University of Chitral
BECOME WHAT YOU WANT TO BE
یونیورسٹی آف چترال

Assistant Director
Academics
University of Chitral

Scheme of Studies BS Chemistry

Department of Chemistry
University of Chitral

ANNEXURE – A

Scheme of studies BS Chemistry 4-year program

Name of Degree: BS Chemistry

Eligibility Criteria: The minimum requirements for admission are at least 45% marks in FSc (Pre medical or pre engineering or equivalent) examination.

Duration: The minimum duration for completion of BS Chemistry degree is four years and maximum is seven years.

Degree Completion Requirements:

To become eligible for award of BS degree, a student must satisfy the following requirements:

a) Must have studied and passed the prescribed courses, totaling 133 minimum and 136 maximum credit hours.

b) Must have earned CGPA (Cumulative Grade Point Average) of at least 2.0 on a scale of 4.0.

BS Curriculum Design

The structure of BS Program is proposed to meet the needs of students through theory and practical. The students are expected to learn theoretical and practical understanding of the respective field of Physical science.

- Minimum credit hours shall be 133 for BS programs.
- Each program comprises eight semesters spread over four years.
- The following table gives the distribution of credit hours in different domains of knowledge.

MISSION STATEMENT

The common purpose is to achieve the highest possible standards of scholarship, teaching and research in chemistry and allied subjects.

1. The objectives of this curriculum are:
   i) To encourage intellectual development and scholarship in and through chemistry;
   ii) To impart a sound knowledge of chemistry to students and to help them to use this knowledge creatively and analytically.
   iii) To develop in students an awareness of the applications of chemistry including its practical, social and economic aspects such as health, agriculture, industry and defense.
   iv) To develop and improve students practical, written and oral communication, information retrieval, computer and problem solving skills.
   v) To encourage students to become effective independent learners.
   vi) To develop the curriculum which is need based and its continuous developments shallbe made considering the changing global and national requirements.
   vii) To develop in students the ability to work in groups so as to acquire respect for human values.
   viii) To encourage students to broaden their knowledge, to develop their own capabilities and self-confidence, to respect learning and to participate incontinuing education.

Course Category

Course Category	Credit Hours (%)
General	21 (15.44)
Compulsory	28 (20.5)
Chemistry	87 (63.9)
Total	136

Compulsory Courses

Compulsory Courses		
10 Courses/28 Credit Hours		
S. No	Course Title	Credit Hours
1	English I (Functional)	3
2	English II (Functional)	3
3	English III (Report Writing)	3
4	University Optional(Sociology)/English-IV	3
5	Pakistan Studies	2
6	Islamic studies	2
7	Mathematics- I (Algebra)	3
8	Mathematics- II (Calculus)	3
9	Computer Applications	3
10	Statistics	3
Total		28

General Courses

General Courses		
7 Courses, 3 credit hour each/21Credit Hours		
#	Course Title	Credit Hours
1	Geography-I	3
2	Principles of Animal life-I	3 (2+1)
3	Psychology/Principles of Animal Life-II	3 (2+1)
4	Philosophy of Science/Plant Diversity	3 (2+1)
5	Principles of Management/AppliedPhysics	3
6	Teaching & Learning/ Research Methodology	3
7	Cell Biology, Genetics and Evolution	3 (2+1)

Scheme of Studies BS Chemistry 4-YEAR Program

1st Year

1st Semester			
Course Code	Course Name	Credit Hours	Course Type
CHEM-111	English-I (Functional)	3(3+0)	
CHEM-112	Geography-I	3(3+0)	General-I
CHEM-113	Principles of Animal Life-I	3(2+1)	General-II
CHEM-114	Mathematics-I	3(3+0)	
CHEM-115	Computer Applications	3(3+0)	
CHEM-116	Inorganic Chemistry-I	4(3+1)	
Total Credit Hours		19(17+2)	

2nd Semester			
Course Code	Course Name	Credit Hours	Course Type
CHEM-121	English-II (Functional)	3(3+0)	
CHEM-122	Principles of Animal Life-II	3(2+1)	General-III
CHEM-123	Mathematics-II	3(3+0)	
CHEM-124	Statistics	3(3+0)	
CHEM-125	Organic Chemistry-I	4(3+1)	
Any one from the following			
CHEM-126	Islamic Studies	2(2+0)	
CHEM-127	Ethics	2(2+0)	
Total Credit Hours		18(16+2)	

2nd Year

3rd Semester			
Course Code	Course Name	Credit Hours	Course Type
CHEM-231	English-III (Technical Writing & Presentation Skills)	3(3+0)	
CHEM-232	Plant Diversity	3(2+1)	General-IV
CHEM-233	Applied Physics	3(3+0)	General-V
CHEM-234	Pakistan Studies	2(2+0)	
CHEM-235	Environmental Chemistry	3(3+0)	
CHEM-236	Physical Chemistry-I	4(3+1)	
Total Credit Hours		18(16+2)	

4th Semester			
Course Code	Course Name	Credit Hours	
CHEM-241	Principlesof Sociology	3(3+0)	General-VI
CHEM-242	ResearchMethodology	3(3+0)	General-VII
CHEM-243	Cell Biology, Genetics and Evolution	3(2+1)	General-VIII
CHEM-244	Analytical Chemistry-I	3(2+1)	
CHEM-245	Applied Chemistry-I	2(2+0)	
CHEM-246	Biochemistry-I	3(2+1)	
Total Credit Hours		17(14+3)	

3rd Year

5th Semester			
Course Code	Course Name	Credit Hours	
CHEM-351	Inorganic Chemistry-II	4(3+1)	
CHEM-352	Organic Chemistry-II	4(3+1)	
CHEM-353	Physical Chemistry-II	4(3+1)	
CHEM-354	Analytical Chemistry-II	4(3+1)	
Total Credit Hours		16(12+4)	

6th Semester			
Course Code	Course Name	Credit Hours	
CHEM-361	Inorganic Chemistry-III	4(3+1)	
CHEM-362	Organic Chemistry-III	4(3+1)	
CHEM-363	Physical Chemistry-III	4(3+1)	
Any one from the following			
CHEM-364	Analytical chemistry-III	4(3+1)	
CHEM-365	Applied Chemistry-II	4(3+1)	
CHEM-366	Biochemistry-II	4(3+1)	
CHEM-367	Fuel Chemistry-I	4(3+1)	
Total Credit Hours		16(12+4)	

4th Year (Specialization in Inorganic Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHIC-471	Inorganic reaction mechanism	3(3+0)	Paper-I
CHIC-472	π-acceptor ligands and inorganic polymers	3(3+0)	Paper-II
CHIC-473	Inorganic Spectroscopy	3(3+0)	Paper-III
CHIC-474	Lab-I (Inorganic)	1(0+1)	
CHIC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following-Other than the field of specialization			
CHIC-475	Applied chemistry-III (Common Industries-I)	3(3+0)	
CHIC-476	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHIC-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	
8th Semester			
CHIC-481	Organometallics	3(3+0)	Paper-IV
CHIC-482	Symmetry and Magneto chemistry	3(3+0)	Paper-V
CHIC-483	Radio and nuclear chemistry	3(3+0)	Paper-VI
CHIC-484	Lab-II (Inorganic Chemistry)	1(0+1)	
CHIC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following- Other than the field of specialization			
CHIC-485	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHIC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	
CHIC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

4th Year (Specialization in Organic Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHOC-471	Heterocyclic and Organometallic Compounds	3(3+0)	Paper-I
CHOC-472	Reactive Intermediates	3(3+0)	Paper-II
CHOC-473	Organic Spectroscopy	3(3+0)	Paper-III
CHOC-474	Lab-I (Organic Chemistry)	1(0+1)	
CHOC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following- Other than the field of specialization			
CHOC-475	Applied Chemistry-III (Common Industries-I)	3(3+0)	
CHOC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHOC-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	
8th Semester			
CHOC-481	Natural Products	3(3+0)	Paper-IV
CHOC-482	Organic synthesis	3(3+0)	Paper-V
CHOC-483	Medicinal Chemistry	3(3+0)	Paper-VI
CHOC-484	Lab-II (Organic Chemistry)	1(0+1)	
CHOC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHOC-485	Inorganic Chemistry-IV (Radio and Nuclear Chemistry)	3(3+0)	Elective Courses
CHOC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	
CHOC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

4th Year (Specialization in Physical Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHPC-471	Electrochemistry and statistical thermodynamics	3(3+0)	Paper-I
CHPC-472	Polymer chemistry	3(3+0)	Paper-II
CHPC-473	Quantum chemistry and molecular spectroscopy	3(3+0)	Paper-III
CHPC-474	Lab-I (Physical Chemistry)	1(0+1)	
CHPC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHPC-475	Applied Chemistry-III (Common Industries-I)	3(3+0)	
CHPC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHPC-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	
8th Semester			
CHPC-481	Reaction dynamics	3(3+0)	Paper-IV
CHPC-482	Radiation and photochemistry	3(3+0)	Paper-V
CHPC-483	Colloid and surface chemistry	3(3+0)	Paper-VI
CHPC-484	Lab-II (Physical Chemistry)	1(0+1)	
CHPC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHPC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHPC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	
CHPC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

4th Year (Specialization in Applied Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHAP-471	Common Industries-I	3(3+0)	Paper-I
CHAP-472	Agro based industries and pollution Control	3(3+0)	Paper-II
CHAP-473	Common Industries-II	3(3+0)	Paper-III
CHAP-474	Lab-I (Applied Chemistry)	1(0+1)	
CHAP-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHAP-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHAP-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHAP-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	
8th Semester			
CHAP-481	Organic based industries	3(3+0)	Paper-IV
CHAP-482	Industrial processes	3(3+0)	Paper-V
CHAP-483	Metallurgy and explosives	3(3+0)	Paper-VI
CHAP-484	Lab-II (Applied Chemistry)	1(0+1)	
CHAP-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHAP-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHAP-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHAP-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

4th Year (Specialization in Analytical Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHAC-471	Atomic spectroscopy	3(3+0)	Paper-I
CHAC-472	Electro analytical techniques	3(3+0)	Paper-II
CHAC-473	Advance separation techniques	3(3+0)	Paper-III
CHAC-474	Lab-I (Analytical Chemistry)	1(0+1)	
CHAC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHAC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHAC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHAC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	
8th Semester			
CHAC-481	Luminescence spectroscopy and thermal Analysis	3(3+0)	Paper-IV
CHAC-482	Nuclear analytical techniques	3(3+0)	Paper-V
CHAC-483	Food and drug analysis	3(0+3)	Paper-VI
CHAC-484	Lab-I (Analytical Chemistry)	1(0+1)	
CHAC-489	Research Project/Research Thesis/ Position paper (literature survey)		
Any one course (elective) from the following			
CHAC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHAC-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHAC-487	Applied chemistry-IV (Industrial Processes)	3(3+0)	

Specialization in Biochemistry

7th Semester			
Specialization in Biochemistry			
Course Code	Course Name	Credit Hours	
CHBC-471	Biomedical Chemistry	3(3+0)	Paper-I
CHBC-472	Molecular Biology	3(3+0)	Paper-II
CHBC-473	Physical Techniques in Biochemistry	3(3+0)	Paper-III
CHBC-474	Lab-I (Biochemistry)	1(0+1)	
CHBC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHBC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHBC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHBC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	

8th Semester Specialization in Biochemistry			
	Course Name	**Credit Hours**	
CHBC-481	Microbiology & Immunology	3+0	Paper-I
CHBC-482	Biotechnology	3+0	Paper-II
CHBC-483	Nutritional Chemistry	3+0	Paper-III
CHBC-484	Lab-II (Biochemistry)	0+1	
CHBC-489	Research Project/Research Thesis/ Position paper (literature survey)	0+3	
Elective Course other than the field of specialization			
CHBC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHBC-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHBC-487	Applied chemistry-IV (Industrial Processes)	3(3+0)	

Specialization: Fuel Chemistry

4th year 7th semester Specialization: Fuel Chemistry			
7th Semester			
Course Code	Course Name	Credit Hours	
CHFC-471	Chemistry of Coal Conversion Processes-I	3(3+0)	Paper-I
CHFC-472	Petroleum and Petrochemicals-I	3(3+0)	Paper-II
CHFC-473	Characterization of Fossil Fuels	3(3+0)	Paper-III
CHFC-474	Lab-I (Fuel Chemistry)	1(0+1)	
CHFC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHFC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHFC-476	Biochemistry-II (Bioenergetics and Metabolism of Biomolecules)	3(3+0)	
CHFC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	

8th Semester Specialization in Fuel Chemistry			
	Course Name	**Credit Hours**	
CHFC-481	Chemistry of Coal Conversion Processes-II	3+0	Paper-I
CHFC-482	Petroleum & Petrochemicals-II	3+0	Paper-II
CHFC-483	Alternate Energy Sources	3+0	Paper-III
CHFC-484	Lab-II (Fuel Chemistry)	0+1	
CHFC-489	Research Project/Research Thesis/ Position paper (literature survey)	0+3	
Elective Course other than the field of specialization			
CHFC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHFC-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHFC-487	Applied chemistry-IV (Industrial Processes)	3(3+0)	

1st Year Semester-I

1st Semester			
Course Code	Course Name	Credit Hours	Course Type
CHEM-111	English-I (Functional)	3(3+0)	
CHEM-112	Geography-I	3(3+0)	General-I
CHEM-113	Principles of Animal Life-I(Zoology-I)	3(2+1)	General-II
CHEM-114	Mathematics-I	3(3+0)	
CHEM-115	Computer Applications	3(3+0)	
CHEM-116	Inorganic Chemistry-I	4(3+1)	
Total Credit Hours		19(17+2)	

Course Code: CHEM-111
Course Name: English I (Functional)
Credit Hours: 3(3+0)
Objectives: Enhance language skills and develop critical thinking.

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 verbs, 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
Note: Extensive reading is required for vocabulary building

Recommended books:
1. Functional English
a) Grammar
1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third editionOxford University Press. 1997. ISBN 0194313492 95.
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third editionOxford University Press. 1997. ISBN 0194313506.

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills.Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and35-41.

c) Reading/Comprehension

1. Reading. Upper Intermediate.Brain Tomlinson and Rod Ellis.Oxford Supplementary Skills.Third Impression 1992.ISBN 0 19 453402 2.

d) Speaking

Course Code: CHEM-112 Geography-I

Course Content; Credit Hours; 3+0

Introduction

Definition, scope and branches of geography

Roots of the discipline and Basics of geographic concepts Themes and traditions of geography Tools of geography

The Universe; Galaxies and solar system

The Earth as a Planet: Celestial Positions. Rotation, revolution and related phenomena

Sphere of the Earth; Lithosphere, Atmosphere, Hydrosphere, Biosphere

Man Environment interaction: Population, Major economic activities, settlements and pollution.

Course Code: CHEM-113

Course Name: Principles of Animal Life-I

PRINCIPLES OF ANIMAL LIFE – I Cr: (2+1) Objectives

The course aims to impart knowledge and understanding of:

- The concept and status of Zoology in life sciences and the common processes of life through its biochemicaland molecular processes.
- The structure and function of cell organelles and how common animal cell diversified in various tissues,organs and organ systems.
- Biochemical mechanisms eventually generating energy for animal work.
- Animals and their relationship with their environment.Course Contents

Scope of Zoology: Introduction; significance and applications of zoology; animal diversity; the scientificmethod; environment and world resources.

The Chemical Basis of Animal Life: Brief introduction to biomolecules; carbohydrates, lipids, proteins, andnucleic acids.

Cellular Organization: Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, vacuoles;the nucleus: nuclear envelope, chromosomes and nucleolus.

Animal tissues: Types: epithelial, connective, muscle and nervous tissue; organs and organ systems.

Enzymes: Structure, types; function and factors affecting their activity; cofactors and coenzymes.

Energy Harvesting: Aerobic and anaerobic respiration: glycolysis, citric acid cycle and electron transportchain; fermentation, the major source of ATP.

Reproduction and Development: Types; asexual and sexual, gametogenesis, fertilization, metamorphosis,zygote and early development.

Lab.

Practicals 1. Tests for different carbohydrates, proteins and lipids. Note: Emphasis on the concept that testsmaterials have been ultimately obtained from living organisms and constituted their body.

1. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac). Note: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.

2. Plasmolysis and deplasmolysis in blood. Preparation of blood smears.

3. Protein digestion by pepsin.

4. Ecological notes on animals of a few model habitats.

5. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Books Recommended 1. Miller, S.A. and Harley, J.B. 2005. Zoology, 6th Ed. (International), Singapore: McGraw-Hill.

2. Molles, M.C. 2005. Ecology: Concepts and Applications. 6 th Ed. McGraw Hill, New York, USA.

3. Hickman, C.P., Roberts, L.S. and Larson, A. 2004. Integrated Principles of Zoology, 12th Ed. (International), Singapore: McGraw Hill.

4. Campbell, N.A. 2002. Biology. 6th Ed. Menlo Park, California: Benjamin/Cummings Pblishing Company, Inc.

5. Miller, S.A. 2002. General Zoology Laboratory Manual. 5thEd. (International), Singapore: McGraw Hill.

6. Hickman, C.P. and Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw HillCourse

Course Code: CHEM-114

Course Name: Mathematics-I (Algebra)

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:

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 quadraticequations, 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 andirrational indices.

Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books:

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, Algebra 2 and Trigonometry,1978, Houghton & Mifflin.
2. Kaufmann JE, College Algebra and Trigonometry, 1987, PWS-Kent Company, Boston
3. Swokowski EW, Fundamentals of Algebra and Trigonometry (6th edition), 1986, PWS-Kent Company, Boston

Course Code: CHEM-115 **Course Name: Computer Applications**

Course Contents:

Basic of Computers

- Introduction and history of computers
- Generations of Computer
- Types of computer (analog, digital, hybrid)
- Classification of Computer
  - Mainframe Computer, Mini Computer, Super Computer & Micro Computer
- Block diagram of Computer System.

Parts of the a Computer System

- Hardware
  - Essential Computer Hardware(Processor, Memory, Input Devices, Output Devices & Storage devices)
- Software
- Data
- User

Processing Unit

- Data Processing Techniques
  - Manual Data Processing
  - Electronic Data Processing
- Central Processing Unit (CPU)
  - ALU and Control Unit
  - Buses and Ports

Computer Memory/ Storage

- Memory and types
  - Primary/Internal memory (RAM & ROM)
  - Cache Memory and Registers
  - Units of Computer Memory(Bit, Byte, KB, MB, GB , TB)
- Secondary Storage
  - Magnetic Devices
  - Optical Devices.
  - Solid State Devices

Input Devices

- Keyboard, Mouse, Scanner, Digital Camera

- **Output device**
  - Monitor(CRT, LED, LCD), Printer, Speaker
- **Software**
  - System software
    - Operating system
  - Application software
    - General purpose and Special purpose Software
- **Networking Basic Concepts**
  - Computer Network(LAN & WAN) and its advantages
  - Server Based Network and Peer to Peer Network
- **Data Communication and Data Communication System(DCS)**
  - Components of DCS(Sender, Receiver, medium, Message & Protocol)
- **The Internet & Internet Services**
  - The World Wide Web
  - Electronic mail
  - File Transfer
  - Chat
  - Online Services
  - Instant Messaging
- Web Browsers, URL, Web Searching/ Browsing, Search Engine
- Social Networking Ethics, Cyber Crime and Types
- **Productivity Software/ Introduction to :**
  1. Microsoft Word (Beginner's Level)
  2. Microsoft Excel (Beginner's Level)
  3. Microsoft Power Point ((Beginner's Level)

Text Books/Reference Books

1. Introduction to Computers by Peter Norton, 6th International Edition, McGraw-Hill

2. Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition, McGraw-Hill

3. Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Sawyer

4. Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.

Course Code: CHEM-116

Course Name: Inorganic Chemistry-I

Cr. Hrs. 3+1

Course Objectives:

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

Course Content:

Chemical Bonding:

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

Acids and Bases:

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

P-Block Elements:

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

Lab:

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD),disposal of chemical waste and first-aid practices, qualitative analysis of salt mixtures, quantitative analysis, acid- base titrations, preparation and standardization of acid and alkalisolutions, redox titrations, preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in determination ofcopper in a given sample, gravimetric analysis, determination of barium in a given sample,determination of chloride in a given solution.

Recommended Books:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., OxfordUniversity Press, (1994).
2. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley &Sons, New York, (2007).
3. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3rd ed.,Harper International SI Edition, (2006).
4. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).
5. Lee, J. D., Concise Inorganic Chemistry, 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 3rd ed., Pearson Education, India,(2008).
7. Huheey, J. E., Kieter E. A., Keiter L. R., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., Inorganic chemistry, 3rd ed., Pearson Education India, (1981).

9. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, Inorganic Chemistry, 3rd ed., Prentice Hall,(2008).
11. Kathleen A. H., James E. H., Descriptive Inorganic Chemistry, 2nd ed., Brooks Cole,(2010).
12. Wulfsberg G., Principles of Descriptive Inorganic Chemistry, 1st ed., University ScienceBooks, (1991).
13. Hill, R. H. JR and Fister, D. C., Laboratory Safety for Chemistry Students, John-Wiley &Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., Vogel'sTextbook of Quantitative Chemical Analysis, 6th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., Vogel's Qualitative Inorganic Analysis, 7th ed., (7th imp.), Pearson Education, Ltd., (2009

FIRST YEAR (SEMESTER-II)

2nd Semester			
Course Code	Course Name	Credit Hours	Course Type
CHEM-121	English-II (Functional)	3(3+0)	
CHEM-122	Principles of Animal Life-II(Zoology-II)	3(2+1)	General-III
CHEM-123	Mathematics-II	3(3+0)	
CHEM-124	Statistics	3(3+0)	
CHEM-125	Organic Chemistry-I	4(3+1)	
Any one from the following			
CHEM-126	Islamic Studies	2(2+0)	
CHEM-127	Ethics	2(2+0)	
Total Credit Hours		18(16+2)	

Course Code: CHEM-121 Course Name: English II (Functional)
Credit Hours: 3

Objectives: Enable the students to meet their real life communication needs.

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 andprécis 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)

Recommended Books:

Communication Skills

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Thirdedition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

2. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
3. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introductionto presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. ThirdImpression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John Langan.
3. Study Skills by Riachard York.

Course Code: CHEM-122 **Course Name: Principles of Animal life-II**

PRINCIPLES OF ANIMAL LIFE–II

Cr 3(2+1)

Objectives the course will impart knowledge and understanding of:

- Cell division and its significance in cell cycle.
- Concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics ofgenetics.
- Animal behavior and communication.
- Theories of evolution, gene flow and mechanism of evolution with reference to animal diversity.

Course Contents

Cell Division: Cell cycles: Mitosis and meiosis; control of the cell cycle.

Inheritance Patterns: Mendelian genetics; inheritance patterns; gene, structure, chemical composition andtypes.

Chromosomes and Gene Linkage: Eukaryotic chromosomes; linkage and crossing over; chromosomal aberrations.

Cellular Control: DNA: the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA technologies and their applications.

Animal Behavior: Behaviour and its types, proximate and ultimate causes; anthropomorphism; development of behavior; learning; factors controlling animal behavior; communication; behavioral ecology; social behavior.

Evolution: A Historical Perspective: Theories of evolution: Natural selection Lamarckism and neo larmarckism, Darwinism and neo Darwinian

Lab.

Practicals related to the course content mentioned above

Books Recommended 1. Pechenik, J.A. 2012. Biology of Invertebrates, 4th Edition (International), Singapore: McGraw Hill. 2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill. 3. Miller, S.A., Harley, J.B. 2002. Zoology, 5th Edition (International),Singapore: McGraw Hill. 4. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International).
Singapore: McGraw Hill. 5. Campbell, N.A. 2002. Biology. 6th Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc. 6. Kent, G.C., Miller, S. 2000. Comparative Anatomy of Vertebrates. New York: McGraw Hill. 7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology. Singapore: McGraw Hill

Course Code: CHEM-123 Course Name: Mathematics-II Cr. Hrs: 3

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

Course Outline:

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

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

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

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

Recommended Books:

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

Course Code: CHEM-124 Course Name: Statistics

Specific Objectives:

This course helps students to understand the basic concepts of statistics, its nature, scope and importance with special focus on its use in social sciences.

Unit 1. What is Statistics?

Definition of Statistics, Population, sample Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources Exercises.

Unit 2. Presentation of Data

Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram and Frequency polygon Exercises.

Unit 3. Measures of Central Tendency

Introduction, Different types of Averages, The Mode, Empirical Relation between Mean (AM), Medianand mode, Relative Merits and Demerits of various Averages. Properties of Good Average, Exercises.

Unit 4. Measures of Dispersion

Introduction, Absolute and relative measures, The Variance and standard deviation, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Exercises.

Unit 5. Sampling

Introduction, sample design and sampling frame, sampling and non-sampling errors, sampling with and without replacement, probability and non-probability sampling.

Unit 6.Hypothesis Testing

Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, levelof significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

Unit 7. Testing of Hypothesis- Single Population

Introduction, testing of hypothesis and confidence interval about the population mean for small and large samples, Exercises

Unit 8. Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, Correlation. Coefficient of linear correlation, Examples

Recommended Books:

1. Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.
2. Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar, Faisalabad.

Course Code: CHEM-125

Course Name: Organic Chemistry-I

Course Objectives:

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

Course Content:

Basic Concepts of Organic Chemistry:

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

Chemistry of Hydrocarbons:

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

Chemistry of Functional Groups:

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

Lab.

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

Recommended Books:

1. Brown, W. and Poon, T., Introduction to Organic Chemistry, 3rd ed., John-Wiley &

Sons, Inc., (2005).
2. John, E. M. Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey,(1992).
4. Younus, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore,Pakistan, (2006).
5. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, 6th ed., Pearson EducationLimited, England, (1986).
6. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons,Inc., (2011).
7. Furniss, B. S., Hannaford , A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook ofPractical Organic Chemistry, 5th ed., Longman, UK, (1989).
8. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach toOrganic Laboratory Techniques, 5th ed., Brooks/ Cole Cengage Learning, (2013).
9. Mayo, D. W., Pike, R. M. and Forbes, D. C., Microscale Organic to Laboratory withMultistep and Multisacle Syntheses, 5th ed., John-Wiley & Sons, Inc., (2011).
10. Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale andMicroscale Approach, 5th ed., Brooks/ Cole Cengage Learning, (2010).
Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed.,Brooks/ Cole Cengage Learning, (2012

Ethics Course Code: CHEM-127 Credit Hours: 2+0

Content:

Elementary theories in normative ethics of behavior, core areas of ethics, cultural relativism, religious approaches to ethics

Intermediate theories in normative ethics of behavior, utilitarianism, Kant theory, social contract theory

Recommended Books:

Barsky,A. E.(2010): Ethics and values in social works: An Interogative Approach to Comprehansive Curricullum, Oxford University Press, New York

Cahn, S.M.(1998) Ethics ; Hostory, Theory and Contemporary Issues. Oxford University Press, New York

Course Code: CHEM-126 Course Name: Islamic Studies

Objectives:

This course is aimed at:

1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships

4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies

1) Basic Concepts of Quran
2) History of Quran
3) Uloom-ul-Quran

Study of Selected Text of Holly Quran

1) Verses of Surah Al-Baqara Related to Faith(Verse No-284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)

Seerat of Holy Prophet (S.A.W) I

1) Life of Muhammad Bin Abdullah (Before Prophet Hood)
2) Life of Holy Prophet (S.A.W) in Makkah
3) Important Events of Life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

1) Life of Holy Prophet (S.A.W) in Madina
2) Important Events of Life of Holy Prophet in Madina

Introduction to Sunnah

1) Basic Concepts of Hadith
2) History of Hadith
3) Kinds of Hadith
4) Sunnah & Hadith
5) Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence

1) Basic Concepts of Islamic Law & Jurisprudence
2) History & Importance of Islamic Law & Jurisprudence
3) Sources of Islamic Law & Jurisprudence

Islamic Culture & Civilization

1) Basic Concepts of Islamic Culture & Civilization
2) Characteristics of Islamic Culture & Civilization

Islam & Science

1) Basic Concepts of Islam & Science

2) Contributions of Muslims in the Development of Science
3) Quran & Science

Islamic Economic System

1) Basic Concepts of Islamic Economic System
2) Islamic Concept of Riba

Political System of Islam

1) Basic Concepts of Islamic Political System
2) Islamic Concept of Sovereignty
3) Basic Institutions of Govt. in Islam

Reference Books:

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

SECOND YEAR (SEMESTER-III)

3rd Semester			
Course Code	Course Name	Credit Hours	Course Type
CHEM-231	English-III (Technical Writing & Presentation Skills)	3(3+0)	
CHEM-232	Plant Diversity(Botany-I)	3(2+1)	General-IV
CHEM-233	Applied Physics	3(3+0)	General-V
CHEM-234	Pakistan Studies	2(2+0)	
CHEM-235	Environmental Chemistry	3(3+0)	
CHEM-236	Physical Chemistry-I	4(3+1)	
Total Credit Hours		18(16+2)	

Course Code: CHEM-231

Course Name: English III ((Technical Writing and Presentation Skill)

Objectives: Enhance language skills and develop critical thinking

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

Recommended Books: Technical Writing and Presentation Skills a) Essay Writing and Academic Writing 1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing). 2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004. 3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press. b) Presentation Skills c) Reading The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students)

Course Code: CHEM-232 Course Name: Plant Diversity
Credit Hours: 2+1
Specific Objectives of course: To introduce the students to the diversity of plants and their structures andsignificance.
Course Outline:
a) **Bacteria and Cyanobacteria** (Nostoc, Anabaena, Oscillatoria) with specific reference to biofertilizers,pathogenicity.
b) **Algae** (Chlamydomonas, Spirogyra, Vaucheria, Pinnularia, Polysiphonia)
c) **Fungi** (Mucor, Penicillium, Agaricus), their implication on crop production and industrial applications.
d) **Lichens** (Physcia)
e) **Bryophytes** i. Riccia ii. Anthoceros iii. Funaria
f) **Pteridophytes.** i. Psilopsida (Psilotum) ii. Lycopsida (Selaginella) iii. Sphenopsida (Equisetum) iv. Pteropsida (Marsilea)
g) **Gymnosperms** i. Cycas ii. Pinus iii.Ephedra
h) **Angiosperms** i. Monocot (Poaceae) ii. Dicot (Solanaceae)
Lab.
Culturing, maintenance, preservation and staining of microorganisms. Study of morphology and reproductive structure of the types mentioned in theory. Identification of various types mentioned from prepared slides and fresh collection.

Course Code: CHEM-233
Course Name: Applied Physics
Course Contents:
Physical Optics: Nature of light, interference of light, Michelson‟s interferometer, Diffraction oflight, Diffraction grating, Diffraction of X-rays by crystal, Bragg‟s law, Polarization of Light andits application in optical activity.
Thermodynamics: Thermodynamics system, Heat, Temperature and internal energy, First law of thermodynamics and its applications, Specific heat, Second law of thermodynamics, Refrigerator, Entropy.
Spectroscopy: Atomic spectra, Spectrum of H-Atom, Rutherford and Bohar atomic model, X-rays, its production and applications, Laser.
Nuclear physics: Nuclear Compositions, Nuclear Properties, Stable Nuclei, Nuclear MagneticResonance, Binding Energy, Isotopes, Mass spectrograph.
Nuclear transformations: Radioactive Decay, Radioactivity and the Earth, Radiation Hazards,Half-Life life of radioactive material, Radiometric Dating, Radioactive Series, Nuclear Fission (Divide and conquer), Nuclear Reactor, Nuclear Fusion, Fusion Reactor.

Course Code: CHEM-234 Course Name: Pakistan Studies

Credit Hours: 2

Introduction/Objectives:

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

Course Outline:

1. **Historical Perspective**

   a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
   b. Factors leading to Muslim separatism

   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**

Political and constitutional phases:

a. 1947-58
b. 1958-71
c. 1971-77
d. 1977-88
e. 1988-99
f. 1999 onward this chapter must be removed as per the recommendations of Subject Experts in the University and Affiliated Colleges to make the content suitable according to the assigned 2 credit hours.

3. **Contemporary Pakistan**
   a. Economic institutions and issues
   b. Society and social structure
   c. Ethnicity
   d. Foreign policy of Pakistan and challenges

e. Futuristic outlook of Pakistan

Recommended Books:

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

Course Code: CHEM-235

Course Name: Environmental Chemistry

Credit Hours: 3

Course Objectives:

Students will be able to acquire knowledge and develop understanding about the fundamental principles of environmental chemistry and different types of pollutions. Such information will be useful in studying and solving pollution related issues and experiments in the laboratory.

Course Contents:

Atmospheric Pollution:

The atmosphere, composition, temperature and pressure profile, role of free radicals in the atmosphere, temperature inversion and photochemical smog, particulate matter in theatmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone theozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Water Pollution:

Water pollution and waste water treatment, municipal, industrial and agricultural sources of pollution, heavy metals contamination of water, eutrophication, detergents and phosphates in water, water quality criteria, water purification: primary, secondary and advanced treatment, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Land pollution:

Soil and mineral resources, general principles of metal extraction, heavy metals contamination ofsoil, toxicity of heavy metals, bio-accumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Chemistry:

Atom economy, integrated pests' management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water basedpaints.

Recommended Books:

1. Baird, C. and Cann, M., Environmental Chemistry, 5th ed., W. H. Freeman & Company, (2012).
2. Dara, S. S. and Mihsra, D. D., A Text Book of Environmental Chemistry and Pollution Control, 9th ed., S. Chand & Co. Ltd., (2004).
3. Singhi, R. and Singh, V., Green Chemistry for Environmental Remediation, John-Willey & Sons, Inc., (2011).
4. Holloway, A. M. and Wayne, R. P., Atmospheric Chemistry, 1st ed., Royal

Society of Chemistry, (2010).
5. Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. Water Treatment Technologies for Removal of High Toxicity Pollutants, Springerlink, UK, (2010).
6. Manahan, S. E., Environmental Chemistry, 9th ed., CRC press, Taylor & Francis group, USA, (2009).
7. Girard, J. E., Principles of Environmental Chemistry, 2nd ed., Jones and Bartlett publishers, (2010).
8. Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. and Hulsal, C., Principles of Environmental Chemistry, 1st ed., Royal Society of Chemistry, (2007).
9. Matalack, A., Introduction to Green Chemistry, 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
10. Wright, J., Environmental Chemistry, Routledge, (2003).
11. O‟Neill, P., Environmental Chemistry, 3rd ed., Blackie Academic & Professional, (1998).

Course Code: CHEM-236

Course Name: Physical Chemistry-I

Course Objectives:

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

Chemical Thermodynamics:

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

Chemical Equilibrium:

General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van‟t Hoff equation, Le-Chatelier‟s principle.

Solution Chemistry:

Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and non- ideal solutions, Raoult‟s law and its

applications, lowering of vapor pressure, elevation of boilingpoint, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions and Henry‟s law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.

Chemical Kinetics:

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

Lab.

1. Determination of viscosity and refractive index of liquids.
2. Determination of percent composition of liquid solutions viscometrically.
3. Determination of refractive index and molar refractivity.
4. Determination of percent composition of liquid solutions by refractive indexmeasurements.
5. Determination of molecular weight of a compound by elevation of boiling point(ebullioscopic method).
6. Determination of molecular weight of a compound by lowering of freezing point(cryoscopic method).
7. Determination of heat of solution by solubility method.
8. Determination of heat of neutralization of an acid with a base.
9. Kinetic study of acid catalyzed hydrolysis of ethyl acetate.
10. Determination of partition coefficient of a substance between two immiscible liquids.

Recommended Books:

1. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach,1st ed.,University Science Books,(1997).
2. Atkins,P. and Paula,J.D., Atkin‟s Physical Chemistry, 9th ed., Oxford University Press,(2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill PublishingCompany Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).
5. Glasstone, S., Textbook of Physical Chemistry, Macmillan London (1960).
6. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman GroupLimited, New York, (1974).
7. Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana,Lahore, (2013).
8. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman,New York, (2010).
9. Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Ptv. Ltd.,(2011).

SECOND YEAR (SEMESTER-IV)

4th Semester			
Course Code	Course Name	Credit Hours	
CHEM-241	Principlesof Sociology	3(3+0)	General-VI
CHEM-242	ResearchMethodology	3(3+0)	General-VII
CHEM-243	Cell Biology, Genetics and Evolution(Botany-II)	3(2+1)	General-VIII
CHEM-244	Analytical Chemistry-I	3(2+1)	
CHEM-245	Applied Chemistry-I	2(2+0)	
CHEM-246	Biochemistry-I	3(2+1)	
Total Credit Hours		17(14+3)	

Principles of Sociology
Course Code: CHEM-241
Credit Hours; 3

Course Objectives:
The course is designed to introduce the students with sociological concepts and the discipline. The focus of the courseshall be on significant concepts like social systems and structures, socioeconomic changes and social processes. The course will provide due foundation for further studies in the field of sociology.

Course Outline:

1. Introduction

a. Definition, Scope, and Subject Matter b. Sociology as a Science c. Historical back ground of Sociology d.Relationship of sociology with other social sciences

2. Basic Concepts

a. Group, Community, Society b. Associations i. Non-Voluntary ii. Voluntary c. Organization i. Informal ii. Formal d.Social Interaction i. Levels of Social Interaction ii. Process of Social Interaction a) Cooperation b) Competition c) Conflict d) Accommodation e) Acculturation and diffusion f) Assimilation g) Amalgamation

3. Social Groups

a. Definition and Functions b. Types of social groups i. In and out groups ii. Primary and Secondary group iii.Reference groups iv. Informal and Formal groups v. Pressure groups

4. Culture

a. Definition, aspects and characteristics of Culture i. Material and non material culture ii. Ideal and real culture b.Elements of culture i. Beliefs ii. Values iii. Norms and social sanctions c. Organizations of culture i. Traits ii. Complexes iii. Patterns iv. Ethos v. Theme d. Other related concepts i. Cultural Relativism ii. Sub Cultures iii. Ethnocentrism and Xenocentrism iv. Cultural lag

5. Socialization and Personality

a. Personality, Factors in Personality Formation b. Socialization, Agencies of Socialization 6 c. Role and Status

6. Deviance and Social Control

a. Deviance and its types b. Social control and its need c. Forms of Social control d. Methods and Agencies of Socialcontrol

7. Collective Behaviour

a. Collective behaviour, its types b. Crowd behaviour c. Public opinion d. Propaganda e. Social movements f.Leadership

Suggested Readings: 1. Anderson, Margaret and Howard F. Taylor. 2001. Sociology the Essentials. Australia: Wadsworth. 2. Brown, Ken 2004. Sociology. UK: Polity Press 3. Gidden, Anthony 2002. Introduction to Sociology.UK: Polity Press. 4. Macionis, John J. 2006. 10th Edition Sociology New Jersey: Prentice-Hall 5. Tischler, Henry L. 2002. Introduction to Sociology 7th ed. New York: The Harcourt Press. 6. Frank N Magill. 2003. International Encyclopedia of Sociology. U.S.A: Fitzroy Dearborn Publishers 7. Macionis, John J. 2005. Sociology 10th ed. SouthAsia: Pearson Education 8. Kerbo, Harold R. 1989. Sociology: Social Structure and Social Conflict. New York: Macmillan Publishing Company. 9. Koening Samuel. 1957. Sociology: An Introduction to the Science of Society. New York: Barnes and Nobel.. 10. Lee, Alfred Mclung and Lee, Elizabeth Briant 1961. Marriage and The family.NewYork: Barnes and Noble, Inc. 11. Leslie, Gerald et al. 1973. Order and Change: Introductory SociologyToronto: Oxford University Pre

Course Code: CHEM-242 Course Name: Research Methodology

Course Content:

1. Literature Review

Type of literature, sources of literature, use of modern techniques in literature review. Impact factor.

2. Academic writings

Types, method, design, format, style, language, layout and application of publication. Use of modern techniques in academic writings, preparing synopsis, manuscript, thesis and reports.

3. Plagiarism

Introduction, types of plagiarism, plagiarism policy. Identification and prevention of plagiarism using modern techniques. Use of anti-plagiarism software/website and its application.

4. Laboratory Safety Guidelines: Research ethics, chemical handling, substances with a hazardous nature, exposure limits, common safety symbols, suggested shelf storage pattern for organics and in- organics, recommended safety and emergency equipment for the Laboratory.

5. Use of Computer Based Software in Chemistry

Chem Draw, EndNote, Turnitine.

Recommended Books:

1. Research Methodology, S.C.Sinha & A.K. Dhiman Ess Ess Publication.

2. Research Methodology, Ranjeet Kumar, 3rd Edition, 2011, SAGE Publications Ltd. Landon.
3. Research Methodology for Biological Sciences N.Gurumani, MJP Publisher.
4. Practical Skills in Chemistry, J. R. Dean, A. M.Jones, D. Holmes, R. Reed, J. Weyers and A Jones,Pearson Education Ltd. [Prentice Hall] (2002).
5. Scientific, Social, Surveys and research P.V. Young & C.F. Schmid Prentice-Hall of India Pvt.Ltd.New Delhi.
6. Essentials of computational chemistry by C. J. Cramer.
7. Fundamentals of analytical chemistry by D. A. Skoog, D. M. West & F. J. Hooler.
8. Computers and Their Applications to Chemistry, by Ramesh Kumari, 2002.
9. The Little Book of Plagiarism, Leeds Metropolitan University,2013.
10. School Chemistry Laboratory Safety Guide, CPSC Publication No. 390. (October 2006).

Course Code: CHEM-244

Course Name: Analytical Chemistry-I (2+1)

Course Objectives:

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

Course Contents:

Chemometrics:

Sampling, significant figures, stoichiometric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard deviation/relative standard deviation, tests for significance, outliers

Quality Control and Quality Assurance:

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

Classical Analytical Methods:

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

Lab.

Calibration of volumetric glassware, electronic and analytical equipment, statistical evaluation of analytical data including linear regression analysis, constructing a calibration curve from a givenanalytical data using spread sheet software, determination of hardness of water using EDTA, determination of chloride in tap water sample, estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry, gravimetric analysis, determination of barium in barium nitrate, determination of nickel in a given steel sample, determination of bicarbonates in a clinical sample using back-titration, determination of cation in a mixture by complexometric titration, studying the effect of common ions on

solubility of sparingly soluble salts (e. g. AgCl / PbSO4). Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Brooks Cole Publishing Company, (2013).
2. Christian, G. D., Analytical Chemistry. 6th ed., John-Wiley & Sons, New York, (2006).
3. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company,New York,USA, (2011).
4. Kealey, D. and Haines, P. J,Instant Notes., Analytical Chemistry, Bios ScientificPublishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, CHEMOMETRICS-Statistics and Computed applications in AnalyticalChemistry, 2nd ed., Wiley-VCH, Germany, (2007).
6. Mitra A., Fundamentals of Quality Control and Improvement, 3rd ed., John-Wiley &Sons, (2008).
7. Miller, J. and Miller, J., Statistics and Chemometrics for Analytical Chemistry, 5th ed.,Prentice Hall, (2005).

Course Code: CHEM-245

Course Name: Applied Chemistry-I

Cr. Hr 2

Course Objectives:

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

Fundamentals of Chemical Industry:

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

Chemical Industries:

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

Recommended Books:

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

Course Code: CHEM-246
Course Name: Biochemistry-I
Credit Hrs. 3(2+1)

Course Objectives:

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

Introduction to Biochemistry:

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

Acid–Base and Electrolyte Chemistry:

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

Carbohydrates, Lipids and Proteins:

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

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

Significance of lipids in biological membranes and transport mechanism.

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

Lab.

Qualitative and quantitative analysis of carbohydrates, lipids and proteins.

Laboratory work illustrating topics covered in the lecture of Chem.131, Determination of pH,Preparation of buffers.

Enzyme catalysis, Progress curve for enzyme catalyzed reactions, Determination of values. To study the effect of different factors on the rate of enzyme catalyzed reactions.

Recommended Books:

1. R. C. Alkire, D. M. Kolb, J. Lipkowski, Biselectro chemistry, volume 13, 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.

2. Nelson,D.L., Lehninger's Principles of Biochemistry, 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
3. Voet, D. and Voet, J.D., Biochemistry, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
4. Murray, R.M. and Harper, H.A., Harper's Biochemistry, 25th ed., Publisher:Appleton& Lange, (2000). ISBN: 0838536840, 9780838536841.
5. Zubay, G. L., Biochemistry, 4th ed., illustrated, Publisher W. M. C. Brown Publishers, (1998), Digitized (2008). ISBN: 0697219003, 9780697219008.
6. Guyton, A. C. & Hall, J. E., Guyton & Hall Textbook of Medical Physiology, 12th ed., Publishers: Saunders Elsevier, (2011). ISBN: 978-1-4160-4574-8.

Harvey, R. A., Ferrier, DR, Karandish S., Lippincott's illustrated Reviews: Biochemistry, 5th ed., and Biochemistry Map (Med maps) Bundle. Publisher: Lippincott Williams & Wilkins, (2010)

Title of the course: CHEM-243 Cell Biology, Genetics and Evolution Credit hours: 3 (2+1)

Specific objectives of course: To understand: 1. Structure and function of cell. 2. Nature of genetic material and hereditary process 3. Familiarization with evolutionary processes.

Course outline:

a) Cell Biology

1. Structure and Function of Bio-molecules i. Carbohydrates ii. Lipids iii. Proteins iv. Nucleic Acids 2. Cell: Cell theory, cell types (prokaryotes, eukaryotes). 3. Brief description of following cell organelles i Cell wall ii Cell membrane iii Nucleus iv Endoplasmic reticulum v Plastids vi Mitochondria viiRibosomes viii Dictyosomes ix Vacuoles 4. Cell cycle **(**Mitosis**,** meiosis**)**

b) Genetics 1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance. 2. Molecular genetics; DNA replication. Nature of gene, genetic code, protein synthesis. 3. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

c) Evolution: Introduction and theories. (Darwanism and Lamarkism)

Lab Outline:

1. Cell Biology

Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs 2. Measurement of cell size. 3. Study of mitosis and meiosis by smear/squash method and from prepared slides. 4. Study of chromosome morphology and variation in chromosome number. 5. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.

2. Genetics

1. Genetical problems related to transmission and distribution of genetic material. 2. Identification of chromosomes in plant material. Carmine/orcein staining. 3. Determination of blood groups

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers. 2. Dyonsager, V. R. (1986). Cytology and Genetics. Tata and McGraw-Hill Publication Co. Ltd,, New Delhi. 3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co. 4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi. 5. Strickberger, M. V. (1988), Genetics, MacMillan Press Ltd., London. 6. Carroll, S. B., Grenier, J. K. and Welnerbee, S. D. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science. 7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science. 8. Strickberger, M. W. 2000 Evolution. Jones & Bartlet Publishers Canada 9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press. 10.Bruce Albert et al. 2009. Essential cell biology. Garland Sciences Publishers. Journals/Periodicals: Theoretical & Applied Genetics, the Cell, Heredity

THIRD YEAR (SEMESTER-V)

5th Semester			
Course Code	Course Name	Credit Hours	
CHEM-351	Inorganic Chemistry-II	4(3+1)	
CHEM-352	Organic Chemistry-II	4(3+1)	
CHEM-353	Physical Chemistry-II	4(3+1)	
CHEM-354	Analytical Chemistry-II	4(3+1)	
Total Credit Hours		16(12+4)	

Course Code: CHEM-351

Course Name: Inorganic Chemistry-II 4 (3+1)

Course Objectives:

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

Chemistry of d-block elements and coordination complexes:

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

Chemistry of f-block elements:

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

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

CHEM-351 Lab.

Preparations of following Inorganic Complexes;
Tetraamminecopper (II) sulphate.
Potassiumtrioxalatochromate (III).
Potassiumtrioxalatoaluminate (III).
cis-Potassium dioxalatodiaquachromate (III).
Determination of zinc and cadmium by

complexometric titration Chromatographic separations of transition metals;
Separation of Ni2+ & Co2+ ions in a mixture by paper chromatography.Separation of Ni2+ & Cu2+ ions in a mixture by paper chromatography.Separation of Cu2+ & Fe2+ ions in a mixture by paper chromatography. Spectrophotometric determination of iron, manganese and nickel.

Recommended Books:

1. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced InorganicChemistry, 6th ed., Wiley-Interscience, (1999).
2. Housecraft, C. and Sharpe, A. G., Inorganic Chemistry, 4th ed., Prentice Hall, (2012).
3. Miessler, G. L. and Tarr, D.A., Inorganic Chemistry, 4th ed., Pearson-Prentice HallInternational, (2010).
4. Douglas, B., McDanial, D., Alexander, J., Concepts and Models of Inorganic Chemistry,3rd ed., John-Wiley & Sons, New York, (1994).
5. Shriver, D. and Atkins, P., Inorganic Chemistry, 5th ed., W. H. Freeman & Company,(2010).
6. Lee, J. D., Concise Inorganic Chemistry, 5th ed., Blackwell Science Ltd., (1996).
7. Atkins, P. and Jones, L., Chemicals Principles, 5th ed., W. H. Freeman & Company,(2010).
8. Svehla, G., Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis,5th ed., Longman Group Limited, (1979).
9. Huheey, J. E., Kieter, E. A. and Kieter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
10. Pass, G., Sutcliffe, H., Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods, 2nd ed., Chapman and Hall (1974).
11. Müller, U., Inorganic Structural Chemistry, 2nd ed., John-Wiley & Sons, Ltd., (2006).
12. Marusak R. A., Doan K., Cummings S. D., Integrated Approach to CoordinationChemistry, 1st ed., John-Wiley & Sons, (2007).
13. Chaudhary, S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Urdu Bazar,Lahore, (2013).

Course Code: CHEM-352
Course Name: Organic Chemistry-II Credit Hours: 4 (3+1)
Course Objectives:

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

Course Contents:

Stereochemistry:

Types of stereoisomers (optical, geometrical, conformational) RS and EZ notation, optical activity, stereoselectivity and stereospecificity, conformational analysis of Ethane, Propane, n-Butane and Cyclohexane.

Organic Reactions and Mechanism:

Detailed mechanism of aliphatic reactions including addition, substitution, and elimination reactions, concept of energy profile, transition state and intermediate.

CHEM-352 Lab.

Experiments using polarimeter such as to determine optical activity of a sugar solution and todetermine sugar concentration by polarimeter, isomerization of maleic acid.

Experiments involving aliphatic addition, elimination and substitution reactions, e.g., synthesis of cyclohexene from cyclohexanol, addition reaction to cyclohexene etc.

Synthesis of a chalcone explaining the concept of condensation and dehydration, N-Alkylation of phthalimide, etc.

Recommended Books:

1. G Marc Loudon, Organic Chemistry, 4th Edition
2. Robert, T. M., and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey,(1992).
3. John, E. M., Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
4. Younas, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore,(2006).
5. Morris, D. G., Stereochemistry (Basic Concepts in Chemistry), Wiley-RSC, (2002).
6. Mislow, K., Introduction to Stereochemistry, Dover Publications Inc., (2003).
7. David M., Stereochemistry (Tutorial Chemistry Texts), Royal Society of Chemistry,(2002).
8. Furniss, B. S, Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook ofPractical Organic Chemistry, 5th ed., Longman, UK, (1989).
9. Mohan J., Organic Analytical Chemistry, Theory and Practice, 1st ed. Alpha ScienceInternational, Ltd. (2003).
10. Seiler, J. P., Good Laboratory Practice: The Why and the How, 2nd ed., Springer, (2005).
11. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed.,Brooks/ Cole Cengage Learning, (2012).
12. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons,Inc., (2011).
13. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/ Cole

Cengage Learning, (2013).
14. Eames, J. and Peach, J. M., Stereochemistry at a Glance, Blackwell Science, Ltd., (2003).
15. Eliel, E. L., Wilen, S. H. and Doyle, M. P., Basic Organic Chemistry, John-Wiley &Sons, Inc., (2001).
16. Eliel, E. L. and Wilen, S. H., Stereochemistry of Organic Compounds, John-Wiley &Sons, Inc., (1994).

Course Code: CHEM-353

Course Name: Physical Chemistry-II 4 (3+1)

Course Objectives:

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

Course Contents:

Quantum Chemistry:

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

Kinetic Theory of Gases:

Probability density for molecular speeds of gas molecules, Maxwell distribution of molecular speeds, average speeds, pressure of an ideal gas, calculation of molecular speeds, binary collisions, effusion and mean free paths, Maxwell-Boltzmann‟s law of energy distribution, method for the determination of the Avogadro‟s number (NA), statistical probability and entropy.

Phase Equilibrium:

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

Lab.

Equilibrium constant of the KI + I2 = KI3 reaction. Kinetics of saponification of ethyl acetate.
Acid catalyzed hydrolysis of sucrose.

Study of the adsorption isotherms of acetic acid-charcoal system.
Study of the charge transfer complex formation between iodine and benzene. Determination of activation energy for the acid catalyzed hydrolysis of ethyl acetate.Determination of partial molar volumes.
Characterization of the given compound by UV-Vis spectroscopy.

Recommended Books:

1. Silbey, R. J., Alberty, R. A., and Bawendi, M. G., Physical Chemistry, 4th ed., Jojn-Wiley & Sons, (2005).
2. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1st ed.,University Science Books, (1997).
3. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press,(2010).
4. Moore. W. J., Physical Chemistry, 4th ed., Longman Publisher (1972).
5. Coulson C. A., Vanlence, Oxford University Press (1980).
6. Keeler. J. and Wothers, P., Chemical Structure and Reactivity: An Integrated Approach,
   1st ed., Oxford University Press, (2008).
7. Helpern, A. M., Experimental Physical Chemistry: A Laboratory Textbook 2nd ed.,Prentice Hall, (1997).
8. Garland, C. W., Nibler, J. W. and Shoemaker, D., P., Experiments in Physical Chemistry,
   8th ed., McGraw-Hill, (2003).
9. Born, Max., Atomic Physics, 8th ed., Blackie & Son Ltd., (1969).
10. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman,New York, (2010).
11. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman GroupLimited, New York, (1974).

Course Code: CHEM-354
Course Name: Analytical Chemistry-II
Cr. Hrs: 4(3+1)
Course Objectives:

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

Separation Methods:

Principle of solvent extraction, solvent extraction of metals, analytical separations, multiple batch extraction, counter current distribution, solid-phase extraction, solvent extraction by flow injection method, principles of chromatography, classification of chromatographic techniques, overview of paper, thin layer, column, ion exchange chromatography and electrophoresis.

Analytical Spectrophotometry:

Properties of light and its interaction with matter, relation between frequency, velocity and wave number, Lambert- Beer‟s law and its limitations, single beam and double beam spectrophotometers, lamps and lasers as sources of light, monochromators, detectors, photomultiplier tube, photodiode array, charged coupled device, FT-IR spectroscopy, fourier analysis, interferometry, noise and its control.

Lab.

Separation of phenol from given organic mixture using solvent extraction.Separation of given mixture of cations using Paper Chromatography.

Analysis of the composition of a mixture of nitro anilines by TLC.Separation of sugars using paper chromatography.

Separation of amino acids using paper/thin layer chromatography. Deionization and softening of water using ion exchange chromatography.

Determination of λmax of $KMnO_4$ and $K_2Cr_2O_7$ solutions and verification of Beer-Lambert‟slaw.

Determination of stoichiometry of a metal complex by visible spectrometry.

Determination of aspirin and caffeine in a proprietary analgesic by double beam UV-Vis.spectrometer.

Quantification of iron in a given sample by using single beam spectrophotometer.A study of characteristics infrared absorption frequencies.

Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Brooks Cole Publishing Company, (2013).
2. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company,New York, USA, (2011).
3. Christian, G. D., Analytical Chemistry, 6th ed., John Wiley and Sons, New York, (2006).
4. Kealey, D. and Haines, P. J., BIOS Instant Notes in Analytical Chemistry, 1st ed.,BiosSaence Publisher Ltd. Oxford UK. (2002).
5. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. A., Introduction tospectroscopy, 4th ed., Cengage Learning, (2008).
6. Wall, P. E., Thin Layer Chromatography: A Modern Approach (RSC Chromatography Monographs), 1st ed., Royal Society of Chemistry, (2005).
7. Deinstrop, E. H., Applied Thin Layer Chromatography, 2nd ed., Wiley-VCH, (2006).
8. Kellener. R, Mermet. J. M., Otto, M., Valcarcel, M., Widmer,

H.M., Analytical Chemistry: A Modern Approach to Analytical Science, Wiley. VCH, (2004).

9. Hollas, J. M., Modern Spectroscopy, 4th ed., John-Wiley & Sons, Ltd., England (2004).

THIRD YEAR (SEMESTER-VI)

6th Semester			
Course Code	Course Name	Credit Hours	
CHEM-361	Inorganic Chemistry-III	4(3+1)	
CHEM-362	Organic Chemistry-III	4(3+1)	
CHEM-363	Physical Chemistry-III	4(3+1)	
Any one from the following			
CHEM-364	Analytical chemistry-III	4(3+1)	
CHEM-365	Applied Chemistry-II	4(3+1)	
CHEM-366	Biochemistry-II	4(3+1)	
CHEM-367	Fuel Chemistry-I	4(3+1)	
Total Credit Hours		16(12+4)	

Course Code: CHEM-361
Course Name: Inorganic Chemistry-III
Cr. Hrs: 4(3+1)
Course Objectives:

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

Course Contents:

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

Lab

1. Estimation of anions in mixtures:
Chloride-phosphate, chloride-nitrate, oxalate-chloride, sulphate-phosphate, bromide-nitrate,borate-acetate, iodide-nitrate.
2. Iodometric titration with potassium iodate.
3. Gravimetric estimation of oxalate.

4. Precipitation Titrations.

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

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

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

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

Recommended Books:

1. Xu, R., Pang, W., Huo, Q., Modern Inorganic Synthetic Chemistry, 1st ed., Elsevier,(2011).
2. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., Vogel's QuantitativeChemical Analysis, 6th ed., Prentice Hall, (2000).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced InorganicChemistry, 6th ed., Wiley-Interscience, (1999).
4. Huheey, J. E., Keiter, E. A. and Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
5. Housecraft, C. and Sharpe, A. G., Inorganic Chemistry, 4th ed., Prentice Hall, (2012).
6. Rodgers G. E., Descriptive Inorganic, Coordination, and Solid State Chemistry, 3rd ed.,Brooks- Cole, (2012).
7. Smart L. E., Moore E. A., Solid State Chemistry: An Introduction, 4th ed., CRC Press,(2012).
8. Müller, U., Inorganic Structural Chemistry, 2nd ed., John-Wiley & Sons, (2006).
9. Schwarzenbach D., Crystallography, 1st ed., John-Wiley & Sons, (1996).

Course Code: CHEM-362
Course Name: Organic Chemistry-III
Cr. Hrs: 4(3+1)

Course Objectives:

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

Course Contents:

Aromatic Substitution Reactions:

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

Oxidation-reductions Reactions:

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

Pericyclic Reactions:

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

Lab.

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

Recommended Books:

1. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).
2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th edition, Longman, UK, (1989).
3. Mohan, J., Organic Analytical Chemistry: Theory and Practice,1st ed. Alpha Science Int.Ltd.New Delhi, India, (2003).
4. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey,(1992).
5. Tse-Lok, H., Symmetry: A Basis for Synthesis Design, John-Willey & Sons, Inc., NewYork, (1995).
6. Pine, S. H., Organic Chemistry, 5th ed., Tata McGraw-Hill, India, (1987).
7. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, 6th ed., PearsonEducation, (1986).
8. Mayo, D. W., Pike, R. M. and Forbes, D. C., Microscale Organic Laboratory withMultistep and Multiscale Syntheses, 5th ed., John-Wiley & Sons, Inc., (2011).
9. Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale andMicroscale Approach, 5th ed., Brooks/ Cole Cengage Learning, (2010).
10. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons,Inc., (2011).
11. Carey, F. A. and Giuliano, R. M., Organic Chemistry, 9th ed., McGraw-Hill Education,(2013).
12. 12. Bruice, P. Y., Organic Chemistry, 7th ed., Perason Education, Ltd., (2013).
13. Smith, M. B., March's Advanced Organic Chemistry: Reactions, Mechanisms, andStructure, 7th ed., John-Wiley & Sons, Inc., (2013).
14. Ansari, F. L., Qureshi, R. and Qureshi, M. L., Electrocyclic Reactions: From Fundamentals to Research, Wiley-VCH, Germany, (1999).

15. Kürti, L. and Czakó. B., Strategic Applications of Named Reactions in Organic Synthesis: Background and Detailed Mechanisms, Elsevier Inc., (2005).

Course Code: CHEM-363

Course Name: Physical Chemistry-III

Cr. Hrs: 4(3+1)

Course Objectives:

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

Conductometry:

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

Electrochemistry:

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

Surface Chemistry:

Interfaces, Gibbs surface excess, curved surfaces, capillary action, adsorption and adsorption isotherms, Freundlich and Langmuir adsorption isotherms, catalysis, colloids, emulsion and theirindustrial applications.

Nuclear Chemistry:

Atomic nucleus, nuclides, nuclear stability, modes of decay, nuclear energetics, nuclear models (shell + liquid drop model), fusion and fission, non-spontaneous nuclear processes, nuclear reactors, beta decay systematic.

Lab.

Spectroscopic determination of Cu percentage in the given sample. Conductometric determination of Cu (II)- EDTA mole ratio in the complex.

To determine the effectiveness of an extraction of I2 solution by using Solvent Extractionmethod.

Determination of molecular weight of a polymer by viscosity method.

Determination of percentage composition of KMnO4/ K2Cr2O7 in a given solution byspectrophotometry.

Evaluation of pKa value of an indicator by spectrometric method.

Conductometric determination of hydrolysis constant (Kh) of conjugate base of a weak acid.

Recommended Books:

1. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley & Sons, (2005).
2. Ball D. W., Physical Chemistry, Brooks/Cole Co. Inc., (2003).
3. Vertes, A., Nagy, S. and Klencsar, Z., Handbook of Nuclear Chemistry. Volume 1: Basicsof Nuclear Science, 1st ed., Springer, (2003).
4. Choppin, G., Liljenzin, J-. O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth- Heinemann, (2002).
5. Loveland, W., Morrisey, D. J. and Seaborg, G. T., Modern Nuclear Chemistry, John-Wiley & Sons, Inc., (2006).
6. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press,(2010).
7. Somorjai, G. A. and Li, Y., Introduction to Surface Chemistry and Catalysis, 2nd ed.,John-Wiley & Sons, Inc., (2010).
8. Laidler. K. J., "Chemical Kinetics" 3rd ed., Prentice Hall, (1987).
9. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman,New York, (2010).
10. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman GroupLimited, New York, (1974).

Course Title: ANALYTICAL CHEMISTRY-III

Course Code: CHEM-364

Credit Hours: 4(3+1)

Course Objectives

To apply the knowledge of separation techniques in chemistry and to realize its significance in instrumental methods.

Course Contents Separation Techniques

Introduction and classification of separation techniques:

Precipitation, volatilization, distillation, masking, solvent extraction, chromatography and electrophoresis.

Solvent Extraction:

Principle of solvent extraction, the distribution coefficient, the distribution ratio, solvent extraction of metals. Analytical separation, multiple batch extraction, solid phase extraction. Applications of solvent extraction.

Classical Chromatographic Techniques:

Principles of chromatography, classification of chromatographic techniques; adsorption, partition, ion exchange, affinity and size exclusion chromatography. Separation techniques of column chromatography, column efficiency in chromatography. Ion exchange chromatography, size exclusion chromatography, paper chromatography and thin layer chromatography

Electrophoresis:

Capillary zone electrophoresis. Low voltage electrophoresis. High voltage electrophoresis. Analytical applications of electrophoresis.

Thermal Analysis:

Thermogravimetric and differential thermal analysis. Basic principle, instrumentation and applications.

PRACTICAL

Course Code: CHEM-364 (ANALYTICAL CHEMISTRY)

Laboratory work illustrating topics covered in the lectures

Recommended Books

1. Barun, R.D., Introduction to Chemical Analysis, International Student Edition, 1985.
2. Stock, R.; Rice, C.B.F., Chromatographic methods, 2nd ed. Chapman and Hall Limited, 1967.
3. Chistian, G.D., Analytical Chemistry, 6th ed. John Wiley and Sons, Inc., NY, USA, 1999.
4. Miller, J.M., Chromatography Concepts and Contrasts, John Wiley and Sons, NY, USA, 1988.

Supplementary Reading Material

1. Kolthoff, I.M.; Sandell, E.B., Text Book of Quantitative Inorganic Analysis, The MacMillan Company, NY, USA, 1943.
2. Skoog, D.A.; West, P.M.; Holler, F.J., Crouch, S. R., Fundamentals of Analytical Chemistry, 8th ed. Holt, Rinehart and Winston, NY, USA, 2004.
3. Dodd, J. W.; Tonge, K.H., Thermal Methods, Analytical Chemistry by Open Book Learning, John Wiley and Sons, NY, USA, 1987.
4. Daniels, T., Thermal Analysis, John Wiley and Sons, Inc., 1973.
5. Vogel, A.I., A Text Book of Quantitative Inorganic Analysis, 3rd ed. The English Language Book Society, 1961.
6. Fifield, F. W.; Kealey, D., Principle and Practice of Analytical Chemistry, 2nd ed. International Text Book Company Limited, London, 1983.

Course Code: CHEM-365

Course Name: Applied Chemistry-II

Cr. Hrs: 4(3+1)

Course Objectives:

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

Course Contents:

Water Treatment, Steam Production and Scale Removal:

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

Distillation:

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

Composite Materials:

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

Lab

Measurement of water hardness with EDTA Titrations. Estimation of total solids in water.
Estimation of chloride in water.
Estimation of Ferrous and Ferric ions in drinking water by redox titration. Extraction of capsicum oil (soxhlet extraction).
Extraction of clove oil from cloves.
Preparation of liquid detergents.
Study of the kinetics of dissolution of Magnesium metal in dilute HCl.Estimation of Manganese in Steel.
Estimation of Ferric Iron in Cement.

Recommended Books:

1. Erwin D. L., Industrial Chemical Process Design, McGraw-Hill, (2002).
2. Chawla, K. K., Composite Materials: Science and Engineering, 3rd ed., Springer, (2012).
3. Methews, F. L., Rawlings, R. D., Composite Materials: Engineering and Sciences, CRCPress, (2003).
4. Deborah, D. L., Composite Materials: Science and Applications, 2nd ed., Springer,(2010).
5. Gay, D. and Hoa, S. V., Composite Materials: Design and Applications, 2nd ed., CRCPress, LLC, (2007).
6. Kister, H., Distillation Operation, 1st ed., McGraw-Hill Professional, (1990).
7. Tchobanoglous, G., Burton, F. L. and Stensel, H. D., Wastewater Engineering: Treatmentand Reuse, 4th ed., McGraw-Hill, (2003).
8. 9. Callister, W. D. Jr., Materials Science and Engineering: An Introduction, 7th ed.,John-Wiley & Sons, Inc., (2007).
9. 10. Roussak, O. V. and Gesser, H. D., Applied Chemistry: A Textbook for Engineers andTechnologists, 2nd ed., Springer, (2013).
10. Mizrahi, J., Developing an Industrial Chemical Process: An Integrated Approach, CRCPress, (2002).
11. Prakash, N. B., Applied Chemistry Lab Manual, LAP Lambert Academic Publishing,(2013).
12. Vermani, O. P., Applied Chemistry : Theory And Practice, 2nd ed., New AgeInternational, (2006).
13. Goostray. S and Schwenck. R. J., Experiments in Applied Chemistry, Collier-Macmillan,(1966).

Course Title: Biochemistry-II
(Bioenergetics and Metabolism of Biomolecules)
Course Code: CHEM-366
Credit Hours: 4(3+1)
Marks: 100
Course Objectives
This course provides fundamental concepts about the energy production and the mechanisms of the major macromolecules metabolism. Regulation and inhibition of the metabolic pathways are also addressed. This course will also integrate knowledge of bioenergetics and the metabolic pathways of amino acids, proteins, carbohydrates, nucleic acids and lipids to solve biological problems.

Course Contents

Intermediary Metabolism and Bioenergetics
Biological oxidation—Reduction including respiratory carriers. Cell bioenergetics. Oxidative Phosphorylation.

Metabolism of Carbohydrates
Digestion, absorption and transport of sugars into cell. Glycolysis, Citric Acid Cycle, HMP pathway and its significance. Uronic acid pathway. Gluconeogenesis, Glycogenesis, Glycogenolysis.

Metabolism of Lipids
Digestion of Lipids, absorption and transport of lipids and fatty Acids. Oxidation of saturated, unsaturated, odd chain and branched chain fatty acids. Biosynthesis of Fatty Acids and eicosanoids. Biosynthesis of triglycerides, phospholipids, steroids and bile Acids. Biosynthesis and utilization of Ketone bodies.

Metabolism of Proteins
Digestion of proteins, absorption and transport of amino acids to the cell. Biochemical reaction of amino acids: Decarboxylation, deamination, transamination and transmethylation etc.
Metabolism of essential amino acids, Metabolic disorders, Urea cycle. Creatine and uric Acid synthesis. Inter-relationship between carbohydrate, lipid and protein metabolism.

Metabolism of Nucleic Acids
Biosynthesis and catabolism of purines and pyrimidines and their regulation. Synthesis and catabolism of nucleic acids and nucleotide. DNA Polymerases and other enzymes involved in metabolism.

1. Berg, J. M.; Tymoczko, J. L.; Stryer, L., Biochemistry, 6th ed. W. H. Freeman, 2006.
2. Murray, R. K.; Mayes P. A.; Granner, D. K.; and Rodwell, V. W.,

Harper'sBiochemistry, Appleton & Lange, 2000.

3. West, W. R.; Todd, H. S., Text Book of Biochemistry, 4th ed. Macmillan, London, 1968.

Supplementary Reading Material

1. Pankajanaik., Biochemistry, 2nd ed. Jaypee brothers medical publishers Ltd., New Delhi,2007.
2. http://www.wiley.com/college/voetfundamentals
3. www.worthington-biochem.com/best

PRACTICALS

Laboratory work illustrating topics covered in the lectures of CHEM-366

Recommended Books

1. Plummer, D.T.; An Introduction to practical Biochemistry, TATA McGraw- Hill Publishing Company LTD.
2. Sawhney, S. K.; and R. Sing (Editors), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, 2005
3. Oser, B. L., Hawks physiological chemistry, 14th ed. McGraw-Hill Book Company,1965.

Course Title: Fuel Chemistry-I
Course Code: CHEM-367
Credit Hours: 4(3+1)

Course Objectives

After completing the course, the students will acquire knowledge about coal beneficiation,storage, briquetting, and coke oven gas conditioning. They will learn about economical and environmentally friendly utilization of coal and coke.

Course Contents

Coke oven gas conditioning (Chemicals from Coal):

Separation of tar from coke oven gas, Hydrogen sulphide removal from coke oven gas: Oxide boxe process, Seaboard process, Hot-actification process, and Thylox sulphur recovery process. Recovery of ammonia from coke oven gas: Semi direct sulphate process, Indirect process.Separation of light oil from coke oven gas.

Coal beneficiation: Gravity separation; Wet Launder washers, Wet Jig washers, Wet classifiers, Wet tables, Air cleaning tables, Air Launder, Air cleaning jig.

Float and sink process; Chance sand flotation process, Air sand process, Froth flotation.

Storage of Coal: Spontaneous heating factors, Precautions in coal storage.

Coal briquetting: Objectives of briquetting, Binder less briquetting, Briquetting with binder.

Classification of coal: Ranks of coal, Parr's, Ralston's, Seyler's,, ASTM, NCB and International(E.C.E) classifications.

Petrology of coal: Thiessen U.S Bureau of mines nomenclature, Stopes nomenclature, International committee for coal petrography (ICCP) nomenclature, Bright coal, Splint coal, and Semi-splint coal.

Carbonization of coal: Low temperature and high temperature carbonization, Coking and non coking coals, Giesceler plastometer, Audibert-Arnu dilatometer, Free swelling index, Gray King assays

PRACTICALS CHEM-367 (1 Cr. Hr)

Laboratory work relating to course CHEM-367

Recommended Books:

1. Berkowitz. N. "An Introduction to Coal Technology" Academic Press, London, NewYork (1981).
2. Wilson, P.J. and Wells, J.H. "Coal Coke and Coal Chemicals" McGraw-Hill BookCompany, London, (1980).

BS 4th Year Specialization; Inorganic Chemistry

7th Semester Inorganic Chemistry(CHIC)			
Course Code	Course Name	Credit Hours	
CHIC-471	Inorganic reaction mechanism	3(3+0)	Paper-I
CHIC-472	π-acceptor ligands and inorganic polymers	3(3+0)	Paper-II
CHIC-473	Inorganic Spectroscopy	3(3+0)	Paper-III
CHIC-474	Lab-I (Inorganic)	1(0+1)	
CHIC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following-Other than the field of specialization			
CHIC-475	Applied chemistry-III (Common Industries-I)	3(3+0)	
CHIC-476	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHIC-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	

Semester-VII **(INORGANIC CHEMISTRY)**
Course Title: **INORGANIC REACTION MECHANISM**
Code: **CHIN-471**
Credit Hours: **3**

Course Objective:

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

Course Content

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

Recommended Books:

1. Huheey, J. E., Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).

2. Shriver, D. F., Atkins, P. W., Inorganic Chemistry, 3rd ed., Oxford University Press, (2001).

3. Wilkins, R. G., Kinetics and Mechanism of Reactions of Transition Metal Complex, 2nd ed., (Rev.), Wiley-VCH, (1991).

4. Jolly, W. L., Modern Inorganic Chemistry, 2nd ed., McGraw-Hill Company, (1991).

5. Jordan, R. B., Reaction Mechanisms of Inorganic and Organometallic Systems , 2nd ed., Oxford University Press, New York, (1998).
6. Atwood, J. D., Inorganic and Organometallic Reaction Mechanisms, 2nd ed., Wiley-VCH, Inc., (1997).
7. Sharma, S. K., Inorganic Reaction Mechanisms, Discovery Publishing House, (2007).

Semester-VII **(INORGANIC CHEMISTRY)**
Course Title: **π- ACEPTOR LIGANDS AND INORGANIC POLYMERS**
Code: CHIN-472
Credit Hours: 3

Course Objective:

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

Course Contents:

π-Acceptor Ligands:

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

Inorganic Polymers:

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

Recommended Books:

1. Brady, J. E., and Sense, F., Chemistry-The Study of Matter and Its Changes, 5th ed., Wiley Plus, (2009).
2. Miessler, G. L.,Tarr, D. A., Inorganic Chemistry, 4th ed., Prentice-Hall International, New Jersey, USA, (2010).
3. Douglas, B., McDanial, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons, New York, (1994).
4. Huheey, J. E., Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).
5. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).
6. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).
7. Atkins, P. and Jones, L., Chemicals Principles: The Quest for Insight, 5th ed., W. H. Freeman, (2010).
8. Mandelkern, L., An Introduction to Macromolecules, 2nd ed., Springer Verlag, New York, (1983).
9. Ravve, A., Principles of Polymer Chemistry, 2nd ed., Plenum Publishers, (2000).
10. Crabtree, R. H., The Organometallic Chemistry of the Transition Metals, 5th ed., John-Wiley and Sons, New Jersey, (2011).
11. Yamamoto, A., Organotransition Metal Chemistry, Prentice Hall, (1992).
12. Billmeyer, F. W., A Text Book of Polymer Science, 3rd, John-Wiley and Sons, (2003).
13. Malmcoim, P.S., Polymer Chemistry: An Introduction, 3rd ed.,Oxford University Press, (2005).

BS 4th Year

Semester-VII **(INORGANIC CHEMISTRY)**
Course Title: **INORGANIC SPECTROSCOPY**

Code: **CHIN-473**
Credit Hours: **3**

Course Objectives:

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

Course Contents;

Electronic States of transition metal complexes, Russel-Sander's coupling scheme, derivation of term symbols for d^1 -d^{10} systems, d-d transitions, connecting atomic states and molecular states, correlation diagrams, Tanabe - Sugano diagrams, calculation of 10Dq values, High- spin and low-spin molecules, Jahn-Teller effect, applications of subgroups, selection rules for electronic transitions in molecules, LMCT and MLCT transitions, some examples involving different geometries.

Recommended Books:

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

BS 4th Year

Semester-VII **(INORGANIC CHEMISTRY)**
Course Title: **Lab-I**

Code: **CHIN-474**
Credit Hours: 1

Course Contents:

The resolution of cis-dichlorobis (ethylenediamine) chromium (III) chloride into its optical isomers. The preparation and resolution of the tris (ethylenediamine) cobalt (III) ion into its optical antipodes. Estimation of Al (III) and Fe (III) using 8-hydroxyquinoloine. Estimation of Ni (II) in the presence of Cu (II). Determination of chloride in the presence of iodide and evaluation of K_{sp} of AgI and AgCl.

Determination of dissociation constant Ka for acetic acid.
Determination of Ni^{+2} ions by EDTA (Back titration).
Determination of Ca^{+2} and Zn^{+2} ions by EDTA (Masking titration).
Titration of strong acid and weak acid with a strong base.
Precipitation titration involving $AgNO_3$ and KCl.

Recommended Books:

1. Bassett, J., Denny, P. C., Jeffery, G. H., Mendham, J., Vogel's textbook of Quantitative Inorganic Analysis, 4th ed., English Language Book Society, (1978).

2. Pass, G., Sutcliffe, H., Practical Inorganic Chemistry: Preparation Reactions and Instrumental Methods, 2nd ed., Chapman and Hall, (1974).

Semester-VII
Course Title: APPLIED CHEMISTRY (Common Industries-I)(ELECTIVE)
Code: CHIN-476
Credit Hours: 3

Course Objectives:

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

Sugar Industry:

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

Starch Industry:

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

Leather Industry:

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

Recommended Books:

1. Rao, G. P., Mogarey, R. C., Solomn, S., Rewal, S. S. and Li,Y-., Sugar Cane: Production Managemnet and Agro-Industrial Imperatives, Ibdc Publisher, (2005).

2. Covington, A. D., Tanning Chemistry: The Science of Leather, Royal Society of Chemistry, (2009).

Semester-VII
Course Title: ORGANIC CHEMISTRY-IV (ORGANIC SPECTROSCOPY) (ELECTIVE)
Code: CHIN-477
Credit Hours: 3

Course Objectives:

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

Course Contents:

UV-Visible:

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

IR spectroscopy:

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

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

HETCOR.

Mass Spectrometry:

Basic concepts; mass spectrometers, ionization techniques, different fragmentation patterns and structure elucidation.

Recommended Books:

1. Mohan, J., Organic Analytical Chemistry: Theory and Practice, 1st ed., Alpha Science Int. Ltd., (2003).

2. Kalsi, P. S., Spectroscopy of Organic Compounds, 6th ed., New Age International, New Delhi, India, (2007).

3. Yadav, L. D. S., Organic Spectroscopy, Springer, UK, (2005).

4. Kemp, W., Organic Spectroscopy, 3rd ed., W. H. Freeman & Company, New York, USA, (1991).

5. Younas, M., Organic Spectroscopy, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).

6. Hollas, J. M., Modern Spectroscopy, 4th ed., John-Wiley & Sons, Inc., (2004).

7. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., Introduction to Spectroscopy, 4th ed., Brooks/ Cole Cengage Learning, (2009).

CHIC-477	**Analytical Chemistry-III (Advanced Separation Techniques)**	**3(3+0)**	**Elective Course**

Semester-VII **(ANALYTICAL CHEMISTRY-III)**
Course Title: **ADVANCED SEPARATION TECNIQUES**

Code: **CHIC-477**

Credit Hours: 3

Course Contents:

Introduction:

Classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency.

Gas Liquid Chromatography:

General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.

HPLC:

General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.

Capillary electrophoresis:

Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

BS 4th Year

4th Year (Specialization in Organic Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHOC-471	Heterocyclic and Organometallic Compounds	3(3+0)	Paper-I
CHOC-472	Reactive Intermediates	3(3+0)	Paper-II
CHOC-473	Organic Spectroscopy	3(3+0)	Paper-III
CHOC-474	Lab-I (Organic Chemistry)	1(0+1)	
CHOC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following- Other than the field of specialization			
CHOC-475	Applied Chemistry-III (Common Industries-I)	3(3+0)	
CHOC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHOC-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	

Semester-VII (ORGANIC CHEMISTRY)
Course Title: HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS
Code: CHOC-471

Credit Hours: 3

Course Objectives:

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

Course Contents:

Aromatic Heterocycles:

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

Organometallic Compounds:

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

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

Recommended Books:

1. Claydem, J., Greeves,N. and Warren, S., Organic Chemistry, 2nd ed., Oxford University Press, (2012).

2. Coxon, J. M. Norman, R. O. C., Principles of Organic Synthesis, 3rd ed., CRC Press, (1993).

3. Joule, J. A., Mills, K., Heterocyclic Chemistry, 5th ed., John-Wiley & Sons, UK, (2010).

4. Crabtree, R. H., The Organometallic Chemistry of the Transition Metals, 5th ed., John-Wiley & Sons, New Jersey, (2009).

BS 4th Year

Semester-VII **(ORGANIC CHEMISTRY)**
Course Title: **REACTIVE INTERMEDIATES**

Code: **CHOC-472**

Credit Hours: 3

Course Objectives:

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

Course Contents:

Reactive Intermediates:

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

Rearrangement Reactions:

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

Recommended Books:

1. Clayden, J., Greeves, N. and Warren, S., Organic Chemistry, 2nd ed., Oxford University Press, (2012).

2. Coxon, J. M. and Norman, R.O.C., Principles of Organic Synthesis, 3rd ed., Chapman and Hall, UK, (1993).

3. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed., Brooks/Cole Learning, (2012).

4. John, E. M., Organic Chemistry, 8th ed., Brooks/Cole Publishing Co., USA, (2012).

5. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).

BS 4th Year

Semester-VII **(ORGANIC CHEMISTRY)**
Course Title: **ORGANIC SPECTROSCOPY**

Code: **CHOC-473**
Credit Hours: **3**

Course Objectives:

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

Course Contents:

UV-Visible:

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

IR spectroscopy:

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

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

Mass Spectrometry:

Basic concepts; mass spectrometers, ionization techniques, different fragmentation patterns and structure elucidation.

Recommended Books:

7. Mohan, J., Organic Analytical Chemistry: Theory and Practice, 1st ed., Alpha Science Int. Ltd., (2003).

8. Kalsi, P. S., Spectroscopy of Organic Compounds, 6th ed., New Age International, New Delhi, India, (2007).

9. Yadav, L. D. S., Organic Spectroscopy, Springer, UK, (2005).

10. Kemp, W., Organic Spectroscopy, 3rd ed., W. H. Freeman & Company, New York, USA, (1991).

11. Younas, M., Organic Spectroscopy, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).

12. Hollas, J. M., Modern Spectroscopy, 4th ed., John-Wiley & Sons, Inc., (2004)

13. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., Introduction to Spectroscopy, 4th ed., Brooks/ Cole Cengage Learning, (2009).

14. Silverstein, R. M., Webster, F. X. and Kiemle, D., Spectrometric Identification of Organic Compounds, 7th ed., John-Wiley & Sons, Inc., (2005).

15. Williams, D. H. and Flemming, I., Spectroscopic Methods in Organic Chemistry, 6th ed., McGraw-Hill Higher Education, (2008).

BS 4th Year

Semester-VII **(ORGANIC CHEMISTRY)**
Course Title: **Lab.I**

Code: **CHOC-474**

Credit Hours: 1

Course Contents:

Experiments based on available spectroscopic techniques may be arranged, both of qualitative and quantitative nature. One- and two-step synthesis using available starting material are recommended.

Recommended Books:

1. Mohan, J., Organic Analytical Chemistry: Theory and Practice, 1st ed.,Alpha Science Int.Ltd., (2003).

2. Williams, D. H. and Flemming, I., Spectroscopic Methods in Organic Chemistry, 6th ed., McGraw-Hill Higher Education, (2008).

3. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).

4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th edition, Longman, UK, (1989).

Semester-VII

CHOC-475	Applied Chemistry-III (Common Industries-I)	3(3+0)

Course Title: **APPLIED CHEMISTRY (Common Industries-I) (ELECTIVE)**
Code: **CHOC-475**
Credit Hours: **3**

Sugar Industry:

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

Starch Industry:

Scope of starch industry, Raw materials for starch production, Manufacture of starch from various raw materials such as corn, rice, wheat, potatoes, Industrial applications of

starch, Chemistry involved in the conversion of starch, Synthesis of d-glucose and dextrin from starch.

Leather Induatry:

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

CHOC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	**Elective Course**

Course Code: CHOC-476 Course Name: Petroleum & Petrochemicals-I

Course Objectives:

The students will acquire knowledge about the modern refining operations for maximum recovery of petroleum products and to get knowledge using crude petroleum and its distillate products in commercial manufacture of highly demanding petrochemicals.

Course Contents:

Petroleum: Composition, properties and classification of crude oils, oil shale and tar sands. Preparation, structure and properties of cracking and reforming catalysts.Mechanism of cracking and reforming.Effect of operating conditions on cracking and reforming products.Hydroforming and desulphurization of petroleum products.

Petrochemicals:

Ethylene production by thermal cracking from ethane.Propane and naphtha.Petrochemicals from oxidation processes. Production of petrochemicals from halogenation processes. Hydrogenation of benzene, fats, and adiponitrite, nitration of benzene and toluene, sulphonation of benzene and toluene, alkylation of aromatics.

CHOC-477	**Analytical Chemistry-III (Advanced Separation Techniques)**	**3(3+0)**	**Elective Course**

Semester-VII (ANALYTICAL CHEMISTRY-III)

Course Title: ADVANCED SEPARATION TECNIQUES

Code: CHOC-477

Credit Hours: 3

Course Contents:

Introduction:

Classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency.

Gas Liquid Chromatography:

General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.

HPLC:

General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.

Capillary electrophoresis:

Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

BS 4th Year

4th Year (Specialization in Physical Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHPC-471	Electrochemistry and statistical thermodynamics	3(3+0)	Paper-I
CHPC-472	Polymer chemistry	3(3+0)	Paper-II
CHPC-473	Quantum chemistry and molecular spectroscopy	3(3+0)	Paper-III
CHPC-474	Lab-I (Physical Chemistry)	1(0+1)	
CHPC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHPC-475	Applied Chemistry-III (Common Industries-I)	3(3+0)	
CHPC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHPC-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	

Semester-VII **(PHYSICAL CHEMISTRY)**
Course Title: **ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS**
Code: **CHPC-471**

Credit Hours: **3**

Course Objectives:

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

Electrochemistry:

Electrical double layer, interface, a look into the interface, OHP (Outer Helmholttz Plane) and IHP (Inner Helmholttz Plane) , contact adsorption, Gibbs Surface Excess, potential differences across metal solution interfaces, outer and surface potential differences, galvanic potential difference, electrochemical potential difference, interfacial tension, electro- capillary thermodynamics, Lippmann's equation, Helmholtz-perrin model, Gouy-Chapmann model, Stern model of electrical double layer, and BDM (Bockris-Devanathan-Muller) model, charge density, differential capacitance, shape of capacitance-charge curve, the Capacitance hump.

Electrochemical devices, charge transfer processes in the absence and presence of electrical field, the over potential, Butler-Volmer's equation,the idea of equilibrium exchange current density, the symmetry factor, high field and low field approximation, Tafel's equation, cyclic voltammetry and its applications, Fuel cell, corrosion and its prevention, electrochemical impedance spectroscopy.

Statistical Thermodynamics:

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

Recommended Books:

1. Gasser, R. P. H., Entropy and Energy Level, Rev. ed., Oxford University Press, New York, (1986).

2. Wayatt, P. A. H., The Molecular Basis of Entropy and Chemical Equilibrium, Royal Institute of Chemistry London, UK, (1971).

3. Bockris J. O. M., and Reddy, A. K. N., Modern Electrochemistry: Ionics, Vol. I, 2nd ed., Plenum Press, London, (1998).

4. Seddon, J. M. and Gale, J. D., Thermodynamics and Statistical Mechanics, Royal Society of Chemistry, (2001).

5. Engel, T., Reid, P., Thermodynamics, Statistical Thermodynamics, and Kinetics, 3rd ed., Prentice Hall, (2012).
6. Bard, A. J. and Faulkner, L. R., Electrochemical Method: Fundamentals and Applications 2nd ed., John-Wiley & Sons, New York, (2001).
7. Kondepudi D., Introduction to Modern Thermodynamics, John-Wiley & Sons, (2008).
8. Hamann, C. H., Hamnett, A. and Veilstich, W., Electrochemistry, 2nd ed., Wiley-VCH Verla Gnb H and Co. KGaA, (2007).
9. Braun R. D. and Walters F., Application of Chemical Analysis, McGraw-Hill, (1982)
10. McQuarrie, D. A., Statistical Mechanics, Viva Books Private Ltd. (2008)

BS 4th Year

Semester-VII **(PHYSICAL CHEMISTY)**
Course Title: **POLYMER CHEMISTRY**

Code: **CHPC-472**
Credit Hours: 3

Course Objectives:

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

Polymer Chemistry:

Introduction to Polymers, step-growth polymerization, polymer chain growth, kinetics of polymer chain growth, co-polymerization, emulsion polymerization, natural and inorganic polymers, physical aspects of polymers, molecular weight of polymers, distribution, averages, and methods of determination, viscosity, osmometry, light scattering method, diffusion, sedimentation, optical rotation method, structure of polymer chain, introduction to chain isomerism, stereochemistry, configurations, and conformations (not in Hiemenz), amorphous state of polymers, in-depth examination of polymer conformation, microstructure, and dynamics in the amorphous state, polymer viscoelasticity, stress relaxation, mechanical models of polymer behavior, time-temperature superposition, polymer rheology, crystalline state of polymers, crystallization and kinetics, crystalline structures, experimental methods, polymer solutions and blends.

Recommended Books:

1. Sperling, L. H. Introduction to Physical Polymer Science, 4th ed., Wiley-Interscience, New York, USA, (2006).

2. Boyd, R. H. and Phillips, P. J., The Science of Polymer Molecules, Cambridge, UK, (1993).

3. Odian, G., Principles of Polymerization, 4th ed., Wiley Interscience, (2004).

4. Carraher Jr, C. E., Carraher's, Polymer Chemistry, 8th ed., CRC Press, Inc., (2010).

5. Ravve, A., Principles of Polymer Chemistry, 3rd ed., Springer, (2012).

6. Stevens, M. P., Polymer Chemistry: An Introduction, 3rd ed., Oxford University Press, (1998).

7. Allcock, H., Lampe, F. and Mark, J., Contemporary Polymer Chemistry, 3rd ed., Prentice Hall, (2003).

8. Flory, J., Principles of Polymer Chemistry, Cornell University Pres (1953)

BS 4th Year

Semester-VII (PHYSICAL CHEMISTRY)
Course Title: QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY

Code: CHPC-473
Credit Hours: 3

Course Objectives:

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

Course Contents:

Quantum Chemistry:

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

Molecular Spectroscopy:

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

Recommended Books:

1. Fayer, M. D., Elements of Quantum Mechanics, Oxford University Press, London, UK, (2001).

2. Becker, E. D., High Resolution NMR; Theory & Chemical Application, 3rd ed., Academic Press, New York, USA, (2000).

3. Graybeal, J. D., Molecular Spectroscopy, 1st ed., McGraw-Hill, New York, (1988).

4. Hayward, D. O., Quantum Mechanics for Chemists, Royal Society Of Chemistry, (2002).

5. House, J. E., Fundamentals of Quantum Mechanics 2nd ed., Elsevier-Academic Press, New York, USA, (2004).

6. Kirsten, H. J. W. M., Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral 1st ed., World Scientific Publishing Co. Pvt. Ltd., (2006).

7. Barrow, G. M., Physical Chemistry, 6th ed., McGraw-Hill Book Company, (1996).

8. Straughan, B. P., and Walker, S., Spectroscopy, Vol. 1 and 2., Chapman and Hall Ltd., (1976).

9. Coulson C. A., Vanlence, Oxford University Press (1980).

10. Sathyanarayana, D. N., Vibrational Spectroscopy, Theory and Applications, New Age International Publishers (2004).

BS 4th Year

Semester-VII **(PHYSICAL CHEMISTRY)**
Course Title: **Lab-I**

Code: **CHPC-474**
Credit Hours: 1

Course 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 advance techniques like XRD and cyclic voltammetry for characterization of materials.

Course Contents:

Determination of partial molar properties.

Determination of free energy changes, standard free energies.
Verification of Kohlrausch's law.
Study of temperature dependence of electrode potentials.

Determination of heat of solution, ionic reactions and other experiments from thermochemistry.

Determination of molecular weight of a polymer by viscosity method.
Precipitation value of electrolytes.Measurement of IR spectra of simple compound and their interpretation.

Measurement of cyclic voltammogram of an organic compound and its interpretation.

Determination of dipole moment of an organic liquid.
Determination of percentage composition of $KMnO_4$-$K_2Cr_2O_7$ in given solution by spectrometry.

Evaluation of pKa value of an indicator by spectrometric method.

Synthesis of metal oxide nanoparticles and their characterization using IR and XRD techniques.

Recommended Books:

1. Garland, C. W., Shoemaker, D. P., and Nibler, J. W., Experiments in Physical Chemistry, 8th ed., McGraw-Hills, New York, (2003).

2. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Prentice Hall Press, (1974).

3. Halpern, A., McBane, G., Experimental Physical Chemistry: A Laboratory Textbook, 3rd ed., W. H. Freeman, (2006).

4. Athawale, V. D., and Mathur. P., Experimental Physical Chemistry, New Age International (2001).

5. Farrington, D., Experimental Physical Chemistry, BiblioBazaar, (2011).

6. Palmer, W. G., Experimental Physical Chemistry, 2nd ed., Cambridge University Press (2009).

CHPC-475	Applied Chemistry-III (Common Industries-I)	3(3+0)	Elective

Semester-VII **(APPLIED CHEMISTRY-III)**
Course Title: **COMMON INDUSTRIES-I**

Code: **CHPC-475**
Credit Hours: 3

Course Objectives:

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

Sugar Industry:

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

Starch Industry:

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

Leather Induatry:

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

CHPC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	

Course Code: CHPC-476 Course Name: Petroleum & Petrochemicals-I

Course Objectives:

The students will acquire knowledge about the modern refining operations for maximum recovery of petroleum products and to get knowledge using crude petroleum and its distillate products in commercial manufacture of highly demanding petrochemicals.

Course Contents:

Petroleum: Composition, properties and classification of crude oils, oil shale and tar sands. Preparation, structure and properties of cracking and reforming catalysts.Mechanism of cracking and reforming.Effect of operating conditions on cracking and reforming products.Hydroforming and desulphurization of petroleum products.

Petrochemicals:

Ethylene production by thermal cracking from ethane.Propane and naphtha.Petrochemicals from oxidation processes. Production of petrochemicals from halogenation processes. Hydrogenation of benzene, fats, and adiponitrite, nitration of benzene and toluene, sulphonation of benzene and toluene, alkylation of aromatics.

CHPC-477	**Analytical Chemistry-III (Applied chemistry Advanced Separation Techniques)**	**3(3+0)**	**Elective**

Course Contents:

Introduction:

Classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency.

Gas Liquid Chromatography:

General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.

HPLC:

General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.

Capillary electrophoresis:

Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

BS 4th Year

4th Year (Specialization in Applied Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHAP-471	Common Industries-I	3(3+0)	Paper-I
CHAP-472	Agro based industries and pollution Control	3(3+0)	Paper-II
CHAP-473	Common Industries-II	3(3+0)	Paper-III
CHAP-474	Lab-I (Applied Chemistry)	1(0+1)	
CHAP-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHAP-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHAP-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHAP-477	Analytical Chemistry-III (Advanced Separation Techniques)	3(3+0)	

Semester-VII **(APPLIED CHEMISTRY)**
Course Title: **COMMON INDUSTRIES-I**

Code: **CHAP-471**
Credit Hours: 3

Course Objectives:

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

Sugar Industry:

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

Starch Industry:

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

Leather Induatry:

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

Semester-VII **(APPLIED CHEMISTRY)**
Course Title: **AGRO BASED INDUSTRIES AND POLLUTION CONTROL**
Code: **CHAP-472**

Credit Hours: 3

Course Objectives:

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

Fertilizers:

Importance of chemical fertilizers, classification of chemical fertilizers, manufacture and chemistry involved in the production of various fertilizers i.e. Urea, Single Super phosphate (SSP), Triple superphosphate (TSP), Nitrophos (NP), Diammonium phosphate (DAP), Calcium ammonium nitrate (CAN), Ammonium nitrate (AN), Ammonium sulphate (AS), Zinc sulphate (ZS) and Complex fertilizers.

Agrochemicals:

Classification of pesticides, formulation and toxicity of pesticides, future trends of pest control, control of weeds, household agrochemicals, plant growth regulators and background chemistry, hazards associated with the use of agrochemicals and environmental aspects.

Industrial Pollution and Its Abatement:

Sources of air, water and soil pollution, Industrial waste control for the protection of environment, modern trends of waste management.

Recommended Books:

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

BS 4th Year

Semester- VII **(APPLIED CHEMISTRY)**
Course Title: **COMMON INDUSTRIES-II**

Code: **CHAP-473**

Credit Hours: 3

Course Objectives:

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

Oils and Fats:

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

Soaps and Detergents:

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

Paints:

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

Recommended Books:

1. Vermani, O. P, Narula, A.K, Applied Chemistry, Theory and Practice, 2nd ed., New Age International. Publisher, India, (1995).

2. Balasaraf, V. M, Applied Chemistry, I. K. International House Pvt. Ltd, India, (2009).

3. P. K. Chattopadyay, Modern Technology of Soaps, Detergents and Toilries: with formulae and project profile, 2nd ed., National Institute of Industrial Research, India, (2003).

4. Bockisch M., Fats and Oils Handbook, American oil Chemists and Society, (1998).

5. Gunstone F., Oils and Fats in Food Industry, Wiley Black Well, (2008).

6. Gunstone F., Vegetable Oil in Food Technology: Composition, Properties and Uses, John-Wiley & Sons, (2011).

7. Lambourme, R., Strivens, T.A., Paint and Surface Coatings: Theory and Practice, 2nd ed., Woodhead Publishing Limited, (1999).

8. Board. B, Paint, Pigment, Solvent, Coating, Emulsion, Paint additives and formulations, Engineers India Research Incorporation, (2008).

9. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/Plenum Publishers, (2003).

BS 4th Year

Semester- VII **(APPLIED CHEMISTRY)**
Course Title: **Lab-I**

Code: **CHAP-474**

Credit Hours: 1

Course Objectives:

The practical design for this course code will polish the psychomotor skills of students and enable them to acquire acquire knowledge about various industrial preparation fertilizers, pesticides and herbicides used in agriculture sector as well as know about the environmental pollution and its protection.

Select suitable practicals for respective courses of Applied Chemistry

Course Contents:

Determination of iodine value of the given oil.
Determination of acid value of the given oil.
To find out the percentage purity of fatty acid.
Preparation of gum sample.
Preparation of liquid detergent or liquid soap.
To determine the temporary and permanent hardness of a given water sample by EDTA method.

To determine the alkalinity of given water sample.
Determination of magnesium and aluminum by EDTA titration.
Analysis of caustic soda and soda ash in mixtures.
Analysis of effluents from tanneries.

Preparation and Testing of: Varnish and Enamel Paints. Adhesives. Emulsion Paints.

Recommended Books:

1. Roger's Industrial Chemistry. Von Norstand Co. N. Y.

2. Reigel's Handbook of industrial chemistry. Von Norstand Reeinhold Co. N. Y.

3. Chemical Process Industries by Shreve and Dum. McGraw Hill.

4. An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.

5. Practical chemistry by O.P. Pandey , D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.

6. Concise Engineering Chemistry, Neetu Goel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, Delhi.).

7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBNO-07-112 721-6 Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.

8. Vogel's Textbook of Qantitative chemical analysis 6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

CHAP-475	**Organic Chemistry-IV (Organic Spectroscopy)**	**3(3+0)**	**Elective**

Course Contents:

UV-Visible:

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

IR spectroscopy:

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

^{1}H-NMR and ^{13}C-NMR:

Chemical shift, factors affecting chemical shift, spin relaxation, spin -spin coupling, coupling constants, nuclear overhauser effect, 2-D NMR, COSY and HETCOR.

Mass Spectrometry:

Basic concepts; mass spectrometers, ionization techniques, different fragmentation patterns and structure elucidation.

CHAP-476	**Fuel Chemistry-II (Petroleum and Petrochemicals-I)**	**3(3+0)**	

Course Contents:

Petroleum: Composition, properties and classification of crude oils, oil shale and tar sands. Preparation, structure and properties of cracking and reforming catalysts.Mechanism of cracking and reforming.Effect of operating conditions on cracking and reforming products.Hydroforming and desulphurization of petroleum products.

Petrochemicals:

Ethylene production by thermal cracking from ethane.Propane and naphtha.Petrochemicals from oxidation processes. Production of petrochemicals from halogenation processes. Hydrogenation of benzene, fats, and adiponitrite, nitration of benzene and toluene, sulphonation of benzene and toluene, alkylation of aromatics.

BS 4th Year

4th Year (Specialization in Analytical Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHAC-471	Atomic spectroscopy	3(3+0)	Paper-I
CHAC-472	Electro analytical techniques	3(3+0)	Paper-II
CHAC-473	Advance separation techniques	3(3+0)	Paper-III
CHAC-474	Lab-I (Analytical Chemistry)	1(0+1)	
CHAC-489	Research Project	3(0+3)	
Any one course (elective) from the following			
CHAC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHAC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHAC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	

Semester-VII **(ANALYTICAL CHEMISTRY)**
Course Title: **ATOMIC SPECTROSCOPY**

Code: **CHAC-471**

Credit Hours: 3

Course Objectives:

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

Course Contents:

Flame Photometry:

Origin and classification of atomic spectroscopic methods, origin of atomic spectrum, position of the signal, intensity of the signal, spectral line width, principle of flame photometry, fate of the sample in the flame, flame and its characteristics,instrumentation for flame photometry, merits and limitations.

Atomic Fluorescence Spectrometry:

Origin of atomic fluorescence, atomic fluorescence spectrum, types of atomic fluorescence transitions, principle of atomic fluorescence spectrometry, fluorescence intensity and analyte concentration, instrumentation for atomic fluorescence spectrometry, applications of atomic fluorescence spectrometry, interferences, merits and limitations.

Atomic Absorption Spectrophotometry:

Principle of atomic absorption spectrophotometry, concentration dependence of absorption, quantitative methodology, instrumentation for atomic absorption spectrophotometry, radiation sources, atomizers, flames, graphite furnaces and electrochemical atomizers, monochromators, detectors, handling background absorption, interferences in atomic absorption spectrophotometry, sample handling in atomic absorption spectrophotometry, preparation of the sample, use of organic solvents, microwave, digestion, sample introduction methods, applications of atomic absorption spectrophotometry.

Atomic Emission Spectrophotometry:

Introduction, principle of atomic emission spectrometry, atomic emission spectrometry using plasma sources, plasma and its characteristics, inductively

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

Recommended Books:

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

2. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, (2011).

3. Kealey, D. and Haines, P. J., BIOS Instant Notes in Analytical Chemistry, Bios Scientific Publishers Limited, Oxford, UK, (2002).

4. Sharma, B. K., Instrumental Methods of Chemical Analysis, 24th ed., Goel Publishing House, Meerut, India, (2005).

5. Skoog, D. A. and West., D. M., Fundamentals of Analytical Chemistry, 8th ed., Hot Reinehart Inc., London, (2008).

6. Ebdon,L., Evaus, E.H, Fischer, A., and Hill, S.J., An Introduction to Analytical Atomic Spectrometry, John Wiley & Sons, England. (1998).

7. Bernhard Welz, Michael Sperling, Atomic Absorption Spectrometry, 3rd ed., Wiley-VCH, Germany, (1998).

8. Farrukh, M. A., Atomic Absorption Spectroscopy, In Tech, (2012).

9. Kellner, R., Mermet, J. M, Otto, M., Valcarcel, M., Widmer, H.M., Analytical Chemistry : A Modern Approach to Analytical Science, Wiley-VCH,(2004)

BS 4th Year

Semester-VII **(ANALYTICAL CHEMISTRY)**
Course Title: **ELECTROANALYTICAL TECHNIQUES**

Code: **CHAC-472**

Credit Hours: 3

Course Objectives:

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

Course Contents:

Potentiometry:

Electrode potential, Nernst equation and its use for measuring half-cell potential, different kinds of electrodes including glass and calomel electrodes, working of potentiometer and its applications including pH measurements, Ion selective electrode systems, Ion exchange membrane electrode, solid state membrane electrodes, and bio-membrane electrodes, Potentiometric titrations.

Coulometry and Electrogravimetry:

Basic electrochemistry, principle, instrumentation of coulometry, principle, instrumentation of electrogravimetry, consequences of electrogravimetry, Ohmic drop, activation over potential, concentration and gas polarization, basic difference and merits/demerits of coulometry and electrogravimetry.

Voltammetry and Polarography:

Basic principle, voltammogram, polarizable and non-polarizable electrodes, solid electrodes, their scope and limitations, cyclic voltammetry, anodic stripping voltammetry. voltammetric equation, basic concept of polarography and interpretation of various polarographic curves, measurement of decomposition potential, diffusion and limiting currents, derivation of Ilkovic equation, logarithmic analysis of polarographic wave, advantages and limitation of dropping mercury electrode.

Recommended Books:

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

2. Harris, D. C., Quantitative Chemical Analysis 8th ed.,W.H. Freeman and Company, New York, (2009).

3. Kealey, D. and Haines , P. J., BIOS Instant Notes in Analytical Chemistry, Bios Scientific Publishers Limited, Oxford, UK, (2002).

4. Sharma, B. K., Instrumental Methods of Chemical Analysis, 24th ed., Goel Publishing House, Meerut, India, (2005).

5. Skoog, D. A. and West, D. M., Fundamentals of Analytical Chemistry, 8th ed., Hot Reinehart Inc., London, (2008).

6. Fritz, Schulz, Electranalytical Methods: Guide to Experiments and Applications. 2nd revised, Springer-Verlag Berlin, Germany, (2010).
7. Monk,P.M.S, Fundamentals of Electroanalytical Chemistry, John-Wiley & Sons Ltd, England, (2001).

BS 4th Year

Semester-VII **(ANALYTICAL CHEMISTRY)**
Course Title: **ADVANCED SEPARATION TECNIQUES**

Code: **CHAC-473**

Credit Hours: 3

Course Objectives:

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

Course Contents:

Introduction:

Classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency. Gas Liquid Chromatography:

General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.

HPLC:

General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.

Capillary electrophoresis:

Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning, (2013).

2. Christian, G. D., Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).

3. Kealey, D. and Haines, P. J., BIOS Instant Notes in Analytical Chemistry, 1st ed., Taylor & Francis, (2002).

4. Sharma, B.K. Instrumental Methods of Chemical Analysis, 24th ed., Goel Publishing House, Meerut, India, (2005).

5. Grob, R. L., Eugene, F. Barry, Modern Practice of Gas Chromatography, 4th ed., John-Wiley & Sons, USA, (2004).

6. Kellner, R., Mermet, J-. M., Otto, M., Valcarcel, M. and Widmer, H. M., Analytical Chemistry: A Modern Approach to Analytical Science, Wiley-VCH, (2004).

7. Meyer, V. R., Practical High-Performance Liquid Chromatography, 5th ed., John-Wiley & Sons, Ltd., (2010).
8. Lindsay, S., High Performance Liquid Chromatography, 2nd ed., John-Wiley & Sons, Ltd., (1992).
9. Braitwaite, A. and Smith, F. J., Chromatographic Methods, 5th ed., Kluwer Academic Publishers, (1999).
10. Miller, J. M., Chromatography: Concepts and Contrasts, 2nd ed., John-Wiley & Sons, Inc., (2005).
11. Camilleri, P., Capillary Electrophoresis: Theory and Practice, 2nd ed., CRC Press, (1998).

BS 4th Year

Semester-VII **(ANALYTICAL CHEMISTRY)**
Course Title: **Lab-I**

Code: **CHAC-474**

Credit Hours: 1

Course Objectives:

Separation of hydrocarbons using GLC, Separation of essential oils, fatty acids, To determine pKa values for the given samples of weak acids by potentiometric method. Quantitative determination of sodium hydroxide by potentiometric titration. Preparation of buffer solutions of definite pH.

Electrogravimetric determination of copper in given samples. Study of thermal decomposition of copper sulfate pentahydrate and calcium oxalate monohydrate.

Recommended Books:

1. Harris, D. C., Quantitative Chemical Analysis., 8th ed., W. H. Freeman and Company, New York, (2011).

2. Braitwaite, A. and Smith, F. J., Chromatographic Methods, 5th ed., Kluwer

3. Camilleri, P., Capillary Electrophoresis: Theory and Practice, 2nd ed., CRC Press, (1998).

4. Weinberger, R., Practical Capillary Electrophoresis, 2nd ed., Academic

   Press, (2000).

CHAC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	Elective

Course Contents:

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

IR spectroscopy:

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

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

Mass Spectrometry:

Basic concepts; mass spectrometers, ionization techniques, different fragmentation patterns and structure elucidation.

CHAC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	

Course Code: CHOC-476 **Course Name: Petroleum & Petrochemicals-I**

Course Objectives:

The students will acquire knowledge about the modern refining operations for maximum recovery of petroleum products and to get knowledge using crude petroleum and its distillate products in commercial manufacture of highly demanding petrochemicals.

Course Contents:

Petroleum: Composition, properties and classification of crude oils, oil shale and tar sands. Preparation, structure and properties of cracking and reforming catalysts.Mechanism of cracking and reforming.Effect of operating conditions on cracking and reforming products.Hydroforming and desulphurization of petroleum products.

Petrochemicals:

Ethylene production by thermal cracking from ethane.Propane and naphtha.Petrochemicals from oxidation processes. Production of petrochemicals from halogenation processes. Hydrogenation of benzene, fats, and adiponitrite, nitration of benzene and toluene, sulphonation of benzene and toluene, alkylation of aromatics.

CHAC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	

Sugar Industry:

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

Starch Industry:

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

Leather Induatry:

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

BS 4th Year

4th Year (Specialization in Biohemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHBC-471	Biomedical Chemistry	3(3+0)	Paper-I
CHBC-472	Molecular Biology	3(3+0)	Paper-II
CHBC-473	Physical Techniques in Biochemistry	3(3+0)	Paper-III
CHBC-474	Lab-I (Biochemistry)	1(0+1)	
CHBC-489	Research Project	3(0+3)	
Any one course (elective) from the following			
CHBC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	
CHBC-476	Fuel Chemistry-II (Petroleum and Petrochemicals-I)	3(3+0)	
CHBC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	

Course Code: CHBC-471 **Course Name: Biomedical Chemistry**

Course Objectives:

Students will acquire knowledge about the fundamental biochemical and molecular aspects of endocrinology and chemistry of blood and other extracellular fluids.

Course Contents:

Endocrinology: General introduction, chemical nature of hormones, common characteristics, mode of action of hormones, hormones receptors, chemistry, biosynthesis, metabolism and biological functions of pituitary, adrenal, thyroid, parathyroid, pancreatic and gonadal hormones, hormones of GIT, renal and pineal Glands.

Blood and Other Body Fluids: General composition of blood, function of blood plasma, plasma protein, composition and functions, composition, development and functions of red blood cells, white blood cells and platelets, Hemoglobin, chemistry properties, synthesis, functions and derivatives, degradation of hemoglobin, respiration and gas transport, blood coagulation and clotting of blood, blood pressure, blood groups, composition of urine, extracellular fluids like: cerebrospinal fluid, lymph, sweat, tears, synovial and interstitial fluid.

Recommended books:

15. Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry,* 6th ed., W. H. Freeman, (2012).
16. Voet, D. and Voet, J. D, *Biochemistry*, 4th ed., illustrated. John Wiley & Sons, (2011).
17. Hall, J. E., *Guyton & Hall Textbook of Medical Physiology,* 12th ed., Elsvier Health Sciences,(2011).
18. Orten, James. M. and Neuhaus, O. W., *Human Biochemistry*, 10th ed., Mosby, Incorporated, (1982).
19. Devlin, T. M., *Textbook of Biochemistry with Clinical Correlations, 7*th ed., Wiley, (2010).
20. Frisell, W. R., *Human Biochemistry,* 1st ed., Macmillan Publication Company, (1982).
21. Hadley, M. and Levine, J. E., *Endocrinology*, 6th ed., pearson, (2006).

Course Code: CHBC-472 **Course Name: Molecular Biology**

Course Objectives:

Students will acquire knowledge about the structural and functional features of DNA and RNA.

Course Contents:

DNA: the primary genetic material, structure, replication in prokaryotes and comparison with eukaryotes, DNA sequencing, chemical synthesis of polynucleotides, DNA repair and recombination. Different types of RNA and their role in protein synthesis, transcription and its regulation, genetic code, post transcriptional processing, structure of transfer RNA, protein synthesis inhibitors, control of translation, post translational modification, plasmids, bacteriophage and cosmids, *invitro* mutagenesis, deletion, insertion and substitution, recombinant DNA and genetic diseases.

Recommended Books:

1. Watson, J. D., Baker, A. T., Bell, S. P., Gann A., Levine, M. and Losick, M. R., *Molecular Biology of the Gene,* 7th ed., Benjamin Cummings, (2013).
2. Watson, J. D., Myers, R. M., Caudy A. A., and Witkowski, J. A., *Recombinant DNA: Genes and Genome. A Short Course,* 3rd ed., W. H. Freeman, (2006).
3. Krabs, J., *Genes X* 10th ed., Jones and Bartlett Learning, (2011).
4. Alberts, B., *Molecular Biology of the Cell,* 5th ed., Publisher: Garland Science, (2008). ISBN: 0815341113, 9780815341116.
5. Brown, T.A., *Genomes 3,* 3rd ed., Publisher: Garland Science Publishing, (2007). ISBN: 0815341385, 9780815341383.

Course Code: CHBC-473 **Course Name: Physical Techniques in Biochemistry**

Course Objectives:

Students will gain knowledge and in depth understanding about the fundamental biochemical techniques such as extraction, purification, fractionation and centrifugation being applicable for macromolecules separation as well as those techniques which are used for characterization of biomolecules.

Course Contents:

Extraction, Fractionation and Purification of Macrobiomolecules:

Homogenization, solubilization and concentration including ultrasonication, lyophilization and ultradecantation, purification based on differential solubility techniques, ion-exchange chromatography, gel chromatography, affinity chromatography, paper & thin layer chromatography and HPLC.

Electrophoresis: Paper and gel electrophoresis, two-dimensional electrophoresis, capillary electrophoresis.

Electrofocusing: Preparative and analytical electrofocusing.

Centrifugation: Principle, preparative centrifugation, application of density gradient and differential centrifugation, ultracentrifugation sedimentation equilibrium and sedimentation velocity methods, application of analytical centrifugation.

Tracer techniques: Detection and measurement of radioactivity, application of radioisotopes in biological system.

U.V. and Visible Spectroscopy: Basic principles, instrumentation and applications.

Enzyme linked immunosorbent assay (ELISA): Basic principle, instrumentation andapplications.

Recommended Books:

1. Cooper, T. C., *The Tools of Biochemistry*, 2nd ed., John Wiley, (2007).
2. Wilson, K. and Golding, K. H., *A Biologist's Guide to Principles and Techniques of Practical Biochemistry*, 3rd ed., Edward Arnold, (1986).
3. Dawes, E. A., *Quantitative Problems in Biochemistry*, 5th ed., Williams & Wilkins, (1972).
4. Morris, J. G., *A Biologist's Physical Chemistry*, 2nd ed., Addison-Wesley, (1974).
5. Scopes, R. K., *Protein Purification: Principles and Practice*, 3rd ed., Springer (1994).

Semester- VII (BIOCHEMISTRY)

Course Title: **Lab-I**

Code: **CHBC-474**

Credit Hours: **1**

Course Contents:

Estimation of water soluble vitamin-C and fat soluble vitamin-D.Estimation and kinetics studies of amylase and peroxidases.
Estimation of total protein in egg. Characterization of proteins by SDS-PAGE.
Isolation and characterization of DNA by Agarose gel electrophoresis.

FOURTH YEAR (SEMESTER-VII)

BS 4th Year

4th Year (Specialization in Fuel Chemistry)

7th Semester			
Course Code	Course Name	Credit Hours	
CHFC-471	Chemistry of Coal Conversion Processes-I	3(3+0)	Paper-I
CHFC-472	Petroleum and Petrochemicals-I	3(3+0)	Paper-II
CHFC-473	Characterization of Fossil Fuels	3(3+0)	Paper-III
CHFC-474	Lab-I (Fuel Chemistry)	1(0+1)	
CHFC-489	Research Project	3(0+3)	
Any one course (elective) from the following			
CHFC-475	Organic Chemistry-IV (Organic Spectroscopy)	3(3+0)	

CHFC-476	Biochemistry-II (Bioenergetics and Metabolism of Biomolecules)	3(3+0)	
CHFC-477	Applied Chemistry-III (Common Industries-I)	3(3+0)	

Course Code: CHFC-471 **Course Name: Chemistry of Coal Conversion Process-I**

Course Objectives:

The students will acquire knowledge about environmentally friendly utilization of coal and how to extract maximum energy and convert coal in to a variety of highly demanding chemicals used as feed stock in a number of Industries.

Course Contents: Coal: Composition, structure, coalification and classification of coal, ASTM international and coal Standards. Use of coal in different industries like power generation, steel and other metallurgical operations.Coal exploration, mining and mining risk handling, pretreatment and preparation of coals.Innovations in coal using industry.

Environmental Aspects: Pollution problems associated with coal combustion, mining and flue gases.

Gasification: Thermodynamics, kinetics and catalytic aspects of coal gasification, fixed bed gasifier, fluidized bed gasifier, transport reactor, liquid medium gasifier and underground gasification. Gas upgrading by carbon monoxide shift, gas purification, methanation and dehydration, properties and processing of gaseous fuels, environmental consideration.

Recommended Books:

1. Wen, C.Y. and Stanley, E. *Coal conversion Technology*, Addison-Wesley, New York. (1979).
2. Probstein, R.F and Hicks, R.E. *Synthetic Fuels*, McGraw Hill, New York. (1982).
3. Francis, W. *Fuels and Fuel Technology*, Pergamon Press, London. (1980).
4. Merick, D. *Coal Combustion and Conversion Technology*, McMillan Ltd., London (1984).
5. Berkowitz, N. *The Chemistry of Coal*, Elsevier Amsterdam. (1985).

Course Code: CHFC-472 **Course Name: Petroleum & Petrochemicals-I**

Course Objectives:

The students will acquire knowledge about the modern refining operations for maximum recovery of petroleum products and to get knowledge using crude petroleum and its distillate products in commercial manufacture of highly demanding petrochemicals.

Course Contents:

Petroleum: Composition, properties and classification of crude oils, oil shale and tar sands. Preparation, structure and properties of cracking and reforming catalysts.Mechanism of cracking and reforming.Effect of operating conditions on cracking and reforming products.Hydroforming and desulphurization of petroleum products.

Petrochemicals:

Ethylene production by thermal cracking from ethane.Propane and naphtha.Petrochemicals from oxidation processes. Production of petrochemicals from halogenation processes. Hydrogenation of benzene, fats, and adiponitrite, nitration of benzene and toluene, sulphonation of benzene and toluene, alkylation of aromatics.

Recommended Books:

1. Hobson, G.D. *Modern Petroleum Technology*, Part 2, John Wiley and Sons, New York. (1984).
2. Gates, B.C, Katzer, J.R and Schuit, G.C.A. *Chemistry of Catalytic Processes*, McGraw Hill Book company, London (1979).
3. List, H.L. *Petrochemical Technology*, Printice-Hall Englewood Cliffs, New Jersey. (1986).
4. Goodger, E.M. *Hydrocarbon Fuels*, Union Brothers Ltd, London. (1975).
5. Maleev, V.L. *Internal Combustion Engines*, McGraw Hill Book Company London, (1985).
6. Hughes, J.R., and Swindells, N.S. *Storage and Handling of Petroleum Liquids*, Charless Griffin and Company Ltd, London. (1987).
7. Wiseman, P. *An Introduction to Industrial Organic Chemistry*, Wiley Interscience, New York (2001).

Course Code: CHFC-473 **Course Name: Characterization of fossil fuels**

Course Objectives:

The students will acquire knowledge of the physicochemical and instrumental analysis of fuels

Course Contents:

Physicochemical: Determination and data interpretation using ASTM methods of API Gravity, Flash Point, Pour Point, Analine Point, Distillation behaviors, Octane no. Cetane number and RVP.

Analytical Methods: Analytical methods in the production of analytes and quality assurance of fuels using GC-FID, GC-MS, Calorimetry, Atomic absorption, ICP.

Recommended Books:

1. Ewing, G.W. *Instrumental Methods of Chemical Analysis*, McGraw Hill, London. (1985).
2. Chrisition, G.D. *Instrumental Analysis,* Allyn and Bacon, Inc, Boston, London. (1986).
3. Kagler, S.H. *Spectroscopic and Chromatographic Analysis of Mineral Oils,* John, Wiley and Sons, New York. (1983).
4. Karr. C. *Analytical Methods for Coal and Coal Products,* Academic Press, New York. (1978).
5. Harker, J.H. and Backurst, J.R. *Fuel and Energy,* Academic Press, London and New York (1988).
6. Skooge, D.A.*Instrumental Analysis*, Sanat Printer, Indian Edition, 2009.

Cours Name: Lab-I (FUEL CHEMISTRY)

Course Code:CHFC 474

Course content:

Semester: VII (FUEL CHEMISTRY)

Title of the Course: Lab-I

Code: CHFC-474

Credit Hours: 1

Course Objective:

Determination of the electrical conductivity of aviation and distillate fuels, containing static dissipator additives. Determination of the total base numberof petroleum products by potentiometric titration. Determination of total salt content in crude petroleum by conductivity method. Determination of the kinematic viscosity of asphalt (bitumen). Determination of heat of combustionof liquid hydrocarbon fuels. Determination of neutralization number oflubricating oils by potentiometric titration. Determination of the calorific value of coal by bomb calorimeter. Determination of total sulfur in coal by bomb calorimeter. Determination of chlorine in coal by bomb calorimeter. Determination of the distillation behavior of petroleum fractions. Determination of sulfur in petroleum products by bomb calorimeter method. Determination of sulfur in petroleum products by lamp method.

BS 4th Year

8th Semester Specialization: Inorganic Chemistry			
CHIC-481	Organometallics	3(3+0)	Paper-IV
CHIC-482	Symmetry and Magneto chemistry	3(3+0)	Paper-V
CHIC-483	Radio and nuclear chemistry	3(3+0)	Paper-VI
CHIC-484	Lab-II (Inorganic Chemistry)	1(0+1)	
CHIC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following- Other than the field of specialization			
CHIC-485	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHIC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	

CHIC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

Semester-VIII **(INORGANIC CHEMISTRY)**
Course Title: **ORGANOMETALLICS**

Code: **CHIC-481**

Credit Hours: 3

Course Objectives:

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

Course Contents:

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

Recommended Books:

1. Powell, P., Principles of Organometallics Chemistry, 2nd ed., Springer, (1998).

2. Yamamoto A., Organotransition Metal Chemistry: Fundamental Concepts and Applications, 1st ed., John-Wiley & Sons, Inc., (1986).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann M., Advanced Inorganic Chemistry, 6th ed., Wiley-Intersceince, New York, (1999).

4. Miessler, G. L., Fisher, P. J. and Tar, D, A., Inorganic Chemistry, 5th ed., Prentice Hall, (2013).

5. Douglas, B., McDaniel, D. and Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons, Inc., (1994).

6. Haiduc, I. and Zuckerman, J. J., Basic Organometallic Chemistry, Walter De Gruyter Inc., (1985).

7. Jolly, W. L., Modern Inorganic Chemistry, 2nd ed., McGraw-Hill Company, (1991).

8. Porterfield, W. W., Inorganic Chemistry: A Unified Approach, 2nd ed., Academic Press, (1993).

9. Vincet, A., Molecular Symmetry and Group Theory: 2nd ed., John-Wiley & Sons, Ltd., (2001).

10. Malik, W. U., Tuli, G. D., Madan, R. D., Selected Topics in Inorganic Chemistry, S. Chand and Co. Ltd., (2010).

BS 4th Year

Semester-VIII **(INORGANIC CHEMISTRY)**
Course Title: **SYMMETRY AND MAGNETOCHEMSITRY**

Code: **CHIC-482**
Credit Hours: 3

Course Objectives:

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

Course Contents:

Symmetry and Group Theory:

Symmetry and group theory, point groups, multiplication tables, group representation and development of character tables. Introduction to the interpretation of spectra and structure elucidation.

Magnetochemistry:

Theory of magnetism, diamagnetism, paramagnetism, ferro, ferri and antiferromagnetism, magnetic susceptibility, magnetic moments, Faraday's & Gouy's methods, effect of temperature on magnetic properties of complexes. Electron spin resonance spectroscopy, Magnetic moment of lanthanides.

Recommended Books:

1. Douglas, B., McDaniel, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons Inc., (1997).

2. Huheey, J. E, Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity", 4th ed., Prentice Hall, (1997).

3. Mackay, K. M., Mackay, R. A. and Henderson, W., Introduction to Modern Inorganic Chemistry, 6th ed., CRC Press, (2002).

4. Miessler, G. L., Fisher, P. J. and Tar, D, A., Inorganic Chemistry, 5th ed., Prentice Hall, (2013)

5. Purcell, K. F., Kotz, J. C., An Introduction to Inorganic Chemistry, W. B. Saunders, Company Holt-Saunders, International ed., (1980).

6. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Intersceince, New York, (1999).

7. Jolly, W. L., Modern Inorganic Chemistry, 2nd ed., McGraw-Hill Company, (1991).

8. Carter, R. L., Molecular Symmetry and Group Theory, 1st ed., John-Wiley & Sons, Inc., New York, (1997).

9. Orchin, M., Jaffe, H. H., Symmetry, Orbitals, and Spectra, John-Wiley & Sons, Inc., New York, (1971).

10. McWeeny, R., Symmetry: An Introduction to Group Theory and its Applications, Dover Publications, Inc., (2002).

11. Vincet, A., Molecular Symmetry and Group Theory, 2nd ed., John Wiley & sons Ltd, (2001).

BS 4th Year

Semester-VIII **(INORGANIC CHEMISTRY)**
Course Title: **RADIO AND NUCLEAR CHEMISTRY**

Code: **CHIC-483**

Credit Hours: 3

Course Objectives:

Students will acquire knowledge about radio and nuclear chemistry and nuclear reactions.

Course Contents:

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

Recommended Books:

1. Friedlander, G., Kennedy, J. W., Miller, J. M. and Maciuas, E. S., Nuclear and Radiochemistry, 3rd ed., John-Wiley & Sons, Inc., (1981).

2. Choppin, G. R., Rydberg, J., Liljenzin, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann Ltd., (2002).

3. Arnikar, H. J., Essentials of Nuclear Chemistry, 4th ed., New Age International Pvt. Ltd. Publishers, (1996).

4. Naqvi, I. I. and Farrukh, M. A., Radiotracers in Chemical Applications VDM Verlag Dr. Müller, Germany, (2010).

Loveland,W., Morrissey, D. J. and Seaborg, J. T., Modern Nuclear Chemistry, John Wiley and Sons, Inc.,(2006)

BS 4th Year

Semester-VIII (INORGANIC CHEMISTRY)
Course Title: Lab-II

Code: CHIC-484

Credit Hours: 1

Use of organic reagents for the estimation of various metal ions;

1. Synthesis of ferrocene and acetyl ferrocene
2. Synthesis of triaryl phosphines
3. Reduction of anisole by lithium-Birch-reduction.
4. Preparation of ferrocenyl oximes
5. Preparation of Zinc-porphyrin complexes
6 Synthesis of Zinc-Phthalocyanine
7. Synthesis of coordination polymers of transition metals.

Recommended Books:

1. Angelici, R. J. (1977). Synthesis and technique in inorganic chemistry, pp. 157-168 Philadelphia: W. B. Saunders Company.

2. Elschenbroich, Ch., & Salzer, A. (1992). Organometallics. VCH Weinheim.

3. Hartley, F. R. (1974). Elements of organometallic Chemistry. London

4. Lucas, C. R., & Walsh, K. A. (1987). Organometallic chemistry of molybdenum. Journal of Chemical Education, 64, 265–266.

5. McNeese, T. J., & Ezbiansky, K. A. (1996). Photochemical preparation and reactivity of cis- Cr(CO)4(CH3CN)2. Journal of Chemical Education, 73, 548–550.

6. Miessler, G. L., & Spessard, G. O. (1991). Organometallic chemistry – A course designed for sophomore chemistry students. Journal of Chemical Education, 68, 16–18.
7. Rabideau, P. W. (1989). The metal–ammonia reduction of aromatic compounds.

8. Tetrahedron, 45, 1579–1603.

9. Spessard, G. O., & Miessler, G. L. (1996). Organometallic chemistry. Upper Saddle River, New Jersey: Prentice Hall.

10. Szafran, Z., Pike, R. M., & Singh, M. M. (1991). Microscale inorganic chemistry. New York: John Wiley & Sons.

11. ZAVIX Holzbecher and other, Hand Book of Organic reagents in Inorganic Analysis Ellis Hurwod Limited, London. (1976)

12. J. Bassett, R. C. Denny, G. H. Jeffery and J. Mendham, Vogel's Text Book of qualitative Inorganic Analysis, the English Language Book Society and Longman, New York, (2008)
13. James S. Pritz, George H. Sehenk, Quantitative Analysis Chemistry, Alby and Becon Inc. London. (2001)

14. Pass, G., Sutcliffe, H., Practical Inorganic Chemistry: Preparation Reactions and Instrumental Methods, 2nd ed., Chapman and Hall, (1974).

CHIC-485	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	

Semester-VIII
Course Title: (Organic Chemistry-V) MEDICINAL CHEMISTRY (ELECTIVE)

Code: CHIN-485
Credit Hours: 3

Course Objectives:

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

Course Contents:

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

Recommended Books:

1. Paul, M. D., Medicinal Natural Products: A Biosynthetic Approach, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd, (2009).

2. Wolff, M. E., Burger's Medicinal Chemistry, 4th ed., Part III, John-Wiley & Sons, New York, (2006).

3. Williams, D. A. and Lemke, T. L., Foye's Principles of Medicinal Chemistry, 6th ed., Lippincott Williams & Wilkins, New York, (2008).

4. D. Sriram, P. Vogeeswari, Medicinal Chemistry, 2nd ed., BITS Pilani, Pearson, Publisher: Darling Kindernley, India, (2010).

5. Carins D., Essential of Pharmaceutical Chemistry, 3rd ed., Pharmaceutical Press, London, (2008)

CHIC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	

Course Contents:

Pharmaceuticals:

Classification of pharmaceutical products and pharmaceutical processing, manufacture of paracetamol and aspirin, chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.

Petroleum and Petrochemicals:

Origin of petroleum, constituents and classification of petroleum, cracking and distillation of various fractions in distillation towers, control of distillation tower in refinery, manufacture of monomers such as acetylene, ethylene, propylene, separation and purification of benzene, toluene and xylene.

CHIC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

Course Contents:

Food Products:

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

Pharmaceuticals:

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

Forensics:

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

BS 4th Year Semester 8th

Specialization: Organic Chemistry

CHOC-481	Natural Products	3(3+0)	Paper-IV
CHOC-482	Organic synthesis	3(3+0)	Paper-V
CHOC-483	Medicinal Chemistry	3(3+0)	Paper-VI
CHOC-484	Lab-II (Organic Chemistry)	1(0+1)	
CHOC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHOC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHOC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	
CHOC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

Semester-VIII **(ORGANIC CHEMISTRY)**
Course Title: **NATURAL PRODUCTS**

Code: **CHOC-482**

Credit Hours: **3**

Course Objectives:

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

Course Contents:

Alkaloids:

Introduction, classification, isolation methods, structure elucidation and discussion with particular reference to structure and synthesis of typical alkaloids such as ephedrine, nicotine, atropine, quinine, papaverine and morphine.

Terpenoids:

Introduction, classification, isolation techniques and discussion with particular reference to structure and synthesis of typical terpenoids such as citral, α-terpineol, α-pinene and camphor.

Steroids:

Study of cholesterol and steroidal hormones with emphasis on their structure and biosynthesis.

Flavonoids:

Introduction and classification of flavonoids, general biosynthetic pathway, synthesis of flavone and flavonol.

Recommended Books:

1. Dewick, P. M., Medicinal Natural Products: A Biosynthetic Approach, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd., (2009).

2. Sell, C. S., A Fragrant Introduction to Terpenoid Chemistry, The Royal Society of Chemistry, UK, (2003).

3. De la Rosa, L. A., Parrilla, E. A. and Aguitar, G. A. G., Fruit and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability, Wiley-Blackwell, (2009).
4. Shahidi, F. and Naczk M., Phenolics in Food and Nutraceuticals, CRC Press, (2004).

5. Oyvind, M. A., and Kenneth, R. M., Flavonoids: Chemistry, Biochemistry and Applications, CRC, Taylor & Francis, New York, (2010).

6. Finar, I. L., Organic Chemistry, Vol. 2, Stereochemistry and the Chemistry of Natural Products, 5th ed., Pearson Education Ltd., Delhi, (2008).
7. Hesse, M., Alkaloid Chemistry, John-Wiley & Sons, New York, (1981)
8. Bhat, S. V., Nagasampagi, B. A. and Sivakumar, M., Chemistry of Natural Products, Narosa Publishing House, (2005).

BS 4th Year

Semester-VIII **(ORGANIC CHEMISTRY)**
Course Title: **ORGANIC SYNTHESIS**

Code: **CHOC-483**
Credit Hours: 3

Course Objectives:

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

Course Contents:

Principles and importance of organic synthesis, Introduction to reterosynthesis and disconnection approach, synthesis of aromatic compounds; one and two group carbon C-X disconnections, donor and acceptor synthons, C-C disconnections and 1,2-, 1,3-, 1,4- , 1,5- and 1,6- difunctionalized compounds, synthesis of cyclic compounds (3-6 membered), chemo-, regio- and stereoselectivity.

Synthetic strategies:

Functional group protection: hydroxyl, amino, carbonyl, carboxylic, sulfanyl, C=C, solid phase synthesis, phase-transfer catalysis.

Recommended Books:

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

6. Norman, R. O. C. and Coxon, J. M., Principles of Organic Synthesis, 3rd ed., CRC Press, (1993).

BS 4th Year

Semester-VIII (ORGANIC CHEMISTRY)
Course Title: MEDICINAL CHEMISTRY

Code: CHOC-484
Credit Hours: 3

Course Objectives:

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

Course Contents:

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

Recommended Books:

6. Paul, M. D., Medicinal Natural Products: A Biosynthetic Approach, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd, (2009).

7. Wolff, M. E., Burger's Medicinal Chemistry, 4th ed., Part III, John-Wiley & Sons, New York, (2006).

8. Williams, D. A. and Lemke, T. L., Foye's Principles of Medicinal Chemistry, 6th ed., Lippincott Williams & Wilkins, New York, (2008).

9. D. Sriram, P. Vogeeswari, Medicinal Chemistry, 2nd ed., BITS Pilani, Pearson, Publisher: Darling Kindernley, India, (2010).

10. Carins D., Essential of Pharmaceutical Chemistry, 3rd ed., Pharmaceutical Press, London, (2008)

BS 4th Year

Semester-VIII (ORGANIC CHEMISTRY)
Course Title: **Lab-II**

Code: **CHOC-485**
Credit Hours: 1

Course Contents:

Experiments based on isolation of natural products from plants are recommended. These may include isolation of caffeine from tea, isolation of nicotine from tobacco, isolation of carvone from mint, isolation of limonene from orange peels, isolation of piperine from black pepper, etc.

Experiments involving multi-step synthesis may also be included, such as the synthesis of methyl orange.

Literature survey for Laboratory work is to be carried out during the course of studies.

Recommended Books:

1. Clarke, H. T., A Handbook of Organic Analysis-Qualitative and Quantitative, John-Wiley & Sons, New York, (2007).

2. Mann, F. G. and Saunders, B. C., Practical Organic Chemistry, 4th ed., Longman, London, (1960).

3. Vogel, A. I., Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis, Longman, London, (1987).

4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., Vogel's Text Book of Practical Organic Chemistry, 5th ed., National Book Foundation, Islamabad, (2008).

5. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., The Systematic Identification of Organic Compounds, 7th ed., John-Wiley & Sons, (1997).

6. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., Vogel's Text Book of Chemical Analysis, Prentice Hall, (2000).

7. Beckett, A. H. and Stenlake, J. B., Practical Pharmaceutical Chemistry, Part II, 4th ed., Continuum International Publishing Group, (1988).

CHOC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	

Course Contents:

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

CHOC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	

Course Contents:

Pharmaceuticals:

Classification of pharmaceutical products and pharmaceutical processing, manufacture of paracetamol and aspirin, chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.

Petroleum and Petrochemicals:

Origin of petroleum, constituents and classification of petroleum, cracking and distillation of various fractions in distillation towers, control of distillation tower in refinery, manufacture of monomers such as acetylene, ethylene, propylene, separation and purification of benzene, toluene and xylene.

CHOC-487	**Analytical Chemistry-IV (Food and Drug Analysis)**	**3(3+0)**	

Course Contents:

Food Products:

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

Pharmaceuticals:

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

Forensics:

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

BS 4th Year

Semester-VIII **Specialization: (PHYSICAL CHEMISTRY)**

CHPC-481	Reaction dynamics	3(3+0)	Paper-IV
CHPC-482	Radiation and photochemistry	3(3+0)	Paper-V
CHPC-483	Colloid and surface chemistry	3(3+0)	Paper-VI
CHPC-484	Lab-II (Physical Chemistry)	1(0+1)	
CHPC-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	
Any one course (elective) from the following			
CHPC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHPC-486	Applied chemistry-IV (Industrial Processes)	3(3+0)	
CHPC-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

Course Title: **REACTION DYNAMICS**

Code: **CHPC-481**
Credit Hours: **3**

Course Objectives:

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

Reaction Dynamics:

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

Reactions in solutions:

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

Recommended Books:

1. Espenson, J. H., Chemical Kinetics and Reaction Mechanism 2nd ed., McGraw-Hill, London (2002).

2. Connors, K. A., Chemical Kinetics: The Study of Reaction Rates in Solution, VCH Publishers, Inc., (1990).

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

4. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).

5. Houston, P. L., Chemical Kinetics and Reaction Dynamics, Dover Publications, (2006).

6. Levine, R., Molecular Reaction Dynamics, Cambridge University Press, (2005).

7. Laidler, K. J., Chemical Kinetics, 3rd Edition, Prentice Hall, (1987).

8. Frost, A. A., and Pearson, R. G., Reaction Mechanism, 2nd Edition John Wiley and sons, Inc; (1961).

9. Benson, S. W., Foundation of Chemical Kinetics, Krieger Publication Co. (1980).

BS 4th Year

Semester-VIII **(PHYSICAL CHEMISTRY)**
Course Title: **RADIATION AND PHOTOCHEMISTRY**

Code: **CHPC-482**
Credit Hours: **3**

Course Objectives:

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

Course Contents:

Radiation Chemistry:

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

Photochemistry:

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

Recommended Books:

1. Spinks, J. W. T. and Woods, R. J., An introduction to Radiation Chemistry, 3rd ed., Wiley Inter Si. Pub., USA, (1990).

2. Aziz, F. and Rodgers, M. A. J., Radiation Chemistry Principles and Applications, 1st ed., VCH Publishers, Inc., (1987).

3. Choppin, G., Liljenzin, J-O., Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann, (2002).

4. Mostafavi, M., Douki, T., Radiation Chemistry: From Basic to Applications in Material and Life Sciences, EDP Science, (2008).

5. Dunkin, I., Photochemistry, Vol. 36, RSC Publishing, (2007).

6. Dickson, D. P. E., Berry, F. J., Mossbauer Spectroscopy, Cambridge University Press, (1986).
7. Scaglia, B., The Fundamentals: An Understanding of Photochemistry, Biblio Bazaar, (2011).

8. Konya, J. and Nagy, N. M., Nuclear and Radiochemistry, 1st ed., Elsevier, (2012).

BS 4th Year

Semester-VIII **(PHYSICAL CHEMISTRY)**
Course Title: **COLLOID AND SURFACE CHEMISTRY**

Code: **CHPC-483**

Credit Hours: 3

Course Objectives:

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

Course Contents:

Colloid and Surface Chemistry:

Colloidal solutions, catalyst preparation methods, industrial catalysts, emulsion, surfactant, nanoscale chemistry, nanomaterials and their applications, dimensional control in nanostructures, macromolecular surface films, charged films and Langmuir-Blodgett layers, characterization methods and applications.

Solid surfaces, surface structures, clean surface structures, gas solid interface, thermodynamics of adsorption, heterogeneous catalysis, kinetic and mechanisms of catalyzed reactions, adsorption at liquid surfaces, chemisorption, physiosorption and dynamics, enzymatic catalysis, organized molecular assemblies, experimental probes for surface and adsorbent structures, scanning probe techniques, low energy electron diffraction (LEED), electron spectroscopy, and other surface analysis techniques.

Recommended Books:

1. Hunter, R. J., Introduction to Modern Colloid Science, Oxford University Press, Oxford, (1994).

2. Poole, C. P. and Owens, F. J., Introduction to Nanotechnology, 1st ed., Wiley-Interscience, (2003).

3. Klabunde, K. J., Nanoscale Materials in Chemistry, John-Wiley & Sons, Inc., (2003).

4. Kolunsiki, K. W., Surface Science: Foundations of Catalysis and Nanoscience, 3rd ed., John-Wiley & Sons, Ltd., (2012).

5. Adamson, A. W. and Gast, A. P., Physical chemistry of Surfaces, 6th ed., Wiley-Interscience, (1997).

6. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 8th ed., Oxford University Press, (2006).

7. Christian, G. D., Analytical Chemistry, 6th ed., John-Wiley & Sons, (2004).

BS 4th Year

Semester-VIII **(PHYSICAL CHEMISTRY)**

Course Title: **Lab-II**

Code: **CHPC-484**
Credit Hours: 1

Course Objectives:

The course will provide basic as well as the advance understandings of experimental methods of kinetics using different interface methods like spectroscopy and polarimetry. The course will also enable the students to understand the effect of operational conditions on reactions and mechanism of surface reactions.

Course Contents:

Sugar analysis and inversion studies by polarimetry.
Study of isotherms and experiments of surface chemistry.
Kinetics of fading of phenolphthalein in alkaline solution.
Study of the effect of pH on the rate constant of the reaction between iodide and persulphate ions.

Study of the salt effect on the rate constant of the reaction between similar charges of ions.

Kinetics of autocatalytic reaction between permanganate and oxalate ions.
Determination of energy of activation of the reaction between similar charged ions.

Kinetics of the reaction between methyl orange and peroxodisulphate ions in presence of bromide ions.

Stoichiometry of a complex in solution by Job's method using spectroscopic methods.

Recommended Books:

1. Halpern, A., McBane, G., Experimental Physical Chemistry: A Laboratory Textbook, 3rd ed., W. H. Freeman, (2006).

2. Palmer, W. G., Experimental Physical Chemistry, 2nd ed., Cambridge University Press, (2009).

3. Athawale, V. D., and Mathur. P., Experimental Physical Chemistry, New Age International (2001).

4. Farrington, D., Experimental Physical Chemistry, BiblioBazaar, (2011).

5. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Prentice Hall Press, (1974).

CHPC-485	**Inorganic Chem-IV (Radio and Nuclear Chemistry)**	3(3+0)	

Course Contents:

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

CHPC-486	**Applied chemistry-IV (Industrial Processes)**	**3(3+0)**	

Course Contents:

Pharmaceuticals:

Classification of pharmaceutical products and pharmaceutical processing, manufacture of paracetamol and aspirin, chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.

Petroleum and Petrochemicals:

Origin of petroleum, constituents and classification of petroleum, cracking and distillation of various fractions in distillation towers, control of distillation tower in refinery, manufacture of monomers such as acetylene, ethylene, propylene, separation and purification of benzene, toluene and xylene.

CHOC-487	**Analytical Chemistry-IV (Food and Drug Analysis)**	**3(3+0)**	

Course Contents:

Food Products:

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

Pharmaceuticals:

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

Forensics:

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

BS 4th Year

Semester-VIII **(APPLIED CHEMISTRY)**

CHAP-481	Organic based industries	3(3+0)	Paper-IV
CHAP-482	Industrial processes	3(3+0)	Paper-V
CHAP-483	Metallurgy and explosives	3(3+0)	Paper-VI
CHAP-484	Lab-II (Applied Chemistry)	1(0+1)	
CHAP-489	Research Project/Research Thesis/ Position paper (literature survey)	3(0+3)	

Any one course (elective) from the following			
CHAP-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHAP-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHAP-487	Analytical Chemistry-IV (Food and Drug Analysis)	3(3+0)	

Semester-VIII **(APPLIED CHEMISTRY)**
Course Title: **ORGANIC BASED INDUSTRIES**

Code: **CHAP-481**
Credit Hours: **3**

Course Objectives:

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

Course Contents:

Paper and Pulp:

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

Polymers:

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

Cosmetics and Perfumes:

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

Recommended Books:

1. Odian, G., Principles of Polymerization, 4th ed., John-Wiley & Sons, Inc., (2004).

2. Carraher, C. E. Jr., Polymer Chemistry, 6th ed., Marcel Dekker Incorporation, New York, (2003).

3. Roussak, D. V., Gesser, H. D., Applied Chemistry; A Textbook of Engineers and Technologists, 2nd ed., Springer, (2013).

4. Bajpai, P., Environmentally Friendly Production of Pulp and Paper, John-Wiley & Sons, Inc., (2010).

5. Schueller, R. and Romanowski, P., Beginning Cosmetic Chemistry: Practical Knowledge for the Cosmetic Industry, 3rd ed., Allured Publishing Corporation, (2009).

6. Barel, A. O., Paye, M. and Maibach, H. I., Handbook of Cosmetic Science and Technology, 3rd ed., Informa Healthcare, (2009).

BS 4th Year

Semester-VIII **(APPLIED CHEMISTRY)**
Course Title: **INDUSTRIAL PROCESSES**

Code: **CHAP-482**
Credit Hours: 3

Course Objectives:

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

Course Contents:

Pharmaceuticals:

Classification of pharmaceutical products and pharmaceutical processing, manufacture of paracetamol and aspirin, chemistry involved in the production and manufacture of various antibiotics such as streptomycin, erythromycin, penicillin etc.

Petroleum and Petrochemicals:

Origin of petroleum, constituents and classification of petroleum, cracking and distillation of various fractions in distillation towers, control of distillation tower in refinery, manufacture of monomers such as acetylene, ethylene, propylene, separation and purification of benzene, toluene and xylene.

Recommended Books:

1. Austin, G. T., Nelson, W. L., Petroleum Refinery Engineering, 4th ed., Aukland. Mcgraw Hill, (1985).

2. Shreve, R. M., George, T. A., Shreve's Chemical Process Industries, 5th ed., McGraw-Hill Book Company Inc., New York, (1984).

3. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10h ed., Kluwer Academic/Plenum publishers, (2003).

4. Vermani, O. P., Narula. A. K, Applied Chemistry, Theory and Practice, 2nd ed., New Age International Publisher, India, (1995).

5. D. G. Watson, Pharmaceutical Chemistry, Churchill Living Stone, (2007).

6. Cairms, D., Essentials of Pharmaceutical Chemistry, Pharmaceutical Press, (2003).

7. Loveland, W. D., Morrisey, D. J, Modern Nuclear Chemistry, Wiley Interscience, (2005).

8. Speight, J. G., The Chemistry and Technology of Petroleum, 3rd ed., Taylor & Francis, (2013).

Course Title: **METALLURGY AND EXPLOSIVES**

Code: **CHAP-483**

Credit Hours: 3

Course Objectives:

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

Course Contents:

Iron, Steel and Alloys:

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

Explosives and Propellants:

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

Nuclear Materials:

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

Recommended Books:

1. Akhawan, J., The Chemistry of Explosives, 2nd ed., Royal Chemical Society, (2004).

2. Campball, F. C., Elements of Metallurgy and Engineering Alloys, ASM. International, (2008).

3. Davis, T. L., The Chemistry of Powder and Explosives, Angriff Press, (2012)

4. Reddy, L. K., Principles of Engineering Metallurgy, 2nd ed., New Age Publishers, (2009).

5. Loveland, W., Morrissey, D. J. and Seaborg, G. T., Modern Nuclear Chemistry, John-Wiley & Sons, Inc., (2006).

6. Choppin, G., Liijenzin, J-O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann, (2002).

7. Vermani, O. P, Narula, A. K, Applied Chemistry, Theory and Practice, 2nd ed., New Age Publishing House,India, (1995).

8. Balsaral, V. M, Applied Chemistry, I.K. International House Pvt. Ltd., India, (2009)

BS 4th Year

Semester-VIII **(APPLIED CHEMISTRY)**
Course Title: **Lab-II**

Code: **CHAP-484**
Credit Hours: **1**

Course Contents:

Analysis of Lithium in industrial effluents, barium in ores, potassium in soil samples.

Spectrophotometry:

Iron in pharmaceuticals, chromium in steel, phosphate in fertilizers.

Preparations:

Calcium gluconate, detergents, cosmetics and vanishing creams. Analysis of Steel and Industrial Alloys. Purification and analysis of waste lubricating oils. Evaluation of edible and industrial oils. Determination of acid value. Saponification value and Iodine value. Extraction and characterization of essential oils from fragment plants. Preparation and characterization of Nylon. Analysis of effluent form industrial wastes. Recovery of chromium from tannery effluents. Preparation of Shaving creams. To determine the percentage of available chlorine in the supplied sample of bleaching powder. To determine the iron contents in the given iron ore solution by using external indicator.

Recommended Books:

1. Roger's Industrial Chemistry. Von Norstand Co. N. Y.
2. Reigel's Handbook of industrial chemistry. Von Norstand Reeinhold Co. N. Y.
3. Chemical Process Industries by Shreve and Dum. McGraw Hill.
4. An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.
5. Practical chemistry by O.P. Pandey , D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.
6. Concise Engineering Chemistry, Neetu Goel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, DelChemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBNO-07-112 721-6
7. .

Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and LondonVogel's Textbook of Qantitative chemical analysis

6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

BS 4th Year

Semester-VIII **Specialization: (ANALYTICAL CHEMISTRY)**

8th Semester			
CHAC-481	Luminescence spectroscopy and thermal Analysis	3(3+0)	Paper-IV
CHAC-482	Nuclear analytical techniques	3(3+0)	Paper-V
CHAC-483	Food and drug analysis	3(0+3)	Paper-VI
CHAC-484	Lab-I (Analytical Chemistry)	1(0+1)	
CHAC-489	Research Project/Research Thesis/ Position paper (literature survey)		
Any one course (elective) from the following			
CHAC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHAC-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHAC-487	Applied chemistry-IV (Industrial Processes)	3(3+0)	

Course Title: **LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS**

Code: **CHAC-481**
Credit Hours: 3

Course Objectives:

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

Course Contents:

Luminescence Spectrophotometry:

Introduction, origin of fluorescence and phosphorescence spectra, Jablonski diagram, activation, deactivation, fluorescence spectrum, fluorescent and phosphorescent

species; photoluminescence and structure, factors affecting fluorescence and phosphorescence, fluorescence quenching, quantum yield, instrumentation for fluorescence measurement, sources, wavelength selectors, sampling, detectors, read out devices, instrumentation for phosphorescence measurement, sampling, recording procedure, applications of fluorescence and phosphorescence.

Thermal Methods of Analysis:

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

Recommended Books:

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

2. Harris, D. C., Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, (2011).

3. Braun, R. D., Introduction to Chemical Analysis, International Student Edition, (1985).

4. Haines, P. J., Whitby, On Canada Mcgraw Hill Ltd., Thermal Methods of Analysis Principles, Applications and Problems, 1st ed., Springer, (1995).
5. Lakowicz, J. R., Principles of Fluorescence Spectroscopy, 3rd ed., Springer (2006).
6. Gabbot, P., Principles & Applications of Thermal Analysis, Wiley-Blackwell, (2007).
7. Brown, M. E., Introduction to Thermal Analysis: Techniques and Applications, 2nd ed., Kluwer Academic Publishers, (2001).
8. Skoog, D. A., West, D. M. and Holler, F. J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 8th ed., (Int.), Cengage Learning, (2004).

9. Burgess, C. and Jones, D. G., Spectrophotometry, Luminescence and Colour; Science and Compliance, Vol. 6, Elsevier Science, (1995).

BS 4th Year

Semester-VIII **(ANALYTICAL CHEMISTRY)**
Course Title: **NUCLEAR ANALYTICAL TECHNIQUES**

Code: **CHAC-482**

Credit Hours: 3

Course Objectives:

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

Course Contents:

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

Recommended Books:

1. Friedlander, G., Kennedy, J. W., Macias, E. S. and Miller. M. J., Nuclear and Radiochemistry, 3rd ed., Wiley, New York, (1981).

2. Arnikan, H. J., Essentials of Nuclear Chemistry, 4th ed., New Age International Pvt. Ltd.(1995)

3. Harvey, B. G., Nuclear Physics and Chemistry, 2nd ed., Prentice Hall Inc., (1969).

4. Naqvi, I. I., Farrukh, M. A, Radiotracers in Chemical Applications: Radiochemistry, VDM Verlog Dr. Muller, (2010).

BS 4th Year

Semester-VIII (ANALYTICAL CHEMISTRY)
Course Title: FOOD AND DRUG ANALYSIS

Code: CHAC-483

Credit Hours: 3

Course Objectives:

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

Course Contents:

Food Products:

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

Pharmaceuticals:

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

Forensics:

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

Recommended Books:

1. Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry, 7th ed., Saunders College Publishing, (1995).

2. Christian, G. D., Analytical Chemistry, John-Wiley & Sons, Inc., 6th ed., (2004).

3. Eckert, W. G., Introduction to Forensic Science, 2nd ed., CRC Press, (1997).

4. Nielsen, S. S., Food Analysis, 4th ed., Springer, (2010).

5. Thomas, G., Medicinal Chemistry: An Introduction, 2nd ed., John-Wiley & Sons, (2007).

6. Kobilinsky, L. F., Forensic Chemistry Handbook, 1st ed., John-Wiley & Sons, USA, (2012).

7. Watson, D. G., Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists, Elsevier, (2012).

8. Stuart H. Barbara, "Forensic Analytical Techniques", 1st ed., John-Wiley & Sons, (2013).

Jackson, A. R. W. and Jackson, J. M., Forensic Science, 2nd ed., Pearson Education, (2008)

BS 4th Year

Semester-VIII	(ANALYTICAL CHEMISTRY)
Course Title:	Lab-II
Code:	CHAC-484

Credit Hours: 1

Course Contents:

Determination of fat content in milk.
Quantification of Proteins.
Determination of cholesterol in food.
Quantification of reducing sugars and total sugars.

Water analysis for drinking purpose.
Determination of caffeine.
Determination of heavy metals in food items.
Determination of citric acid in juices.
Determination of ascorbic acid in fruit juices.
Evaluation of Rancidity of edible oil [Acid value].
Evaluation of Iodine value of edible oils.

Evaluation of Ester value of edible oils.
Determination of Aflatoxin in grains.
Extraction of DNA from Saliva, Cheek cells and blood.
Detection of Saliva by α-amylase activity.
Finger print analysis by $AgNO_3$, iodine vapour method.

Spot test/TLC of arsons and explosive (i.e. picric acid, nitrobenzenes and nitro-toluene)

Calibration and validation of HPLC system as per requirements of British or US pharmacopoeia.

Analysis of the binary mixture of pharmaceutical dosage by HPLC and statistical evaluation of data (RSD, CV, precision, accuracy, LOD, LOQ, resolution, Tailing factor).

Recommended Books:

1. Latimer, Jr., G. W., AOAC Official Methods of Analysis, 19th ed., (2012).

2. Ranganna, S., Handbook of Analysis & Quality Control for Fruits & Vegetables, 2nd ed., TATA McGraw-Hill Education, (1986).

3. Stuart H. Barbara, "Forensic Analytical Techniques", 1st ed., John-Wiley & Sons, (2013).

4TH YEAR (SEMESTER-VIII) SPECIALIZATION IN BIOCHEMISTRY

S.NO	Course Code	Course Name	Credit Hours
1	**CHBC-481**	Microbiology & Immunology	3+0
2	**CHBC-482**	Biotechnology	3+0
3	**CHBC-483**	Nutritional Chemistry	3+0
4	**CHBC-484**	Lab-II (Biochemistry)	0+1
5	**CHEM-489**	Research Project/Research Thesis/ Position paper (literature survey)	0+3
Any one course (elective) from the following			
6	**CHBC-485**	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)
7	**CHBC-486**	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)
9	**CHBC-487**	Applied chemistry-IV (Industrial Processes)	3(3+0)
Total Credit Hours			12+4(16)

Course Code: CHBC-481 Course Name: Microbiology & Immunology

Course Objectives:

Students will learn about fundamentals of microbiology and immunology as well as the related disorders such as microbial borne infectious diseases, allergy, inflammation, and hypertension and their control.

Course Contents:

Fundamentals of Microbiology: Prokaryotic cell structure and function, Prokaryotic growth and nutrition, prokaryotic genetics. Virus and eukaryotic microorganisms, virus, bacteria, fungi and parasites.Bacterial diseases, airborne, foodborne and waterborne bacterial diseases.Industrial microbiology and biotechnology, microorganism in industry, alcoholic beverages, other important microbial products.

Immunology: Chemistry of immunoglobulins, myeloma and hybridoma immunoglobulins, immune system and its abnormalities, allergy and inflammation, complement system, Peripheral leucocytes and macrophages, Type I lgE-mediated hypersensitivity, other types of hypersensitivity autoimmune disorders, immunodeficiency disorders.

Recommended Books:

1. Nester, E., Nester, M., Anderson, D. and Roberts, C. E. Tr., *Microbiology: A Human Perspective,* 7th ed., McGraw-Hill, (2011).

2. Duan, T., Melvold, R., Viselli, S. and Waltenbaugh, C., *Lippincott's Illustrated Reviews, Immunology,* 2nd ed., Lippincott William & Wilkins, (2012).

3. Harvey, R. A., Cornelissen, C. N. and Fischer, B. D., *Lippincott's Illustrated Reviews: Microbiology,* 3rd ed., Lippincott William & Wilkins, (2012).

4. Wiley, J. M., Sherwood, L. M. and Woolnerton, C. J., *Prescott's Microbiology,* 7th ed., McGraw-Hill Education, (2011).

5. Male, D., Brostoff, J., Roth, D. B. and Roitt, I. M., *Immunology,* 8th ed., Elsevier, (2012).

Course Code: CHBC-482 **Course Name: Biotechnology**

Course Objectives:

The aim of the course is to acquire knowledge about bionanotechnology in general and its potential applications in particular. Bionanotechnology aims to exploit attributes of new materials like biosensors for medical applications. Understanding of the structure and assemblyof nanoparticles opens some exciting possibilities to construct artificial structures in applied nanotechnology, which will mimic the functions of the biological systems.

Course Contents: Introduction to nanoparticles, overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, bionanotechnology systems, protein based nanostructures, nanobiosensors, challenges and opportunities associated with biology on the nanoscale, green nanoparticle production, self-assembly and templating, surface patterning and functionalization, characterization techniques of nanostructures.

Recommended Books:

1. Ratner, M.A. and Ratner, D., *Nanotechnology: A Gentle Introduction to the Next Big Idea*, Prentice Hall Professional, upper saddle river, New Jersey (2003).

2. Goodsell, D.S., Bionanotechnology: Lessons from Nature, Wiley-Liss, Inc., Hoboken, New Jersey (2004).

3. Papazoglou, E. S., *Bionanotechnology*, Morgan & Claypool Publishers, California, USA (2007).

4. Renugopalakrishnan V., Lewis, R. V., *Bionanotechnology: Proteins to Nanodevices*, Springer (2006).

5. Iqbal, S., *Bionanosensors*, Morgan & Claypool Publishers, California USA (2008).

6. Kotov, N. A., *Nanoparticle Assemblies and Superstructures*, CRC press, USA (2006).

7. Dinh, T.V., *Nanotechnology in Biology and Medicine: Methods, Devices and Application* CRC press, USA (2007).

8. Kumar, C., *Nanomaterials for Biosensors*, Wiley-VCH, Germany (2007).

9. Niemeyer, C.M., and Mirkin, C.A., *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley-VCH, Germany(2004).

Course Code: CHBC-483 Course Name: Nutritional Chemistry

Course Objectives:

Students will acquire knowledge about dietary components; energy needs based nutritional requirements of different age groups as well as the importance of minerals and vitamins.

Course Contents:

Major Dietary Constituents: Nutritional importance of carbohydrates, proteins and aminoacids, lipids, and dietary fiber.

Energy Needs: Assessment and requirement of energy in different age groups nutrition in growth and aging, nutritional requirement during infancy and childhood, diet, nutrition and adolescence, nutrition in the elderly minerals, biochemical role of Calcium, Chromium, Copper, Iron, Iodine, Magnesium, Phosphorous, Selenium and Zinc, their dietary source daily requirements and deficiency diseases.

Vitamins: Role of vitamins as coenzymes structure, physiological functions, deficiency diseases and recommended dietary allowances of the following vitamins, fat soluble vitamins: A, D, E, and K, water soluble vitamins: Thiamine, Riboflavin, Niacin, Pantothenic acid, Folic acid, Blotinand Ascorbic acid.

Recommended Text Books:

1. Wilson, K. and Walker, J., *Principles and Techniques of Biochemistry,* 5th ed., Cambridge University Press, (2000)

2. Belitz, H. D., Grosch, W. and Schieberle, P., *Food Chemistry,* 4th ed., Springer-Verlag Berlin, Germany, (2009).

3. Spallholz, J. E., Boylan, L. M. and Driskell, J. A., *Nutrition: Chemistry & Biology*, 2nd ed., CRC Press Inc., USA, (1999).

4. Ross, A. C., Caballero, B., Cousins, R. J., Tucker, K. L. and Ziegler, T. R., *Modern Nutrition in Health and Disease,* 11th ed., Lippincott Williams & Wilkins, (2012).

5. McDowell, L. R., *Vitamins in Animal and Human Nutrition*, 2nd ed., Iowa State University Press, (2000).

6. Zempleni, J., Rucker, R. B., McCormick, D. B. and Suttie, J. W., *Handbook of Vitamins,* 4th

ed., CRC Press, (2007).

Course Name: Lab-II

Course Code: 484

Semester- VIII (BIOCHEMISTRY)
Course Title: **Lab-II**
Code: CHBC-484
Credit Hours: **1**

Course Contents:

Estimation of Na^{+1} ions in blood.Estimation
of K^{+1} ions in blood.
Determination of blood group of the patient. Determination of serum
aldolase in heart patient Determination of protease activity of bacterial
enzymesEnzyme purification by ion-exchange chromatography
Synthesis of silver nanoparticles by using plant extracts
Synthesis of nanoparticles and study of surface plasmon response by UV-Visible
Spectrophotometry

FOURTH YEAR (SEMESTER-VIII)

SPECIALIZATION IN FUEL CHEMISTRY

8th Semester Specialization in Fuel Chemistry			
	Course Name	**Credit Hours**	
CHFC-481	Chemistry of Coal Conversion Processes-II	3+0	Paper-I
CHFC-482	Petroleum & Petrochemicals-II	3+0	Paper-II
CHFC-483	Alternate Energy Sources	3+0	Paper-III
CHFC-484	Lab-II (Fuel Chemistry)	0+1	
CHFC-489	Research Project/Research Thesis/ Position paper (literature survey)	0+3	
Elective Course other than the field of specialization			
CHFC-485	Inorganic Chem-IV (Radio and Nuclear Chemistry)	3(3+0)	
CHFC-486	Organic Chemistry-V (Medicinal Chemistry)	3(3+0)	
CHFC-487	Applied chemistry-IV (Industrial Processes)	3(3+0)	

Course Code: CHFC-481 **Course Name: Chemistry of Coal Conversion Processes-II**

Course Objectives:

The students will acquire knowledge about the coal conversion processes like solvent extraction, hydrogenation, and importance of catalysis in such reactions, product up gradation and analysis and environmental problems relating to synthetic fuels obtained from coal.

Course Contents:

Liquefaction of Coal

Historical Developments: Historical developments of coal liquefaction, earlier coal liquefaction processes; (a) Pott and Broch Process (b) Bergius process.

Solvent Extraction: Solvent extraction of coal, some experiments on solvent extraction, mechanism of solvent extraction, types of solvent extraction, solvent systems, super critical gas extraction, commercial processes of solvent extraction like SRC-I, SRC-II, EDS, Super critical gas extraction.

Direct Liquefaction: Direct liquefaction of coal through catalytic hydrogenation, mechanism, catalysts‟ system, catalyst poisoning, catalytic role of coal minerals, commercial processes of catalytic hydrogenation like H-coal and Synthoil process.

Indirect Liquefaction: Indirect liquefaction through Fischer Tropsch synthesis, methanol synthesis and MTG (Methanol to Gasoline) processes.

Effect of Parameters: Effect of coal properties, catalyst and solvent on liquefaction behaviour of coal, effect of coal properties like rank, maceral components and mineral matter on liquefaction, effect of operating condition like temperature, pressure, residence time, solvent, catalyst, etc.

Processing of Coal Liquids: Purification of liquefaction products, solid-separation, fractionation, upgrading and characterization of coal derived liquids, properties of coal derived liquids.

Liquefaction Reactor: Description of high pressure coal liquefaction reactor and auxiliary devices, ebulated bed reactor, fluidization.

Environmental Aspects: Environmental consideration, aerial emissions, water effluents, solid waste disposal.

Recommended Books:

1. Wen, C. Y. and Stanley, E. *Coal Conversion Technology.* Addison-Wesley, New York.(1979).

2. Probstein, R. F and Hicks, R. E. *Synthetic Fuels.* McGraw Hill, New York. (1982).

3. Francis, W. *Fuels and Fuel Technology.* Pergamon Press, London (1980).

4. Merick, D. *Coal Combustion and Conversion Technology.* McMillan Ltd., London (1984

Course Code: CHFC-482 Course Name: Petroleum & Petrochemicals-II

Course objectives:

The students will acquire knowledge about the modern thermodynamics and combustion of hydrocarbons fuels. The students will also be able to learn about the safe storage and transportation of hydrocarbons fuels.

Course Contents:

Thermo chemistry and Combustion of Hydrocarbon Fuels: Basic thermodynamics principles, standard enthalpy of formation, standard enthalpy of reaction, enthalpy of combustion products, mechanism of combustion of gaseous and liquid hydrocarbon, theory of flame propagation, method of measuring flame speed, fuel performances in reciprocating piston engines, environmental pollution from hydrocarbon fuel utilization.

Storage and Handling of Hydrocarbon Fuels: Various types of storage tanks, different methods of transportation of crude and refined petroleum products. Health hazards associated with petroleum handling, volatility losses, fire hazards and its prevention. Extinguishing of oil fire methods.

Recommended Books:

1. Hobson, G. D. *Modern Petroleum Technology*. Part 2, John Wiley and Sons, New York.(1984).

2. Gates, B. C, Katzer, J. R, and Schuit, G. C. A. *Chemistry of Catalytic Processes*.. McGrawHill Book company, London (1979).

3. List, H. L. *Petrochemical Technology*. Printice-Hall Englewood Cliffs, New Jersey. (1986).

4. Goodger, E. M. *Hydrocarbon Fuels*. Union Brothers Ltd, London. (1975).

5. Maleev, V. L. Internal Combustion Engines. McGraw Hill Book Company London, (1985).

6. Hughes, J.R., and Swindells, N. S. *Storage and Handling of Petroleum Liquids*. CharlessGriffin and Company Ltd, London (1987).

Course Code: CHFC-483 Course Name: Alternate Energy Sources

Course objectives:

This course will enable students to know about the challenging sources of alternate sources ofenergy. The students will also be able to learn about the safe uses of natural resources.

Course Contents:

Biomass Resources: Biomass conversion processes, bio gas technology. Various traditionalmethods of alcohol production.Alcohols and its uses as alternative fuel.

Biofuels: Production of Bio-ethanol and biodiesel, uses of bioethanol as supplement withpetroleum gasoline as E10 and E20 etc

Hydrogen: Hydrogen production, storage, handling and its uses as alternative fuel. Fuel cells:Fuel Cells and its application,

Solar Energy: Photovoltaic power conversion & solar energy collectors.

Nuclear fuels: Nuclear fuels processing, fission and fusion, nuclear reactors.

Hydel Energy: introduction to Hydel energy. Prospecting of hydel powers in Pakistan.

Recommended Books:

1. Gyngell, E. bS. *Applied Chemistry for Engineers*.Edward Arnold Publisher, Ltd. London.(1989).

2. Harker, J.b .and Backurst, J.R. *Fuel and Energy*. Academic Press, London and New York(1988).

3. Goodger E. M. *Alternative fuels (chemical energy resources).* The Macmillan press Ltd,London, (1980).

4. Twidell, J. and Weir, T. *Renewable Energy Resources*. John Wiley and Sons,

London, NewYork, (1986).

Course Name: Lab-II

Course Code: 484

Semester-VIII (FUEL CHEMISTRY)
Course Title: **Lab-II**
Course Code: CHFC-484
Credit Hours: **1**

Course Contents:

Determination of ash in petroleum products.
Determination of calcium and barium in lube-oil.
Determination of the acidity and alkalinity of greases.
Determination of mercaptane sulfur in motor fuels, kerosene, and similar petroleum products.
Determination of total solids in used engine oils.
Determination of total sediments in residual fuel oils.
Determination of total sulfur in coal and coke by Eschka mixture method.
Determination of chlorine in coal by Eschka mixture method.
Cleaning of coal using gravity separation and froth flotation method. Determination of aniline point, diesel index and approximate Cetane number ofdiesel fuel.

Recommended Books:

1. Speight, J. G Handbook of Petroleum Analysis Wiley-Interscience, (2002)
2. Speight, J. G. Handbook of Coal Analysis. John Wiley and Sons, New Jersey, (2005)
3. ASTM, 2000, Annual Book of ASTM Standards, American Society forTesting and Materials, West Consbohockm, PA, USA

List of Examiners:

S. No	Name
1.	Dr. Muhammad Zahoor Associate Professor, Department of Biochemistry, University of Malakand
2.	Dr. Sumaira Naz Assistant Professor, Department of Biochemistry, University of Malakand
3.	Dr.Manzoor Ahmad Associate Professor, Department of Chemistry, University of Malakand
4.	Dr. Abdul Wahid Kamran Lecturer, Department of Chemistry, University of Malakand
5.	Dr. Hazrat Ali Associate professor, Department of Chemistry, University of Malakand.
6.	Dr.Mumtaz Ali Associate professor, Department of Chemistry, University of Malakand.
7.	Dr. Zarif Gul Assistant professor, Department of Chemistry, University of Okara.
8.	Dr. Adnan Shehzad Assistant professor, Department of Chemistry, University of Swat.
9.	Dr. Syed Abdul Khaliq jan Associate professor, Department of Chemistry, SBBU, Sheringal
10.	Dr.Saira Nayab Assistant professor, Department of Chemistry, SBBU, Sheringal
11.	Dr. Noor Rehman Assistant professor, Department of Chemistry, SBBU, Sheringal
12.	Dr.Farman Ali Khan Assistant professor, Department of Chemistry, SBBU, Sheringal
13.	Dr. SherWali Khan Assistant professor, Department of Chemistry, SBBU, Sheringal
14.	Dr.Nasruddin Lecturer, Department of Chemistry, SBBU, Sheringal
15.	Dr.Muhammad Tariq Lecturer, Department of Chemistry, SBBU, Sheringal
16.	Dr Asadullah Assistant Professor Department of Chemistry GC Chitral Lower
17.	Mr. Muhammad Sabir Khan Assistant Professor Department of Chemistry GC Chitral Lower
18.	Mr. Tanzil ur Rehman

	Assistant Professor Department of Chemistry GC Chitral Lower
19.	Mr. Samiullah Assistant Professor GC Chitral
20.	Mr. Iltaf ud Din Lecturer GC Chitral
21.	Mr. Mustafiz ur Rehman Lecturer GC Chitral
22.	Mr. Ifham ud Din Lecturer GDC Dir
23.	Mr. Ahmad Faraz Lecturer GDC Dir
24.	Dr. Zahir ud Din Associate Professor GDC Wari
25.	Miss. Razia Bibi Assistant Professor GGDC Booni
26.	Dr Zahid Ali Ghazi Assistant Professor NCE Physical Chemistry UoP
27.	Dr. Afsar Khan Post Doc Research Associate Central South University China
28.	Dr Luqman Ali Shah Associate Professor NCE Physical Chemistry UoP
29.	Miss Saba Shams Lecturer GGDC Chitral Lower