CBS Publishers.
3. Chemistry of Pulp and Paper making, Edwin Sutermeister, Ed-3rd (1946)
4. Fertilizers and Soil Fertility, U.S.Jones, Reston Publishing Co. Virginia, 1979.
5. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
6. Shereve's Chemical Process Industries, 5th Ed.1975, by G.T.Austin, McGraw Hill Book Co. New York.

Module Code:	**Chem-436**
Module Title:	**Bio Chemistry – I Nucleic Acids**
Name of Scheme:	**BS CHEMISTRY 7th semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

This course will enable students to understand nucleic acid, its fundamental structure, properties and processes. It will also assist students to understand synthesis and degradation of purine and pyrimidine nucleotides.

SYLLABUS OUTLINES

Basics and importance of nucleic acids; major components and their structures, Phosphodiester linkage. Chargaff rules and Watson and Crick Postulates and their importance about the Structure of DNA. Classification of DNA and RNA and their importance. Chromatin and chromosomes. Determination of Primary structure of Nucleic acids. Nucleic acid hydrolysis. Biosynthesis and Catabolism of Purines and Pyrimidines. Biosynthesis of nucleotides. Urea cycle. Disorders linked to serum urate levels. Synthesis and splicing of RNA.

RECOMMENDED BOOKS:

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000 Pub: worth Publishers
2. Biochemistry by Lubert Stryer(2006) Pub: Freeman and Company
3. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
4. Lippincott's Biochemistry by champ c; Harvey.R. A and Ferrie. D .R. 3rd edition., Pub: J. B. Lippincott company

Module Code:	**Chem-437**
Module Title:	**Bio Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 7th semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

The course will be helpful for students to understand the absorption, isolation and estimation of genetic material by using animal sources.

SYLLABUS OUTLINES

- Preparation of solution for the Isolation of RNA from animal sources.
- UV absorption of nucleic acids.
- Isolation of DNA by organic and inorganic method.
- Qualitative and Quantitative estimation of DNA by gel electrophoresis.
- Spectrophotometric analysis of DNA and RNA.
- DNA purification by gel electrophoresis
- Use of micro pipettes of varying range.
- Isolation and estimation of DNA from plant sources.

RECOMMENDED BOOKS:

1. Practical clinical Biochemistry by Varley. Pub: CBSpublishersAn
2. Introduction to Practical Biochemistry By D. T. Plummer Pub: McGrawHill
3. Practical Clinical Biochemistry 4th Edition (English, Paperback, Harold Varley)
4. Varleys Practical Clinical Biochemistry 6th Edition (English, Hardcover, Alan H. Gowenlock)

Module Code:	**Chem-438**
Module Title:	**Bio Chemistry – II Human Physiology**
Name of scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

After studying this course, students will be able to understand human physiology and body fluids. It will help to understand composition of blood and CSF. It will also help to explain the structure, functioning and importance of human immune system in term of health and disease. Identify the major components of the endocrine system and describe their functions. The mechanisms of hormone action and the role hormones play in body.

SYLLABUS OUTLINES

Introduction to human physiology. Body fluids; General composition of Blood and blood plasma. Biosynthesis and metabolism of Porphyrin and Hemoglobin. Coagulation and anti-coagulating agents of blood. Composition and Biochemical effects of urine. Composition and importance of CSF. Structure and detoxification function of liver and Kidney. Introduction to Endocrine system. Mechanisms of action, and Biological functions of Pancreatic, Pituitary, Gonadal, Adrenal, Thyroid and Parathyroid hormones. Pheromones.

RECOMMENDED BOOKS:

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,200
2. Pub: worth Publishers
3. Biochemistry by Lubert Stryer(2006) Pub: Freeman and Company
4. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
5. Guyton and Hall Textbook of Medical Physiology (12th Edn)

Module Code:	**Chem-439**
Module Title:	**Bio Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

This course will help students to understand practical grounds of urine and blood analysis. In addition, it will assist to estimate blood constituents.

SYLLABUS OUTLINES

- Analysis of organic constituents of blood.
- Mineral determination such as calcium and magnesium by titration and atomic absorption spectroscopy.
- Mineral determination of sodium and potassium by flame photometry.
- Mineral determination of zinc, phosphate and cobalt by atomic absorption spectroscopy.
- Analysis of Urea, creatinine, cholesterol, triglycerides and Biliuribin by chemical method.
- Determination of blood groups.

RECOMMENDED BOOKS:

1. Practical clinical Biochemistry by Varley. Pub: CBSpublishers
2. An Introduction to Practical Biochemistry By D. T. Plummer Pub: McGrawHill
3. Practical Clinical Biochemistry 4th Edition (English, Paperback, Harold Varley)
4. Varleys Practical Clinical Biochemistry 6th Edition (English, Hardcover, Alan H. Gowenlock)

Module Code:	**Chem-440**
Module Title:	**Bio Chemistry – III Enzymology**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

After studying these course students will be able to understand types of enzymes. It will also help to understand the factors affecting enzyme activity and Chemical kinetics of enzymes.

SYLLABUS OUTLINES

Chemical nature, nomenclature and classification of enzymes. Cofactors and Coenzymes. Concepts of active site and substrate specificity. Factors affecting the enzyme activity. Kinetics of single substrate enzymatic reactions. Competitive, non-competitive and irreversible enzyme inhibition. Mechanism of enzyme inhibition. Regulatory, allosteric, immobilized enzymes, zymogens, isoenzyme and multienzyme system.

RECOMMENDED BOOKS:

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000 Pub: worth Publishers
2. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
3. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
4. Lippincott's Biochemistry by champ c; Harvey.R. A and Ferrie. D .R. 3rd edition., Pub: J. B. Lippincott company

Module Code:	**Chem-441**
Module Title:	**Bio Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

In this module student will learn how to isolate enzyme from different sources and effects of different parameters on enzymes activity. It will also provide practical grounds of enzyme inhibition by using UV/Visible spectrophotometer. Students will use assay methods to estimate clinically important enzymes.

SYLLABUS OUTLINES

- Isolation of enzyme from different sources.
- Study of different factors like temperature, pH, Concentration of substrate on the properties of Alkaline Phosphatase and LDH.
- Determination of the kinetic parameters of the enzymes and their mode of inhibition using UV / Visible Spectrophotometer.
- Estimation of Clinically important enzymes like alkaline phosphatase, acid phosphatase, SGPT, SGOT, creatine kinase, etc by using specific assay methods
- Agglutination tests; Enzyme linked immunosorbent assay (ELISA), Western blotting.

RECOMMENDED BOOKS:

1. Practical clinical Biochemistry by Varley. Pub: CBS publishers.
2. Introduction to Practical Biochemistry By D. T. Plummer Pub: McGrawHill.
3. Practical Clinical Biochemistry 4th Edition (English, Paperback, Harold Varley).

Module Code:	**CHEM-442**
Module Title:	**Bio Chemistry – IV Immunochemistry**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

Objectives:

After studying this course, student will be able to understand antigens, antibodies and immunity. It will also help to understand the abnormalities of immune system.

SYLLABUS OUTLINES

The immune system. Detailed structure, chemistry and synthesis of immunoglobulins. Immunogenicity and antigenicity. Properties of Immungens for B and T lymphocytes activation. Myeloma and hybridoma immunoglobulins. Complement system. Inflammatory process. Peripheral leucocytes and Macrophages. Abnormalities of the immune system- autoimmunity.
Diagnostically important plasma enzymes and proteins, identification and treatment of enzyme deficiencies. Assessment of cell damage, factors affecting results of plasma essay, abnormal plasma enzymes

RECOMMENDED BOOKS:

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000
2. Pub: worth Publishers
3. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
4. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.
5. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
6. Lecture notes on clinical chemistry, Alistaire F Smith, Geoffrey Beckett, Simon walker, Peter Rae 6th Edition, John Wile & Sons, 1998

Semester – VIII

Module Code:	**Chem-400**
Module title:	**Research Thesis**
Name of Scheme:	**BS CHEMISTRY 7th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Compulsory**
Module Rating:	**4 credits**

OBJECTIVES

Students will acquire knowledge and understanding about the research methodology and report writing. A topic will be allotted to the students by the supervisor. The students will do the literature survey, design their research work and analyze the experimental data and then report their results in the form of thesis. In the end, they will be judged by the presentation and viva voce examination.

Module Code:	**Chem-443**
Module title:	**Physical Chemistry – I Polymer Chemistry**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will learn chemistry of all types of polymers in this course. They will be able to understand synthetic techniques of various polymers. They will be able to characterized polymer samples using different analytical techniques.

SYLLABUS OUTLINES

An introduction to polymers, Classification of polymers, kinetics of condensation and addition (free radical, cationic and anionic polymerization), copolymers and their classification, kinetics of copolymerization, concept of molecular mass average in polymers and its determination Molecular mass distribution, determination of molecular mass average (viscosity average, number average and weight average) by different methods. Analysis techniques like spectroscopic methods (UV visible and IR) and thermal analysis.

RECOMMENDED BOOKS

1. Billmeyer, F, Textbook of Polymer Science, 2nd ed., John Wiley and Sons, Inc., NY (1971).
2. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
3. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
4. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
5. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
6. Hand book of surface and Colloid Chemistry by Birdi, K.S., CRC Press, 1997.
7. Te Nijenhuis, Klaas. Thermoreversible networks: viscoelastic properties and structure of gels. Vol. 130. Berlin Heidelberg: Springer, 1997.
8. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).

Module Code:	**Chem-444**
Module title:	**Physical Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

This course will enable the students to analyze polymer samples and to investigate their properties.

SYLLABUS OUTLINES

1. Molecular Mass Determination of different Polymers by Viscosity measurement.
2. Determination of heat of solution of a substance by solubility methods.
3. Determination of CMC of block copolymer/polymeric surfactant by surface tension method.
4. Preparation of different polymeric systems and their characterization by FTIR.
5. Determination of partial molar properties.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker

Module Code:	**Chem-445**
Module title:	**Physical Chemistry – II UV & Raman Spectroscopy**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will learn basic of all types of electronic and Raman spectroscopy and will be able to apply this knowledge in practical applications.

SYLLABUS OUTLINES

Principles of electronic transition. Types of electronic transition. Energies of atomic orbital-with reference of H-atom spectrum electronic angular momentum fine structure of H-atom spectrum. Photoelectron spectroscopy (PES).

Raman Spectra-idea of Raman scattering, Theories of Raman effect Rayleigh scattering Molecular poparazability. Rotational Raman Spectra of linear Molecules. Symmetric top molecules and spherical top molecules Vibrational Raman spectra.

RECOMMENDED BOOKS

1. Molecular spectroscopy by KV Raman, R Gopalan,P S Raghavan,Vijay Nicole imprints Ltd. 2004.
2. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
3. Fundamentals of chemical kinetics by Logan, S.R, Longman Group Ltd. 1996.
4. Elementry reaction kinetics by Latham.J.L. And Burgess, A.E.3rd Ed., Butterworths, London, 1977.
5. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
6. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
7. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.

Module Code:	**Chem-446**
Module title:	**Physical Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Students will be trained for practical applications of spectroscopic methods. They will be able to monitor the progress of a chemical reaction using spectroscopic methods.

SYLLABUS OUTLINES

1. Evaluation of pKa value of an indicator by spectrometric method.
2. Kinetics of the reaction between methyl orange and peroxodisulphate ions in presence of bromide ions.
3. Spectroscopic determination of Cu percentage in the given sample.
4. Characterization of the given compound by UV-Vis spectroscopy.
5. Determination of molar extinction co-efficient of a colored substance.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker

Module Code:	**Chem-447**
Module title:	**Physical Chemistry – III Photochemistry**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will be able to learn fundamentals and applications of photochemistry in this course.

SYLLABUS OUTLINES

Laws of photochemistry, quantum efficiency and its determination, Photochemical reactions, excited state symbols; photosensitized reactions, phosphorescence, fluorescence, chemiluminescence, Lasers.

RECOMMENDED BOOKS

1. Mukherjee, K.K.R., Fundamentals of Photochemistry, Revised Ed., New Age International (P) limited, Publishers, New Delhi, (2000).

2. Molecular spectroscopy by KV Raman, R Gopalan,P S Raghavan,Vijay Nicole imprints Ltd. 2004.
3. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
4. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
5. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
6. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
7. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).

Module Code:	**Chem-448**
Module title:	**Physical Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Students will learn different experimental skills related to physical chemistry and photochemistry.

SYLLABUS OUTLINES

1. Investigation of the kinetics of hydrolysis of ethyl acetate in the presence of an acid.
2. Determination of the relative strength of acids (HCl and H_2SO_4) studying the hydrolysis of an ester.
3. Verification of Langmuir adsorption isotherm for Adsorption of acetic acid on active charcoal.
4. Determination of surface excess concentration of an emulsifier by surface tension method.
5. Characterization of the given compound by FTIR spectroscopy.

RECOMMENDED BOOKS

1. Advanced Experimental Physical Chemistry by Ayodhya Sing.
2. Experimental Physical Chemistry by Daniel
3. Experimental Physical Chemistry by G.Peter Mattews.
4. Experiments in Physical Chemistry by Shoemaker

Module Code:	**Chem-449**
Module title:	**Physical Chemistry – IV Nuclear Chemistry**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

The course is designed to strengthen fundamental knowledge of students for understanding of processes based on nuclear chemistry.

SYLLABUS OUTLINES

Composition of the nucleus, natural and artificial radioactivity, rate of radioactive disintegration, radioactive equilibrium, transformation of elements cyclotron and linear accelerators; nuclear processes; nuclear fission, atomic bomb, nuclear reactor, nuclear fusion, hydrogen bomb, steller energy, radiation hazards, use of tracers in chemistry.

RECOMMENDED BOOKS

1. Physical Chemistry by Kundu, N and Jain, S.K.S. Chand and Company Ltd. 1984.
2. Physical chemistry by Atkins, P.W. 5th Ed., W.H.Freeman and Company, New York, 1994.
3. Physical Chemistry by Alberty, R.A. and Silbey. R.J., John Wiley, New York, 1995.
4. Physical chemistry by Engel, T. and Ried, P., 1st Ed., Pearson Education, Inc. 2006.
5. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, (2014).

Module Code:	**Chem-450**
Module title:	**Inorganic Chemistry – I Radioactivity**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

Objectives:

The aim of this course is to provide the concepts for better understanding of nuclear chemistry, radioactivity and its applicationin daily life and industry.

SYLLABUS OUTLINE:

1. Radioactivity:

Natural radioactivity, Artificial radioactivity, types of radioactive rays, Saddy-Fajans and Russel group displacement law, Half life period of a radioactive substance, Disintegration constant K, Average life period, Radioactive equilibrium, Law of successive disintegration, Activity of a radioactive substance, Transmutation of elements, Artificial transmutation reactions induced by different bombarding projectiles, Applications of artificial transmutation reactions, Natural and artificial radioactive series.

RECOMMENDED BOOKS:

1. Katz, Joseph J., Glenn T. Seaborg, and Lester R. Morss. The chemistry of the actinide elements. Volume 1. New York, USA: Chapman and Hall, 1986.
2. R.D.Madan, Satya Prakash's Modern Inorganic Chemistry, S. Chand Company and Ltd, 2002.
3. OpenStax . (2016) Chapter 21 – Nuclear Chemistry. Chemistry by Rice University is licensed under a Creative Commons Attribution 4.0 International Accessed, Dec 1st, 2018 from: https://opentextbc.ca/chemistry/chapter/introduction-2/
4. J.D.Lee, Concise Inorganic Chemistry, 5th Edition.

Module Code:	**Chem-451**
Module title:	**Inorganic Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students use of instrumental methods of analysis, (AAS, FES).

SYLLABUS OUTLINE:

Instrumental methods of analysis:

i. Atomic absorption spectroscopy

Estimation of following:

Mg^{2+} , Zn^{2+}, Al^{3+} , Cu^{2+} , Fe^{2+} , Ni^{2+}, Pb^{2+}, Cd^{2+}

ii. Flame Photometer spectroscopy

Estimation of following:

Li^{+}, Na^{+}, K^{+} , Ca^{2+}

RECOMMENDED BOOKS:

1. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
2. Quantitative Analysis Chemistry, James S. Pritz, George H. Schenk, 1987 Alby and Becon Inc. London.

3. Theory and practice of chromatography by Prof. Dr. Javed Iqbal (2002).
4. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
5. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
6. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006.

Module Code:	**Chem-452**
Module title:	**Inorganic Chemistry – II Bio-inorganic Chemistry**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

Objectives:

The aim of this course is to provide the concepts for better understanding of biological systems and chemistry working behind various physiological processes. The students will learn about inorganic chemistry in biological systems and various medicinalcompounds used for curing disease by heavy metals toxicity.

SYLLABUS OUTLINE:

1. Biological aspects of inorganic compounds:

Energy sources for life, metalloporphyrins. Photosynthesis, Chlorophyll, Respiration, Heme and Non heme proteins, cytochromes, Nitrogen fixation: in vitro and in vivo, the biochemistry of Iron, calcium, magnesium, Sodium, Potassium. Essential and trace elements in biological systems, biochemistry of the nonmetals: Carbon, Phosphorus, Oxygen, Silicon. Toxicity of heavy metals in biological systems, medicinal chemistry, chelate therapy for curing disease by heavy metals toxicity.

RECOMMENDED BOOKS:

1. Inorganic Chemistry by James E. Huheey 1983 Harper International London.
2. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkineon 1972, Interscience, Publishers, London.
3. R.D.Madan, Satya Prakash's Modern Inorganic Chemistry, S. Chand Company and Ltd, 2002.
4. J.D.Lee, Concise Inorganic Chemistry, 5th Edition.

Module Code:	**Chem-453**
Module title:	**Inorganic Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students use of chromatographic techniques and inorganic compounds preparations.

SYLLABUS OUTLINE:

1. Chromatographic Techniques:

Thin layer techniques for the qualitative analysis of group II & IV metal complexes.

2. Preparations:

(i) Sodium Cobaltinitrite.
(ii) Pot. Trioxalato Aluminate.
(iii) Pot. Trioxalatoferrate.
(iv) Ammonium sulphate Nickel (II) Sulphate.
(v) Ammonium Sulphate Copper (II) Sulphate Pentahydrate.

RECOMMENDED BOOKS:

1. Pass, Geoffrey. Practical inorganic chemistry: preparations, reactions and instrumental methods. Springer Science & Business Media, 2013.
2. Vogel, I. (1724). A Text-Book of Macro And Semimicro Qualitative Inorganic Analysis. Willam Clowes And Sons Limited; London; Bxccles.
3. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
4. Quantitative Analysis Chemistry, James S. Pritz, George H. Schenk, 1987 Alby and Becon Inc. London.
5. Theory and practice of chromatography by Prof. Dr. Javed Iqbal (2002).
6. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
7. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.
8. Mendham, John. Vogels textbook of quantitative chemical analysis. Pearson Education India, 2006.

Module Code:	**Chem-454**
Module title:	**Inorganic Chemistry – III Organometallics**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

Objectives:

The aim of this course is to provide the concepts for better understanding of advance study in inorganic chemistry and other interdisciplinary subject related to inorganic chemistry. The students will learn about inorganic chemistry in biological systems, organometallic compounds (synthesis aspects, structural and bonding aspects).

SYLLABUS OUTLINE:

Organo Metallic Chemistry:

(a) Introduction to organometallic chemistry

Nature of carbon-metal bond, General synthesis and properties of organometallic compounds, Classification ($^{c}n_2$-bonded olefin, n_3-allylic, n_4-cyclopentadienyl, n_6-organometallic compounds).

(b) Structure and reactivities

Experimental techniques in Organometallic chemistry, oxidative-addition, reductive elimination, insertion and de-insertion reactions, fluxional behaviour. Applications of organometallic compounds. Characterization of organometallic compounds with the help of IR, NMR, mass spectrometry etc.

RECOMMENDED BOOKS:

1. Organotransition metal Chemistry by Akin Yamamto, 1986, A. Wiley Interscience Publication London.
2. Inorganic Chemistry by James E. Huheey 1983 Harper International London.
3. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkineon 1972, Interscience, Publishers, London.
4. Comprehensive organometallic chemistry, M. Imran, H. M. Farooq, Ilmi Kitab Khana, Lahore, 2019.
5. J.D.Lee, Concise Inorganic Chemistry, 5th Edition.

Module Code:	**Chem-455**
Module title:	**Inorganic Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

The aim of this course is to interpret the concepts for better understanding in inorganic chemistry. This course will familiarize the students use of instrumental methods of analysis and salt analysis.

SYLLABUS OUTLINE:

1. Application of Atomic Spectroscopy

Theory and application of Flame photometer. Atomic absorption spectrophotometer, Inductively coupled plasma emission. Metal contents analysis of clinical, industrial, geochemical, biological and environmental samples.

2. Salt Analysis

Identification of acid and basic radicals of a given salt/mixture.

RECOMMENDED BOOKS:

6. Vogel, I. (1724). A Text-Book Of Macro And Semimicro Qualitative Inorganic Analysis. Willam Clowes And Sons Limited; London; Bxccles.
7. Vogel, Arthur I. A Text-Book Of Quantitative Inorganic Analysis-Theory And Practice. Longmans, Green And Co.; London; New York; Toronto, 2013.
8. Quantitative Analysis Chemistry, James S. Pritz, George H. Schenk, 1987 Alby and Becon Inc. London.
9. Theory and practice of chromatography by Prof. Dr. Javed Iqbal (2002).
10. Rabia Rehman and Haq Nawaz Bhatti, "Experimental Inorganic Chemistry", Carvan Book House Lahore in 2015.
11. Haq Nawaz Bhatti and Rabia Rehman "Advanced Experimental Inorganic Chemistry" Carvan Book House Lahore in 2017.

Module Code:	**Chem-456**
Module title:	**Inorganic Chemistry – IV Inorganic Polymers**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

The aim of this course is to provide the concepts for better understanding of advance study in inorganic chemistry and other interdisciplinary subject related to inorganic chemistry. The students will learn about advanced atomic spectroscopy and radio chemistry, polymeric inorganic compounds, advanced chemistry of s-block elements.

SYLLABUS OUTLINE:

(a) Chains: Catenation, Homocatenation, Heterocatenation, Silicones, Silicates, Zeolites, talc, mica, clay.

(b) Rings: **(i)** Heterocyclic systems of borazines, Phosphazenes, S-N rings.
(ii) Homocyclic system of sulfur and selenium.

(c) Cages compounds of phosphorus, and boron

(d) Inorganic Polymers as Conductors.

RECOMMENDED BOOKS:

12. Mark, James E., et al. Inorganic polymers. Oxford University Press on Demand, 2005.
13. Archer, Ronald D. Inorganic and organometallic polymers. Vol. 4. John Wiley & Sons, 2004.
14. Uchimaru, Yuko. "Borazine Polymers." Encyclopedia of Polymeric Nanomaterials. Springer, Berlin, Heidelberg, 2015. 255-262.

Module Code:	**Chem-457**
Module title:	**Organic Chemistry – I Natural Products**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 Credits**

OBJECTIVES:

To develop knowledge about the basic rules and principles for working, instrumentation, sample handling and applications for

structural characterization of organic compounds by Mass spectrometry. To gain understanding about the isolation and general methods of structure determination and biosynthesis of different classes of natural products.

SYLLABUS OUTLINES:

1. Mass Spectrometry

Introduction; types, Isotopic abundance, molecular and metastable ions; modes of fragmentation, applications of mass spectrometry in different classes of organic chemistry, interpretation of mass spectra of small organic molecules.

2. Natural Products

Introduction, classification, isolation and general methods of structure determination of alkaloids, terpenes, (triterpenoids and steroids), biosynthesis of alkaloids, steroids & terpenoids and their stereochemistry.

RECOMMENDED BOOKS:

15. Organic Spectroscopy and Chromatography, by M. Younas. Ilmi kitab khana, kabir street, urdu bazar, Lahore.
16. Organic Chemistry, (4th - 7th Ed) by Paula Yurkanis Bruice, Pearson Education (Singapore) Pvt. Ltd. 2004-2015.
17. Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, (2nd – 5th Ed). Saunders Golden Sunburst Series, 1996-2018.
18. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
19. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
20. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.
21. Chemistry for Pharmacy Students by Satyajit D Sarkar, Lutfun Nahan. John Wiley & Sons, Ltd 2007.
22. Natural Product Chemistry at a Glance by Stephen P. Stanforth. Blackwel Publishing ltd, 9600 Garsuington Road, Oxford OX4 2DQ, UK.

Module Code:	**Chem-458**
Module title:	**Organic Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 Credit**

OBJECTIVES:

To gain experimental skills for separation, purification by chromatography (TLC, etc) and analysis of different organic compounds by spectroscopy (UV, IR).

SYLLABUS OUTLINES:

Purification and Spectroscopic Identification

Preparation of hydrazones of aromatic aldehydes and ketones and their spectroscopic analysis. Preparation, separation and identification of regio-isomers: *o*-nitrotoluene and *p*-nitrotoluene from toluene; *o*-nitrosophenol and *p*-nitrosophenol from phenol etc.

RECOMMENDED BOOKS:

23. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
24. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
25. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
26. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
27. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code:	**Chem-459**
Module title:	**Organic Chemistry – II Organic Synthesis**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**

Module Rating: **2 Credits**

OBJECTIVES:

To acquire knowledge about the usefulness of synthetic organic chemistry involving the application of new reagents. To develop basic understanding about asymmetric synthesis, application of protecting groups in organic synthesis and disconnection approach (Retrosynthesis).

SYLLABUS OUTLINES:

1. Organic Synthesis

An outline of the recent developments in organic syntheses involving new reagents, reaction conditions and methods; Asymmetric synthesis. Introduction to protective groups, protection of hydroxyl, amino, carbonyl and carboxylic acid groups, and their deprotection, synthetic applications of these protective groups in total synthesis of organic molecules. Introduction to disconnection approach with examples.

RECOMMENDED BOOKS:

28. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
29. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
30. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
31. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
32. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and R.K. Boyd, Benjamin Cummings, 1992.
33. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.
34. Organic Synthesis, The disconnection approach, Stuart Warren, John Willey and Sons 1993; and work book be same 1994.
35. Designing Organic Synthesis, A Programmed Introduction to synthon approach, S. Warren, John Willey and Son, 1992.
36. Guide book to Organic Syntheses, R. K. Mackie, D. M. Smith, Longman Group
37. Limited, 1982.

Module Code: **Chem-460**
Module title: **Organic Chemistry Lab - II**
Name of Scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **1 Credit**

OBJECTIVES:

To gain experimental skills for different organic reactions, separation and identification of products obtained in a multistep organic synthesis.

SYLLABUS OUTLINES:

1. Organic Synthesis

Multi-step preparation and spectroscopic characterization: Benzoin to benzyl to benzylic acid; *p*-nitroaniline from aniline; *p*-bromotoluene from *p*-toluidine, *o*-Bromotoluene from *o*-toluidine, Appel reaction and Finklestein reaction etc.

RECOMMENDED BOOKS:

38. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
39. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
40. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
41. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
42. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code: **Chem-461**
Module title: **Organic Chemistry – III Heterocyclic Chemistry**
Name of Scheme: **BS CHEMISTRY 8th Semester**

Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 Credits**

OBJECTIVES:

To develop basic understanding about methods of preparation, reactions and applications of different types of heterocyclic compounds.

SYLLABUS OUTLINES:

1. Heterocyclic Chemistry

Five and six membered aromatic and aliphatic heterocyclic compounds with one and more identical hetero-atoms, five and six membered heterocycles with two different hetero-atoms. Their syntheses and reactions

RECOMMENDED BOOKS:

43. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
44. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
45. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
46. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
47. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and R.K. Boyd, Benjamin Cummings, 1992.
48. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.
49. Organic Synthesis, The disconnection approach, Stuart Warren, John Willey and Sons 1993; and work book be same 1994.
50. Designing Organic Synthesis, A Programmed Introduction to synthon approach, S. Warren, John Willey and Son, 1992.
51. Guide book to Organic Syntheses, R. K. Mackie, D. M. Smith, Longman Group
52. Limited, 1982.

Module Code: **Chem-462**
Module title: **Organic Chemistry Lab - III**
Name of Scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **1 Credit**

OBJECTIVES:

To gain experimental skills for separation and identification of three components in a mixture of unknown compounds via systematic physical and chemical tests.

SYLLABUS OUTLINES:

1. Qualitative analysis

Three component organic mixture analysis (separation and identification of the unknown components). Recrystallization and Derivatizations

RECOMMENDED BOOKS:

53. The Systematic Identification of Organic Compounds (8th Ed.) by R.L. Shriner et al., Wiley, 2003.
54. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Longman, UK. 1978.
55. Vogel's Textbook of Practical Organic Chemistry (5th Ed.) by A.I. Vogel et al. Longman, UK, 1989.
56. Advanced Practical Organic Chemistry, by J. Leonard, B. Lygo, G. Procter, CRC. 1994.
57. Advanced Practical Organic Chemistry (2nd Ed.) by N.K. Vishnoi, Vikas Publishing House Pvt. Ltd. India, 1996.

Module Code: **Chem-463**
Module title: **Organic Chemistry – IV Reaction Mechanism-IV**

Name of Scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 Credits**

OBJECTIVES:

To grasp ideas about the mechanisms, basic rules and principles working behind different types of pericyclic reactions. Introduction, method of generation, reactions and applications of reactive intermediates.

SYLLABUS OUTLINES:

1. **Reactive Intermediates**
   Carbenes, nitrenes, and benzynes, structure and evidence for formation, general reactions and synthetic applications.
2. **Pericyclic reactions**
   Introduction, Wood-ward-Hoffmann rules and molecular orbital theory; cycloaddition, electrocyclic and sigmatropic rearrangement and group transfer reactions.

RECOMMENDED BOOKS:

58. Organic Chemistry, Vol. I (6th Ed.) and II (5th Ed.) by I.L. Finar, Pearson Education (Singapore) Pvt. Ltd. 2008.
59. March's Advance Organic Chemistry: Reactions, Mechanisms and Structures. (6th Ed.) by M.B. Smith and J. March, Wiley, 2007.
60. A Text-Book of Organic Chemistry by M. Younas, ILMI, Pakistan.
61. Organic Chemistry, (5th Ed.) by S.H. Pine, McGraw Hill, New York, USA, 1987.
62. Organic Chemistry, (6th Ed.) by Francis A. Carey, McGraw Hill, USA, 2005.
63. Organic Chemistry, (6th Ed.) by R.T. Morrison, R.N. Boyd and R.K. Boyd, Benjamin Cummings, 1992.
64. Electrocyclic Reactions, by F.L. Ansari, R. Qureshi, M.L. Qureshi, Wiley-VCH, 1999.
65. Reactive Intermediates in Organic Chemistry, by N.S. Isaac, John Wiley and Sons, 1974.
66. Organic Chemistry, by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press, 2000.

Module Code: **Chem-464**
Module title: **Analytical Chemistry – I Electroanalysis Method-II**
Name of Scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 credits**

OBJECTIVES:

This course deals with the electroanalytical techniques. The students will learn the details about the theory and applications of advanced electroanalytical techniques including coulometry, voltammetry, polarography, amperometry and conductometry. After this course, the students will be able to understand the mechanisms involved in these techniques and their applications for multielemental analysis

SYLLABUS OUTLINE:

1. **Voltrametry:**
   Excitation signals in voltametry, voltametric Instrumentation, Hydrodynamic Voltrametry, Cydic Voltametry, Stripping methods, voltametric with ultra-micro-electrodes

2. **Polarography:**
   Introduction and principle of polarography, basic instrumentation, working and advantages of DME (dropping mercury electrode); limiting and residual current; half-wave potential; qualitative and quantitative aspects of polarographical analysis

3. **Amperometry:**
   Principle of Amperometry, types of amperometry and amperometric titrations, amperometric titrations with one micro-electrode,

amperometric titration with twin microelectrodes, applications of amperometry.

RECOMMENDED BOOKS:

67. Vogels, s text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman.
68. Vogels, text book of Quantitative chemical analysis byJ.mendham, RCDenny, JDBarnes, MJ KTHomas, Pearson education Ltd.
69. Fundamentals of Analytical Chemistry by Skoog, West and Holler (5th Edition).
70. Principles of Instrumental Analysis, Skoog, Holler and Neman (5th Edition).

Module Code:	**Chem-465**
Module title:	**Analytical Chemistry Lab - I**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJCTIVES:

The students will learn the in-hand use of electroanalytical techniques like Voltametry in quantitative analysis of various acids and bases. The students will learn to obtain relevant information from these analyses and interpret the results obtained.

SYLLABUS OUTLINE:

- Reduction of ferricyanide ion using Pt electrode
- Oxidation of acetaminophen using glassy carbon electrode
- Preparation of carbon paste electrode
- Determination of Electrode surface area using cyclic voltammetry using potassium ferricyanide solution
- Effect of scan rate on the electrode properties using potassium ferricyanide solution
- Determination of half-wave potential for various analytes
- Determination of metal ions using anodic stripping voltammetry by carbon paste electrode
- Determination of various organic molecules using voltammetric studies

RECOMMENDED BOOKS:

1. New Instrumental Methods in Electro Chemistry by Faul-Delabay, Inter Science Publisher, London, N.Y.

ANALYTICAL CHEMISTRY (BS CHEMISTRY 8th Semester)

Module Code:	**Chem-466**
Module title:	**Analytical Chemistry – II Compound Analysis**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

This course in about the advanced spectroscopic techniques. The students will learn the advanced structural elucidation techniques. They will be able to determine the structure of various molecules on the basis of their NMR and mass spectrometric data. The use of laser spectroscopy for the purpose of analysis will also be studied in this course

SYLLABUS OUTLINE:

1. **Nuclear Magnetic Resonance Spectroscopy:**
Basic principles; properties of nuclei, Chemical shifts; Spin-Spin coupling; Pulsed Fourier Transform NMR Spectrometry; Identification of structural features; Use of NMR imaging in medicine; Analytical applications of NMR spectroscopy.

2. **Mass Spectrometry:**
Principle, sample for mass spectrometer, sample introduction system, ionization source, mass analyzers, detections system,

qualitative analysis, quantitative analysis, applications, confirmation of synthesis products, isotopes incorporation, structure elucidation, hyphenated mass-spectrometric techniques.

RECOMMENDED BOOKS:

1. New Instrumental Methods in Electro Chemistry by Faul-Delabay, Inter Science Publisher, London, N.Y.
2. Instrumental Methods of Analysis by Hobert H. Willart, Lyle L. Merrit, D. Van Nosrant Company Inc. N.Y. London.
3. Principles of Polarography by J. Herosky& J. Kuta, Academic PressN.Y. (1968).
4. Analytical chemistry by Kellner, J.M. Mermet, Wiley-VCH Verlag GmbH & Co. KGaA.
5. A text book of analytical chemistry by Y-Anjaneyulu, K-chamdarekhar, ValiManickam, Pharma book syndicate.

Module Code:	**Chem-467**
Module title:	**Analytical Chemistry Lab – II**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

This course in about the advanced spectroscopic techniques. The students will learn the advanced structural elucidation techniques. They will be able to determine the structure of various molecules on the basis of their NMR and mass spectrometric data.

SYLLABUS OUTLINE:

- Determination of Chemical Shift values for protons in Ethanol
- Elucidation of ^{1}H NMR spectrum of Acetone, Ethanol, Benzoic acid, acetaminophen
- Determination of coupling constant in 1H NMR spectra
- Determination of isomers based on their 1H NMR spectra
- Structure Elucidation of poly aromatic hydrocarbons (PAH) by GC-MS.
- Identification of haloacetic acid (HAA) by using GC-MS

RECOMMENDED BOOKS:

1. Analytical chemistry by Kellner, J.M. Mermet, Wiley-VCH Verlag GmbH & Co. KGaA.
2. A text book of analytical chemistry by Y-Anjaneyulu, K-chamdare khar, ValiManickam, Pharma book syndicate.

Module Code:	**Chem-468**
Module title:	**Analytical Chemistry – III Thermoanalysis Method**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

In This course, the students will be able to learn the use of laser spectroscopy for the purpose of analysis. Furthermore, the structural features responsible for the luminescence and The role of thermal methods in the analysis of various samples will also be studied.

SYLLABUS OUTLINE:

1. Thermal Methods of Analysis

General Principle, instrumentation, Application, Limitations; of these techniques

- TGA (thermogravimetric analysis),

- DTA (differential thermal analysis),
- DSC (differential scanning calorimetry),
- TT (thermometric titrations) and
- EGD (evolved gas detection)

RECOMMENDED BOOKS:

1. Vogels's text book of Quantitative chemical analysis by J.mendham, RCDenny, JDBarnes, MJ KTHomas, Pearson education Ltd.

Module Code:	**Chem-469**
Module title:	**Analytical Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES:

The students will be able to analyse various samples by Thermal analysis methods.

SYLLABUS OUTLINE:

- Thermogravimetric analysis of calcium oxalate
- TG and DTG analysis of polymer gels
- TG and DTG analysis of polythene
- Determination of thermal stability of a given compound
- Determination of carbon black content in epoxy sample
- DTA analysis of biomass/plant materials
- Determination of purity/melting point of benzoic acid/oxalic acid/naphthalene

RECOMMENDED BOOKS:

1. Vogels, text book of Quantitative chemical analysis by J.mendham, RCDenny, JDBarnes, MJ KTHomas, Pearson education Ltd.

Module Code:	**Chem-470**
Module title:	**Analytical Chemistry – IV Conducto/Oscillometry**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES:

This course in about the advanced spectroscopic techniques. The students will learn the advanced structural elucidation techniques. They will be able to determine the structure of various molecules on the basis of their NMR and mass spectrometric data. The use of laser spectroscopy for the purpose of analysis will also be studied in this course.

SYLLABUS OUTLINE:

1. **Laser Spectroscopy:**
   Principle of laser operation; Stimulated emission Population inversion, Single level and multi-level laser systems, Properties of laser light and its general and analytical applications; ruby laser, nitrogen laser, dye laser, Use of laser radiation in absorption and fluorescence spectroscopic methods.

2. **Molecular Luminescence Flourimetry and Phosphorimetry:**

Theory of Fluorescence and phosphorescence, instruments for measuring Fluorescence and phosphorescence and photoluminescence methods, chemiluminescence

RECOMMENDED BOOKS:

1. Laser spectroscopy by Wolfgang Demtroder, springerlink.
2. Fundamentals of Molecular Spectroscopy by Banwell.

Module Code:	**Chem-471**
Module title:	**Applied Chemistry – I Polymers**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

Objectives:

This course content will increase the understanding of student about Polymerization techniques; Basic theory, mechanisms, chemistry, processing and applications.

SYLLABUS OUTLINE:

1. Polymerization Mechanisms

Introduction, characteristics and significance, Classification including, synthetic and natural, thermoplastic and thermosets, Concept of homo and co-polymers, polyblends, Tacticity and its importance, Glass transition temperature, Molecular weight of Polymers, Polymerization types involving various mechanisms including addition and condensation polymerization, Ionic polymerization including anionic and cationic, Co-ordination polymerization.

2. Polymers Processing

Polymerization techniques – Bulk, Solution, Emulsion and Suspension techniques
Polymer Fabrication – extrusion, injection, modeling and blow molding of plastics.
Detailed description and uses of the following polymers:
Polyethylene, Polystyrene, Epoxy resins, Polyethylene tetrapthalate, Elastomers, Conducting polymers and Biopolymers.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
3. An Introduction to Polymer Chemistry, W.R.Moor, London Press, London.
4. Principles of Polymer Systems, Rodri-Guez, McGraw Hill Book Co. New York.
5. Modern Technology of Plastics and Polymer Processing Industries, NIIR Board

Module Code:	**Chem-472**
Module title:	**Applied Chemistry Lab – I**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1credit**

Objectives:

Students will apply their knowledge to synthesize and depolymerize the important polymers. Also will learn about the characterization of Oils and Fats

SYLLABUS OUTLINE:

Depolymerization of PET and Polyethene
Determination of Acid Value, Saponification Value, Ester value and iodine value of oils.
Preparation of Urea Formaldehyde, Phenol formaldehyde resins.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
3. An Introduction to Polymer Chemistry, W.R.Moor, London Press, London.
4. Principles of Polymer Systems, Rodri-Guez, McGraw Hill Book Co. New York.
5. Modern Technology of Plastics and Polymer Processing Industries, NIIR Board

Module Code:	**Chem-473**
Module title:	**Applied Chemistry – II Agro-industries**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

This course content will increase the knowledge of the students regards the processes involved in Agro-based industries especially Fertilizers and Sugar.

SYLLABUS OUTLINE:

1. Sugar and Fermentation Industries:

Sugar - Importance of sugar industry, chemistry and sources of sucrose, manufacture of raw and refined sugar with flow sheet, estimation of sugar (physical and chemical methods)

Fermentation - importance of various fermentation industries, basic requirements for fermentation, steps in fermentation process. Manufacture of alcohol from molasses, preparation of absolute alcohol, proof sprit, and denatured spirit.

2. Fertilizers

Need of Fertilizers; Classification of Fertilizers, Importance of Macro- and Micro-nutrients; Raw materials along with their sources, manufacturing procedure, flowsheet(s) and assimilation in soil for important fertilizers include Ammonia, Urea, Calcium ammonium Nitrate, Calcium Cyanamide, diammonium hydrogen phosphate, Calcium superphosphate, Calcium triple superphosphate, potash fertilizers, Organic Compost.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Pulp and Paper Technology, Testing and Applications, K.P. Rao (2003), CBS Publishers.
3. Chemistry of Pulp and Paper making, Edwin Sutermeister, Ed-3rd (1946)
4. Fertilizers and Soil Fertility, U.S.Jones, Reston Publishing Co. Virginia, 1979.
5. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
6. Shereve's Chemical Process Industries, 5th Ed.1975, by G.T.Austin, McGraw Hill Book Co. New York.

Module Code:	**Chem-474**
Module title:	**Applied Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

It will increase the practical handling of the students regarding analysis of sugar cane juice and liquid effluents from sugar industry

SYLLABUS OUTLINE:

Determination of Sucrose content in sugar cane juice by polarimerty and refractive index, Determination of reducing sugars, Determination of BOD, COD and DO in water bodies and industrial effluents, Determination of pH of soil, Determination of calcium in agricultural effluents.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Pulp and Paper Technology, Testing and Applications, K.P. Rao (2003), CBS Publishers.
3. Chemistry of Pulp and Paper making, Edwin Sutermeister, Ed-3rd (1946)
4. Fertilizers and Soil Fertility, U.S.Jones, Reston Publishing Co. Virginia, 1979.
5. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
6. Shereve's Chemical Process Industries, 5th Ed.1975, by G.T.Austin, McGraw Hill Book Co. New York.

Module Code:	**Chem-475**
Module title:	**Applied Chemistry – III Textile Industries**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

Students will learn about the Textile processing; Synthesis of Fibers, finishing of fibers and dyeing of fibers. They will also learn about the synthesis to textile dyes.

SYLLABUS OUTLINE:

1. Textile Fibers:

Classification of textile fibres, sources and properties of natural fibres, chemistry and manufacturing of Viscose rayon, Cellulose Acetate, Nylons and Polyesters and conversion to fibres, Finishing processes for 100% cotton fabrics such as singeing, desizing, scouring, mercerizing and bleaching

2. Textile Dyeing:

Color and chemical constitution, Important classes of chromogens, Classification and nomenclature of dyes, manufacturing of dye intermediates and dyes, Selection of dyes for wool, cellulosic and synthetic fibers, Application methods of dyes to wool and cellulosic fibers.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Dyes and Dyeing, C.E. Pellow, Abhishek Publishers, 1998.
3. Textile Dyes and Pigments, H. Panda, NIIR Publishers.
4. Fibre to fabric, 4th Ed, Potter & Corban, McGraw Hill book Company, 1959.
5. Sugar: Science and Technology, G. G. Birch and K.. J. Parker, Applied Science Publishers Ltd., 1979.
6. Principles of Sugar Technology, Pieter Honig Vol I, Elsevier Publishing Company, 1953.

Module Code:	**Chem-476**
Module title:	**Applied Chemistry Lab - III**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

Students will understand about the Applications of Analytical techniques in chemical characterization of dyes. Also they will learn how to apply dyes to fabircs.

SYLLABUS OUTLINE:

Dyeing of clothes in different shades using Acid dyes, Determination of pK value of indicators (methyl orange and methyl red). Catalytic / photolytic degradation of Dyes. Removal of dyes from industrial effluents. Estimation of dyes by spectrophotometry.

RECOMMENDED BOOKS:

1. Applied Chemistry, Haq Nawaz Bhatti and Muhammad Salman, 2017, Caravan Book Publisher, Pakistan.
2. Dyes and Dyeing, C.E. Pellow, Abhishek Publishers, 1998.
3. Textile Dyes and Pigments, H. Panda, NIIR Publishers.
4. Fibre to fabric, 4th Ed, Potter & Corban, McGraw Hill book Company, 1959.
5. Sugar: Science and Technology, G. G. Birch and K.. J. Parker, Applied Science Publishers Ltd., 1979.
6. Principles of Sugar Technology, Pieter Honig Vol I, Elsevier Publishing Company, 1953.

Module Code:	**Chem-477**
Module title:	**Applied Chemistry – IV Environmental Chemistry**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

The student will learn about the basic concepts of Environmental chemistry. They will also learn that how industrial activities contribute Water and Air Pollution.

SYLLABUS OUTLINE:

1. Introduction:

History and significance of environmental degradation, impact of the modern life-style on environmental quality, resource depletion, environmental pollution and its types, environmental education, Environmental management systems, institutions for the protection of environment, inter-disc nature of environmental studies, environmental segments and their interrelation ships, Environmental quality standards (air, drinking water and wastewater).

2. Air and Water Environment:

Composition of atmosphere, temperature and pressure profile of different layers of the atmosphere, common air pollutants and their sources, greenhouse effect and global warming, stratospheric ozone depletion, Importance of water, BOD and COD, sources of water pollution (industrial, agricultural, municipal and natural), primary, secondary and advanced treatment of water.

RECOMMENDED BOOKS:

1. Kumar. Environmental Chemistry, Wiley Eastern, New Delhi.
2. J.W. Moore & EM. Moore, Environmental Chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental Chemistry, Prentice Hafl, Delhi.
4. K. Banerji, Environmental Chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental Chemistry, Brooks, California.
6. Neil, P.O. Environmental Chemistry, Chapmann, London.
7. Baird, C. Environmental Chemistry, Freeman, New York.

Module Code:	**Chem-478**
Module Title:	**Bio Chemistry – I Lipids**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**

Module Rating: **2 credits**

OBJECTIVES

After studying this course student will be able to understand lipids, classification and importance of lipids, significance of lipids in biological membranes, triglyceride metabolism, phospholipids metabolism, cholesterol metabolism and lipid transport in plasma.

SYLLABUS OUTLINES

Nature, structure and classification of lipids. Structure and chemical properties of triglycerides, phospholipids, glycolipids, sphingolipids and steroids. Lipids with specific biological activities. Acid value, Saponification value and Iodine value of lipids/fats. Properties of lipid aggregates: Micelles and Bilayers. Structure and function of prostaglandins. Structure and assembly of Biological membranes and membrane proteins. Fluid Mosaic model. The erythrocyte membrane. Digestion and aBS CHEMISTRYorption of Lipids. Detailed Synthesis and Oxidation of fatty acids. Involving of Acyl carrier protein and Carnitine carriers. Metabolism of essential fatty acids and their metabolic disorders. Control of fatty acid Metabolism. Ketone Bodies.

RECOMMENDED BOOKS

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000
2. Pub: worth Publishers
3. Biochemistry by Lubert Stryer(2006) Pub: Freeman andCompany
4. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.
5. Immunology by J. Kuby 2nd ed. 1996 Pub: W. H. freeman and Co.
6. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
7. Lippincott's Biochemistry by champ c; Harvey.R. A and Ferrie. D .R. 3rd edition., Pub: J. B. Lippincott company

Module Code: **Chem-479**
Module Title: **Bio Chemistry Lab - I**
Name of scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **1 credit**

OBJECTIVE

This study will assist students for qualitative and quantitative determination of different lipids. It will also help to extract lipids from animal and plant sources. Students will be able to learn acid value, saponification value and Iodine value of fats.

SYLLABUS OUTLINES

- Qualitative tests for lipids and fatty acids, sterols and phospholipids.
- Extraction and Thin layer chromatography (TLC) of Lipids from animal and plant sources.
- Acid value, saponification Value and Iodine Value of fats.

RECOMMENDED BOOKS

1. Modren Experimental Biochemistry by R. F. Boyer 3rd ed, 2000, Pub: Pearson Education Inc.
2. Practical clinical Biochemistry by Varley. Pub: CBS CHEMISTRY publisher
3. An Introduction to Practical Biochemistry by D. T. Plummer 3rd Ed. (1987) Pub: McGraw Hill
4. Fundamentals of Microbiology. By E. Aicamo 1994 Publisher; Benjamin- Cummings Publishing Co.
5. Varleys Practical Clinical Biochemistry 6th Edition (English, Hardcover, Alan H. Gowenlock)

Module Code: **Chem-480**
Module Title: **Bio Chemistry – II Molecular Biology**
Name of Scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **2 credits**

OBJECTIVES

After studying this course, students will be able to understand molecular biology, DNA as hereditary material, DNA replication, reverse transcription, DNA damage and repair. It will also assist to understand Transcription and Translation of DNA, machinery of protein synthesis and process of protein synthesis.

SYLLABUS OUTLINES

Introduction of molecular biology and history. DNA as genetic material. Chromatin and structure of Eukaryotic chromosomes, DNA replication and transcription in prokaryotes and eukaryotes. Translation; synthesis and splicing of RNA, Protein synthesis. DNA damage, repair and recombination. Restriction enzymes. Regulation of gene expression in prokaryotes, eukaryotes and Operon model. Plasmids, bacteriophages, and cosmids. Method of Recombinant DNA.

RECOMMENDED BOOKS

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000Pub: worth Publishers
2. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
3. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.
4. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
5. Lippincott's Biochemistry by champ c; Harvey.R. A and Ferrie. D .R. 3rd edition., Pub: J. B. Lippincott company
6. BRS Biochemistry, Molecular Biology,and Genetics 5th edition.

Module Code:	**Chem-481**
Module Title:	**Bio Chemistry Lab - II**
Name of Scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**1 credit**

OBJECTIVES

This course will help students to understand practical grounds to isolate DNA from animal and bacterial sources. It will also help students to understand the technique of gel electrophoresis.

SYLLABUS OUTLINES

- Preparation of stock and working solution for the isolation of DNA.
- Isolation of genomic DNA by inorganic method.
- Isolation of genomic DNA by organic method.
- Determination of messenger RNA expression of candidate gene by PCR.
- Determination of DNA, cDNA by gel electrophoresis.
- Separation of different spliced DNA by gel electrophoresis.
- Isolation and estimation of DNA from animal sources and bacteria.
- Restriction enzyme digestion of DNA and its separation by gel electrophoresis

RECOMMENDED BOOKS

1. Ausubel FM, 2005. Short Protocols in Molecular Biology (2 volume set). 5th Edition; John Wiley and Son. 2. Green MR and Sambrook J, 2001.
2. Molecular Cloning: A Laboratory Manual. 3rd Edition; Cold Spring Harbor Laboratory Press. 3. Primrose SB and Twyman R, 2006.
3. Principles of Gene Manipulation and Genomics. 7th Edition; Wiley-Blackwell. 4. Wilson K and Walker J, 2010.
4. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition; Cambridge University Press. 5. Walker JM and Rapley, 2008.

Module Code:	**Chem-482**
Module Title:	**Bio Chemistry – III Microbiology & Drug Metabolism**
Name of scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**

Module Type: **Elective**
Module Rating: **2 credits**

After studying this course, students will be able to understand development of drug resistance. Students will learn the mode of action of different drugs which in turn will help to understand physiology, biochemistry, and genetics of microorganisms.

SYLLABUS OUTLINES

Microorganisms and their gross Classification, Bacterial growth and cultivation techniques. Identification of Microorganisms, Factors for the growth of microbes. Methods of Growth measurement, Growth under extreme environments. Mutation and protoplast fusion in cultures and its benefits. Gene transfer: transformation, transduction and conjugation. Bacteriophages chemistry, metabolism and mechanism of action of anti-malarials, anti-bacterials, antivirals and antifungal drugs. Drug resistance, Biochemical transformation of drugs. Anticancer drugs.

RECOMMENDED BOOKS

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000
2. Pub: worth Publishers
3. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
4. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.
5. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.

Module Code: **Chem-483**
Module Title: **Bio Chemistry Lab - III**
Name of scheme: **BS CHEMISTRY 8th Semester**
Department: **School of Chemistry**
Faculty: **Science**
Module Type: **Elective**
Module Rating: **1 credit**

OBJECTIVES

This study will provide better understanding of sterilization techniques, bacterial culturing and understanding of bacterial growth curves by chemical tests. It will also help to understand the structure of cell.

Syllabus Outlines

- Study and practical demonstration of laboratory safety measures.
- Preparation of serial dilution from stock solution.
- Sterilization techniques, culturing of bacteria in liquid and solid medium, gram staining of bacteria, colony and cell morphology, bacterial cell count and growth curves by chemical tests.
- Isolation of bacteria.
- Growth of bacteria.
- Antibiotic sensitivity test.
- Activity of drug
- Cell structure: Study of cell structure by light microscope.

RECOMMENDED BOOKS

1. Modern Experimental Biochemistry by R. F. Boyer 3rd ed, 2000, Pub: Pearson Education Inc.
2. Practical clinical Biochemistry by Varley. Pub: CBS publisher
3. An Introduction to Practical Biochemistry by D. T. Plummer 3rd ed. (1987) Pub: McGraw Hill
4. Fundamentals of Microbiology. By E. Aicamo 1994 Publisher; Benjamin- Cummings Publishing Co.

Module Code: **Chem-484**
Module Title: **Physical Chemistry – IV Biochemical Techniques**

Name of scheme:	**BS CHEMISTRY 8th Semester**
Department:	**School of Chemistry**
Faculty:	**Science**
Module Type:	**Elective**
Module Rating:	**2 credits**

OBJECTIVES

After studying this course, students will be able to understand proteins extraction and purification techniques, chromatographic techniques, different biochemical techniques used for separation, types of PCR and its applications.

SYLLABUS OUTLINES

General methods for extraction, fractionation and purification of proteins. Principles of chromatography, ion exchange chromatography, paper chromatography, affinity chromatography, gas chromatography and column chromatography. High performance liquid chromatography (HPLC), Filtration, Polyacrylamide and agarose gel electrophoresis, SDS PAGE, Southern blotting, Western blotting, Northern blotting. Immunoelectrophoresis. Enzyme linked immunosorbent assay (ELISA) and its types, Radioisotopes and their applications in Biochemistry. PCR and its types,

RECOMMENDED BOOKS

1. Principles of Biochemistry by Lehninger AL, Nelson DL and CoxMN,2000
2. Pub: worth Publishers
3. Biochemistry by Lubert Stryer (2006) Pub: Freeman and Company
4. A biologist's guide to Principles and Techniques of Practical Biochemistry by Bryan L Williams and Keith Wilson Pub: Edward Arnold Ltd.
5. Immunology by J. Kuby 2nd ed. 1996 Pub: W. H. freeman and Co.
6. Harpers Biochemistry, 27th ed. (2006) McGraw Hill Inc.
7. (Methods in Molecular Biology) - Histopathology (2014) [PDF] [UnitedVRG]