

CURRICULUM
FOR
Bachelor of Science
in
Chemistry



BS Chemistry

Session 2017 to Onwards

Department of Chemistry

UNIVERSITY OF OKARA

University of Okara, Department of Chemistry
Syllabus for BS Chemistry Program

MISSION STATEMENT

1. The common purpose of this program is to achieve the highest possible standards of teaching and research to make professionals in chemistry and chemistry related disciplines.
2. **The aims in teaching 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 etc.
 - 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 that is need based and its continuous development shall be made considering the changing global and national requirements.
 - vii. To develop in students the ability to work in groups for cooperative learning 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 in continuing education.

RATIONALE

The Government policy is to shift the emphasis from aimless rote learning to more purposeful science education through active participation of the students in the classroom. The subject of chemistry is introduced from elementary level in General Science and as a subject at secondary and higher secondary levels.

Entry qualification for secondary school science teacher is BS in science subjects, such as biology, chemistry, mathematics or physics, with a professional degree in education.

Keeping in view the acute shortage of chemists, scientists, and realizing that the success of any country depends upon the availability of well trained chemists, eight semesters post graduate degree program entitled **BS Chemistry**, is proposed which is after F.Sc. (with Chemistry). This **BS Chemistry** program will cater secondary and higher secondary school chemistry education. The UO graduates after completion of this program will be able to compete with graduates at other Universities because this program is designed so as to include the normal BS Chemistry, course and to cater the needs of chemists, scientist, chemistry teachers/ subject specialists/ lecturers.

The teaching is based on the development of knowledge based on fundamentals of Organic, Inorganic, Physical, Analytical Chemistry, and Biochemistry which ultimately lead to Applied Chemistry during research and specialization.

ELIGIBILITY FOR BS CHEMISTRY

F. Sc. with Chemistry or 12 years of schooling.

ADMISSION CRITERIA

Merit lists will be prepared in accordance with the criteria given in “Admission Regulations”.

ASSESSMENT MECHANISM

Assessment and evaluation of students will be according to the “Assessment and Evaluation Regulations” of the University of Okara.

TITLE OF THE DEGREE

The title of the degree will be “Bachelor of Science in Chemistry”.

Semester Wise Break Up
BS Chemistry (Total Credit Hrs. = 137)

Course Code	Course Title (Theory + Practical)	Cr. Hr.
BS Semester – I		
ENGL 2111	English I (3+0)	3
BOT 2011/PHYS 2051	Botany I /Physics I (2+1)	3
ZOOL 2015/MATH 3011	Zoology I /Mathematics I (2+1)	3
PAKS 2111	Pak Studies (2+0)	2
COMP 2001	Computer and Its Applications in Chemistry (2+1)	3
CHEM 2051	Inorganic Chemistry-I (3+1)	4
	Total	18
BS Semester - II		
ENGL 2112	English II (3+0)	3
ISL 2111	Islamic studies / Ethics (2+0)	2
BOT 2021 /PHYS 2052	Botany II /Physics II (2+1)	3
ZOOL 2016/MATH 3012	Zoology II /Mathematics calculus (2+1)	3
STAT 100	Statistics (3+0)	3
CHEM 2061	Organic Chemistry-I (3+1)	4
	Total	18
BS Semester – III		
ENGL 2113	English III (3+0)	3
BOT 2031 / PHYS 2053	Botany III / Physics III (2+1)	3
ZOOL 2023 / MATH 3013	Zoology III / Mathematics (2+1)	3
CHEM 2041	Environmental chemistry (3+0)	3
CHEM 2071	Physical Chemistry-I (3+1)	4
	Total	16
BS Semester -IV		
ENGL 2114	English IV (Report writing)/ University optional (3+0)	3
BOT 2041/PHYS 2054	Botany IV / Physics IV (2+1)	3
ZOOL 2033/MATH 3014	Zoology IV / Mathematics (3+0)	3
CHEM 2011	Analytical Chemistry-I (2+1)	3
CHEM 2081	Industrial Chemistry (2+1)	3
CHEM 2031	Biochemistry (2+1)	3
	Total	18
BS Semester – V		
CHEM 3051	Inorganic Chemistry-II (3+1)	4
CHEM 3061	Organic Chemistry-II (3+1)	4
CHEM 3071	Physical Chemistry-II (3+1)	4
CHEM 3011	Analytical Chemistry-II (3+1)	4
MATH 2044	Mathematics for Chemist (3+0)	3
	Total	19

Course Code	Course Title (Theory + Practical)	Cr. Hr.
BS Semester – VI		
CHEM 3052	Inorganic Chemistry-III (3+1)	4
CHEM 3062	Organic Chemistry-III (3+1)	4
CHEM 3072	Physical Chemistry-III (3+1)	4
CHEM 3012/ CHEM 3013/ CHEM 3014/-----	Applied Chemistry/ Biochemistry / Fuel Chemistry/----etc (3+1)	4
Total		16
BS Semester – VII		
Specialization (Inorganic/Organic/Physical/Applied/ Analytical/Bio chemistry)		
CHEM XXXX	Paper-I & Practical-I (3+1)	4
CHEM XXXX	Paper-II (3+0)	3
CHEM XXXX	Paper-III (3+0)	3
CHEM 3041	Elective course- I (other than the field of specialization) (3+0)	3
CHEM4119R/A/P	Research thesis/ Research project / Advanced Practical / Position Paper-I (Literature Survey) (0+3)	3
Total		16
BS Semester – VIII		
Specialization (Inorganic/ Organic/Physical/ Applied/ Analytical-/Bio-chemistry)		
CHEM XXXX	Paper - IV & Practical – II (3+1)	4
CHEM XXXX	Paper - V	3
CHEM XXXX	Paper - VI	3
CHEM 3081	Elective course - II (other than the field of specialization) (3+0)	3
CHEM4119R/A/P	Research thesis/ Research project / Advanced practical / Position paper –II (write-up) (0+3)	3
Total		16
Total Credit Hours for BS Chemistry		137

Decoding of CHEM XXXX

CHEM XXXX	Analytical	Biochem.	Applied	Inorganic	Organic	Physical	Fuel
CHEM XXXX Paper-I	CHEM 4011	CHEM 4031	CHEM 4041	CHEM 4051	CHEM 4061	CHEM 4071	CHEM 4081
CHEM XXXX Paper-II	CHEM 4012	CHEM 4032	CHEM 4042	CHEM 4052	CHEM 4062	CHEM 4072	CHEM 4082
CHEM XXXX Paper-III	CHEM 4013	CHEM 4033	CHEM 4043	CHEM 4053	CHEM 4063	CHEM 4073	CHEM 4083
CHEM XXXX Paper-IV	CHEM 4014	CHEM 4034	CHEM 4044	CHEM 4054	CHEM 4064	CHEM 4074	CHEM 4084
CHEM XXXX Paper-V	CHEM 4015	CHEM 4035	CHEM 4045	CHEM 4055	CHEM 4065	CHEM 4075	CHEM 4085
CHEM XXXX Paper-VI	CHEM 4016	CHEM 4036	CHEM 4046	CHEM 4056	CHEM 4066	CHEM 4076	CHEM 4086

CHEM4119R for Research thesis / Research Project

CHEM4119A for Advanced practical

CHEM4119P for Position paper

Sr. No.	Discipline specific foundation courses	Major courses including research project/internship	Elective courses within the major
	9-10 Courses	11-14 Courses	4 Courses
	30-33 Credit hours	36 - 52 Credit hours	12 Credit hours
1	Physical Chemistry-I (3+1)	Inorganic Chemistry-II (3+1)	Elective course- I (other than the field of specialization) (3+0)
2	Inorganic Chemistry-I (3+1)	Organic Chemistry-II (3+1)	Research project / Advanced Practical I / Position Paper (Literature Survey) (0+3)
3	Organic Chemistry-I (3+1)	Physical Chemistry-II (3+1)	Elective course - II (other than the field of specialization) (3+0)
4	Analytical Chemistry-I (2+1)	Analytical Chemistry-II (3+1)	Research project / Advanced practical II / Position paper (write-up) (0+3)
5	Industrial Chemistry (2+1)	Inorganic Chemistry-III (3+1)	
6	Biochemistry (2+1)	Organic Chemistry-III (3+1)	
7	Statistics (3+0)	Physical Chemistry-III (3+1)	
8	Environmental Chemistry (3+0)	Applied Chemistry / Biochemistry / Fuel Chemistry (3+1)	
9	Mathematics for Chemist (3+0)	Specialization Paper-I & Practical-I (3+1)	
10		Specialization Paper-II (3+0)	
11		Specialization Paper-III (3+0)	
12		Specialization Paper - IV & Practical – II (3+1)	
13		Specialization Paper – V (3+0)	
14		Specialization Paper – VI (3+0)	
Total	30 Cr. Hr.	52 Cr. Hr.	12 Cr. Hr.

Sr. No.	Compulsory Requirements	General Courses to Be Chosen
1	English I (3+0)	Botany I /Physics I (2+1)
2	English II (Functional) (3+0)	Zoology I (2+1)/Mathematics I (3+0)
3	English III (Communication skill) (3+0)	Botany II /Physics II (2+1)
4	English IV (Report writing) (3+0)	Zoology II (2+1)/Mathematics II (3+0)
5	Pak Studies (2+0)	Botany III /Physics III (2+1)
6	Islamic studies / Ethics (2+0)	Zoology III (2+1)/Mathematics III (3+0)
7	Computer and Its Applications in Chemistry (2+1)	Botany IV /Physics IV (2+1)
8	-----	Zoology IV (2+1)/ Mathematics IV (3+0)
Total	19 Cr. Hr.	24 Cr. Hr.

List of Elective Courses (CHEM 3041)

Analytical Chemistry (3+0)
Assessment in Chemistry (3+0)
Basics of Research (3+0)
Bio Chemistry (3+0)
Clinical Chemistry (3+0)
Computational Chemistry (3+0)
Environmental Chemistry (3+0)
Food Chemistry & Analysis (3+0)
Forensic Chemistry (3+0)
Industrial Chemistry (3+0)
Inorganic Chemistry (3+0)
Lab Safety and Management (3+0)
Nanomaterials & Nanochemistry (3+0)
Nuclear Chemistry (3+0)
Organic Chemistry (3+0)
Physical Chemistry (3+0)
Polymer Chemistry (3+0)
Quality Control & Quality Assurance (3+0)
Teaching Methods of Chemistry (3+0)
Or University Option

Note

- Elective courses / Position Paper/ Advanced Practicals will be offered depending upon the expertise available / Facilities.
- Outlines of the Elective courses / Position Paper/ Advanced Practicals will be taken from the course contents of CHEM XXXX Paper-I to CHEM XXXX Paper-VI depending upon the expertise available.
- In semester VII of BS Chemistry there will be offered Position paper or Research Project or Advanced Practicals depending upon the expertise available.
- All students (Special paper and Research Project) will study the elective course suggested by chemistry discipline.

Advanced Practical / Position Paper CHEM4119R/A/P

Advanced Practical / Position Paper / Research thesis / Research project (**literature survey**) 3 Cr. Hr.

Advanced Practical / Position Paper / Research thesis / Research project (**write-up**) 3 Cr. Hr.

Outline BS chemistry Semester I

Semester – I		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
ENGL 2111	English I (3+0)	3
BOT 2011/PHYS 2051	Botany I/Physics I (2+1)	3
ZOOL2015/MATH 3011	Zoology I (2+1)/Mathematics (3+0)	3
PAKS 2111	Pak Studies (2+0)	2
COMP 2001	Computer and Its Applications in Chemistry (2+1)	3
CHEM 2051	Inorganic Chemistry-I (3+1)	4
	Total	18

BS Chemistry 1st Year

Semester-I

Course Title:

ENGLISH-I

Code: ENGL 2111

Credit Hours: 03 (3+0)

Objectives: Enhance language skills and develop critical thinking.

COURSE OUTLINE:

Grammar: Parts of speech and use of articles, Sentence structure, Subject-Verb agreement, Sentence fragments, Run-ons, Standard English verbs, Irregular verbs, Transitive and intransitive verbs, Phrases and clauses, Consistent verb tense, Misplaced modifiers, Dangling modifiers, Parallel structure, Faulty parallelism, Pronoun agreement, Reference and Point of View

Books Recommended:

- *English Skills with Readings* by John Langan, McGraw-Hill, New York, 1998
- *Reading and Study Skills* by John Langan
- *Practical English Grammar* by A.J. Thomson and A.V. Martinet, Oxford University Press, 1997
- *Writing: Intermediate* by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet, Oxford Supplementary Skills
- *Reading: Upper Intermediate* by Brian Tomlison and Rod Ellis, Oxford Supplementary Skills

BS Chemistry 1st Year
Semester-I

Course Title: Diversity of Plants
Course Code: BOTN 2011 **Credit Hours:** 3 (2+1)

Objectives of course: The Students will be able to:

- a. Get awareness between photosynthetic and non photosynthetic plants.
- b. Know about beneficial and harmful aspects of micro organisms in every day life.
- c. Know the role of Algae and Fungi in the improvements of environment.
- d. Know the phyletic lineage among plants.

Course Outline:

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

- a. Viruses (RNA and DNA types) with special reference to TMV;
- b. Bacteria and Cyanobacteria (Nostoc) with specific reference to biofertilizers, pathogenicity and industrial importance;
- c. Algae (Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)
- d. Fungi (Penicillium, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications.
- e. Lichens (Physical)
- f. Bryophytes
 - i. Anthoceros Funaria
- g. Pteridophytes. (General characteristics and life cycles only)
 - i. Psilopsida (Psilotum)
 - ii. Lycopsida (Selaginella)
 - iii. Sphenopsida (Equisetum)
 - iv. Pteropsida (Marsilea)
- h. Gymnosperms
 - i. Cycas Ephedra
- i. Angiosperm
 - i. Monocot (Poaceae) ii. Dicot (Solanaceae)

Lab Outline:

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

Recommended Books:

1. Lee, R.E. 1999. *Phycology*. Cambridge University Press, UK
2. Prescott, L.M., Harley, J.P. and Klein, A.D. 2004. *Microbiology*, 3rd ed. W.M. C. Brown Publishers.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. *Introductory Mycology*. 4th ed. John Wiley and Sons Publishers.
4. Agrios, G.N. 2004. *Plant Pathology*. 8th ed. Academic press London.
5. Vashishta, B.R. 1991. *Botany for degree students* (all volumes). S. Chand and Company. Ltd. New Delhi.
6. Andrew, H. N. 1961. *Studies in Paleobotany*. John Willey and Sons.

BS Chemistry 1st Year

Semester-I

Course Title:

PHYSICS -I

CODE: PHYS 2051

Credit Hours: 03 (2+1)

Mechanics I

Vector Derivatives and Operators, Gauss' Divergence Theorem, Stokes Theorem, Particle dynamics, Effect on frictional and drag forces on motion, Non-inertial frames and pseudo forces, Work energy theorem, Conservative and non-conservative forces, Particle systems, Center of mass of solid objects, Angular velocity and stability of spinning objects, Linear and angular momentums, Gravitational effect of spherical mass distribution, Kepler's laws

Books Recommended:

1. UNIVERSITY PHYSICS with Modern Physics, 12th edition, Hugh D. Young and Roger A. Freedman, Sears and Zemansky
2. Physics vol. I by Resnick, halliday, and Krane, 4th Edition, John Wiley & Sons

PHYS 2071 PHYSICS LAB-I (1 Cr.hr)

LIST OF EXPERIMENTS

1. The Harmonic Oscillation of Helical springs-parallel and series connection of spring
2. Measuring moments of inertia of different bodies disc-Hollow of Solid cylinder
3. Measurement of the speed of sound in air
4. Coherence & width of spectral lines
5. Diffraction intensity at slit of double slit system
6. Stephen-Boltzmann's law of Radiation
7. Characteristics curve of a solar cell
8. Magnetic field of paired coils in Helmholtz coils

BS Chemistry 1st Year

Semester-I

Course Title:

ZOOLOGY-I

CODE: ZOO 2015

Credit Hours: 03 (2+1)

PRINCIPLES OF ANIMAL LIFE-II+PRINCIPLES OF ANIMAL LIFE- I-A (Cr. 2+1)

PRINCIPLES OF ANIMAL LIFE- I-A

Aims and Objectives:

The course aims to impart knowledge and understanding of:

- a. The concept and status of Zoology in life sciences.
- b. The common processes of life through its chemistry, biochemical and molecular processes.
- c. The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
- d. Biochemical mechanisms eventually generating energy for animal work.
- e. Animals and their relationship with their environment.

1. The Chemical Basis of Animal Life

Atoms and elements: building blocks of all matter; Structure of atoms; acids, bases, and buffers; Measuring of acidity and alkalinity, pH control by buffer; the molecules of animals: fractional account of carbohydrates, lipids, proteins, nucleotides and nucleic acids based on their structural aspects.

2. Cells, Tissues, Organs, and Organ System of Animals

Structure and functions of cell membranes; various movements across membranes; cytoplasm, organelles, and cellular components: functional account of ribosomes, endoplasmic reticulum, golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, and vacuoles based on their structural aspects. The nucleus: nuclear envelope, chromosomes and nucleolus. Tissues: diversity in epithelial tissue, connective tissue, muscle tissue and nervous tissue to perform various functions. Structural integrations for functions in organs and organ systems.

PRINCIPLES OF ANIMAL LIFE-II

Aims and Objectives:

The course imparts knowledge and understanding of:

- a. cell division and its significance in cell cycle.
- b. concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
- c. animal behaviour and communication.
- d. theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

Course Contents

1. Cell Division

Mitosis, cytokinesis, and the cell cycle: an overview; meiosis: the basis of sexual reproduction.

2. Inheritance Patterns

Mendelian inheritance patterns; other inheritance patterns (multiple allele, Codominance, Incomplete dominance)

3. Chromosomes and Gene Linkage

Organization of DNA and protein; Sex chromosomes and autosomes; Number of chromosomes; Linkage relationships (only definition); changes in chromosome number and structure (Detecting number and structure changes).

4. Molecular Genetics: Ultimate Cellular Control

DNA: the genetic material; DNA replication in eukaryotes; genes in action; mutations; applications of genetic technologies; recombinant DNA.

5. Animal Behaviour

Learning (types); communication; social behavior.

6. Evolution: A Historical Perspective

Darwin's early years and His journey; the theory of evolution by natural selection; Adaptation, Alfred Wallace Russel.

7. Evolution and Gene Frequencies

The Hardy-Weinberg theorem; evolutionary mechanisms: population size, genetic drift, natural selection, gene flow, mutation; species and speciation.

Practicals

1. Tests for different carbohydrates, proteins and lipids.

Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.

2. 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.

3. Plasmolysis and deplasmolysis in blood.

4. Study of mitosis in onion root tip.

5. Study of meiosis in grasshopper testis (students should prepare the slide).

Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).

6. Problem based study of Mendelian ratio in animals.

7. Multiple alleles study in blood groups.

8. Survey study of a genetic factor in population and its frequency.

9. Study of karyotypes of *Drosophila*, mosquito.

10. Study of cytochemical detection of DNA in protozoa and avian blood cell.

11. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).

12. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

13. Study of representative groups of class Reptilia.

14. Study of representative groups of class Aves.

15. Study of representative groups of class Mammalia.

16. Field trips to study animal diversity in an ecosystem.

Books Recommended

1. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.

2. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

BS Chemistry 1st Year

Semester-I

Course Title:

MATHEMATICS-I

CODE: MATHS 3011

Credit Hours: 03

Preliminaries: Intervals, Inequalities, Functions, Graphs of Functions, Lines, Circles, Parabolas, Shifting and Scaling of Graphs

Limits and Continuity: The Precise Definition of a Limit, Calculating Limits Using the Limit Laws, One-Sided Limits, Limits at Infinity, Infinite Limits and Vertical Asymptotes, Continuity

Differentiation: Secant and Tangent Lines, Rates of Change, The Derivative, Physical and Geometric Interpretation of a Derivative, Techniques of Differentiation, The Chain Rule, Implicit Differentiation, Linearization, Differentials

Applications of Derivatives: Extreme Values of Functions, Monotonic Functions and the First Derivative Test, Concavity, Rolle's Theorem, The Mean-Value Theorem, Curve Sketching: Graphs of Polynomials and Rational Functions, Applied Optimization Problems, Indeterminate Forms and L'Hôpital's Rule

Derivatives of Transcendental Functions: Logarithmic and Exponential Functions, Derivatives of Logarithmic and Exponential Functions, Graphs Involving Logarithmic and Exponential Functions, Inverse Functions, Derivatives of Hyperbolic and Inverse Hyperbolic Functions, Derivatives of Inverse Trigonometric Functions

Recommended Books:

1. CALCULUS by Howard Anton, 8th Edition, John Wiley & Sons
2. CALCULUS by George B. Thomas, 11th Edition, Pearson Education, India

BS Chemistry 1st Year

Semester-I

Course Title:

Pakistan Studies

CODE: PAKS 2111

Credit Hours: 02

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-i-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

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

Books Recommended

1. Burki, Shahid Javed. *State & 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 & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Banglades.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, .
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.

BS Chemistry 1st Year

Semester-I

Course Title: Computer and Its Applications in Chemistry

CODE: COMP 2001

Credit Hours:(2+1)

Definition of Computer, Core Components of Computer, Brief history of Computers, Types/ Classification of Computer, **Software:** Definition, Types, Significance, Software Development Life Cycle, **Hardware:** Definition, Types, **Computer Architecture:** Modern Computer Architecture, Central Processing Unit, Main Memory, Bus Interconnection, IO Unit , CPU Registers, Instruction Set/ Instruction Format, **Programming Languages:** Definition, Types, Language Translators, **Introduction to Data Communication and Computer Networks:** Components of Data Communication, LAN, WAN and MAN, Internet, Viruses and Anti-Viruses, Use of office productivity tools, such as word processors, spreadsheets, presentation applications, database software, etc., Social, Ethical, Professional and Legal Issues

**Use of MS Wors, Excel, Power Point, Use of Software e.g.Chemsketch/
Chemdraw**

Recommended Books:

1. Discovering Computers 2012, Cashman
2. Introduction to Computers, Peter Norton
3. Discovering Computers Complete, 2013 Shelly Cashman series.
4. Exploring Computers Complete 2012 by Floyd Fuller, Brian Larson
5. Microsoft® Office Word 2007 Step by Step (Step By Step (Microsoft)) by Joyce Cox and Joan Preppernau (Paperback - Jan 31, 2007)
9. Steve Lambert and M Dow Lambert, Microsoft® Office Access(TM) 2007 Step by Step (Step By Step (Microsoft)), 2007.
10. Carl S. Chatfield, Timothy D. Johnson (2000), "*Microsoft Project 2000 Step by Step*", Microsoft Press, ISBN: 0735609209.
6. Joyce Cox and Curtis Frye and Joan Preppernau, Microsoft® Office Home and Student 2007 Step by Step, 2007.
7. Joyce Cox and Joan Preppernau, Microsoft® Office Word 2007 Step by Step (Step By Step (Microsoft)), 2007.
8. Joyce Cox and Joan Preppernau, Microsoft® Office PowerPoint® 2007 Step by Step (Step By Step (Microsoft)), 2007.

Reference Book/s:

11. Peter Zorkoczy and Nicholas Heap, "*Information Technology: An Introduction*" 4th Edition, 1995 ISBN: 0-273-60591-7

BS Chemistry 1st Year
Semester-I

Course Title:

Inorganic Chemistry-I

Code: CHEM 2051

Credit Hours: 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:

Periodicity:

Modern periodic table; Similarities and differences in first row elements, their diagonal and vertical relationship with other elements; Electro negativity of elements (Pauling and Mullikan scales); Polarizability and polarizing power of ions; Periodicity in the properties of transition and inner transition elements.

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.

p-Block Elements:

Physical and chemical properties of p-block elements with emphasis on some representative compounds.

PRACTICAL (CHEM 2051) (1-Cr. Hr.)

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 alkali solutions, 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 of copper 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., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).
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., Keiter E. A., Keiter L. R., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., Inorganic chemistry, 3rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, Inorganic Chemistry, 3rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., Descriptive Inorganic Chemistry, 2nd ed., Brooks Cole, (2010).
12. Wulfsberg G., Principles of Descriptive Inorganic Chemistry, 1st ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., Laboratory Safety for Chemistry Students, John-Wiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., Vogel's Textbook of Quantitative Chemical Analysis, 6th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., Vogel's Qualitative Inorganic Analysis, 7th ed., (7th imp.), Pearson Education, Ltd., (2009).

Outline BS Chemistry Semester II

Semester - II		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
ENG 2112	English II (Functional) (3+0)	3
ISL 2111	Islamic studies / Ethics (2+0)	2
BOT 2021 / PHYS 2052	Botany II /Physics II (2+1)	3
ZOOL2016/MATH 3012	Zoology II (2+1)/ Mathematics II (3+0)	3
STAT 100	Statistics (3+0)	3
CHEM 2061	Organic Chemistry-I (3+1)	4
	Total	18

BS Chemistry 1st Year

Semester-II

Course Title:

English II (Functional)

Code: ENG 2112

Credit Hours: 03

Paragraph writing:

The first four steps in writing: 1) Making a Point, 2) Supporting the Point with Specific Evidence, 3) Organizing and connecting the Specific Evidence, 4) Writing clear Error-Free Sentences

The four bases for evaluating writing: 1) unity, 2) Support, 3) Coherence, Sentence Skills

Types of paragraph development: Introduction to paragraph development, Providing examples, Examining cause and effect, Explaining a process, Comparing and contrasting, defining a term, Dividing and classifying, Describing a scene or person, Narrating an event, Arguing a position

Essay Writing: The difference between a paragraph and an essay, Planing an essay, Making a thesis, developing paragraphs in an essay, Writing an essay

Books Recommended:

1. English Skills with Readings by John Langan, McGraw-Hill, New York, 1998
2. Reading and Study Skills by John Langan
3. Practical English Grammar by A.J. Thomson and A.V. Martinet, Oxford University Press, 1997
4. Writing: Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet, Oxford Supplementary Skills
5. Reading: Upper Intermediate by Brain Tomlison and Rod Ellis, Oxford Supplementary Skills

BS Chemistry 1st Year
Semester-II

Course Title:

Islamic studies

Code: ISL 2111

Credit Hours: 02

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-Baqra 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)
- 5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Selected Text of Holly Quran

- 1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

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 Lessons Derived from the 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 Holy Prophet in Madina
- 3) Important Lessons Derived from the life of Holy Prophet in Madina

Introduction To Sunnah

- 1) Basic Concepts of Hadith 2) History of Hadith 3) Kinds of Hadith
- 4) Uloom –ul-Hadith 5) Sunnah & Hadith 6) 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
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

Islamic Culture & Civilization

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

Islam & Science

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quranic & Science

Islamic Economic System

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

Political System of Islam

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

Islamic History

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

Social System of Islam

- 1) Basic Concepts Of Social System Of Islam
- 2) Elements Of Family
- 3) Ethical Values Of 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
4. 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)

BS Chemistry 1st Year

Semester-II

Course Title:

Botany II

Code: BOT 2021

Credit Hours: 03

Plant Systematics, Anatomy and Development

Specific objectives of course: To understand

1. Various systems of classification, identification and nomenclature of higher plants,
2. Structures and functions of tissues and organs at embryonic level.

Course outline:

a) Plant systematic

1. Introduction to Plant Systematic: aims, objectives and importance.
2. Classification: brief history of various systems of classification with emphasis on Takhtajan.
3. Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN). Vienna code.
4. Morphology: a detailed account of various, orphological characters
 - i. Stem
 - ii. Leaf
 - iii. Inflorescence
 - iv. Flower
 - v. Placentation .
5. Diagnostic characters, economic importance and distribution pattern of the following families:
 - i. Brassicaceae (Cruciferae)
 - ii. Fabaceae (Leguminosae)
 - iii. Rosaceae
 - iv. Euphorbiaceae
 - v. Cucurbitaceae
 - vi. Lamiaceae (Labiatae)
 - vii. Asteraceae (Compositae)

b) Anatomy

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like:
 - i. Parenchyma
 - ii. Collenchyma
 - iii. Sclerenchyma
 - iv. Epidermis (including stomata and trichomes)
 - v. Xylem
 - vi. Phloem
3. Meristem: types, stem and root apices
4. Vascular cambium

5. Structure and development of root, stem and leaf. Primary and secondary growth of dicot stem, periderm
6. Characteristics of wood: diffuse porous and ring –porous, sap and heart wood, soft and hard wood, annual rings.

c) Development / Embryology

Early development of plant body:

1. Structure and development of Anther MicrosporogenesisMicrogametophyte
2. Structure of Ovule MegasporogenesisMegagametophyte
3. Endosperm formation
4. Parthenocarpy
5. Polyembryony

Lab Outline:

Anatomy

1. Study of stomata, epidermis,
2. Tissues of primary body of plant
3. Study of xylem 3-dimensional plane of wood.
4. T.S of angiosperm stem and leaf.
5. Anatomy of germinating seeds
6. Study of pollens

Taxonomy

1. Identification of families given in syllabus with the help of keys.
2. Technical description of common flowering plants belonging to families mentioned in theory syllabus.
3. Field trips shall be undertaken to study and collect local plants.
4. Students shall submit 40 fully identified herbarium specimens.

Recommended Books:

1. Mauseth, J.D. 1998. An Introduction to *Plant Biology*: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R.C., W.D. Clarke and Vodopich, D.S. 1998. *Botany*. McGraw Hill Company, U.S.A.
3. Raven, P.H., Evert, R.E. and Eichhorn, S.E. 1999. *Biology of Plants*. W.H. Freeman and Company Worth Publishers.
4. Stuessy, T.F. 1990. *Plant Taxonomy*. Columbia University Press, USA.
5. Lawrence, G.H.M. 1951 *Taxonomy of Vascular Plants*. MacMillan & Co. New York.
6. Panday, B.P. 2004. *A textbook of Botany (Angiosperms)*. S. Chand and Co. New Delhi.
7. Raymond E, S. E. Eichhorn. 2005. *Esau's Plant Anatomy*. Meristems cells and tissues of the plant body, 3 rd ed. John Wiley & Sons. Inc.
8. Fahn, A. 1990. *Plant Anatomy*. Pergamon Press, Oxford.
9. Esau, K. 1960. *Anatomy of Seed Plants*. John Wiley, New York.
10. Maheshwari, P. 1971. *Embryology of Angiosperms*, McGraw Hill. New York.

BS Chemistry 1st Year

Semester-II

Course Title:

Physics II

Code: PHYS-2052

Credit Hours: 03

Mechanics II

Relation between linear and angular variables, Kinetic energy of rotation, Rotational dynamics of rigid bodies, Equations of motion and effects of application of torques, Elastic properties of matter, physical basis of elasticity, tension, compression & shearing, Elastic modulus, Postulates of relativity, Galilean and Lorentz transformation, Length contraction and time dilation, Relativistic mass

Books Recommended:

1. University Physics with Modern Physics, 12th edition, Hugh D. Young and Roger A. Freedman, Sears and Zemansky
2. Physics vol. I by Resnick, halliday, and Krane, 4th Edition, John Wiley & Sons

PHYS 2072

PHYSICS LAB-II

(1 Cr.hr)

LIST OF EXPERIMENTS:

1. Interference of light Fresnel Biprism
2. Measurement of wavelengths of sodium light, difference of wave lengths and thickness of thin film e.g. mica using Michelson interferometer.
3. The determination of Cauchy's constants using spectrometer.
4. Determining the modulus of elasticity.
5. Determining resistances using a Wheatstone bridge.

BS Chemistry 1st Year
Semester-II

Course Title:

ZOOLOGY-II

CODE: ZOO 2016

Credit Hours: 2+1

Animal diversity-i (classification, phylogeny and organization)+principles of animal life- i-b(cr. 2+1) Principles of animal life- i-b

3. Energy and Enzymes: Life's Driving and Controlling Forces

Energy; enzymes: structure, function and factors affecting their activity; cofactors and coenzymes; ATP: The cell's energy currency.

4. How Animals Harvest Energy Stored in Nutrients

Glycolysis: the first phase of nutrient metabolism; fermentation: "life without oxygen"; aerobic respiration: the major source of ATP; metabolism of fats and proteins.

ANIMAL DIVERSITY-I

Aims and Objectives:

The course is designed to provide students with:

- a. concepts of evolutionary relationship of animal kingdom.
- b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

Course Contents

1. Animal Classification, Phylogeny And Organization

Classification of organisms; A taxonomic hierarchy; Nomenclature; Animal systematics; patterns of organization.

2. Animal-Like Protists: The Protozoa

Life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (Table 17.1, up to phyla, subphyla and super classes, wherever applicable). Flagellar, Pseudopodia and amoeboid locomotion; cilia and other pellicular structures.

3. Multicellular and Tissue Levels of Organization

Phylum porifera: General characteristics; cell types, body wall, and skeletons; water currents and body forms; Phylum cnidaria (coelenterata): General characteristics; the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class (Table 18.2).

4 Triploblastics and Acoelomate Body Plan

phylum platyhelminthes: General characteristics classification up to class (Table 19.1); the free-living flatworms (Class Turbellaria in detail) and some important tapeworm parasites (*Taeniarhynchussaginatus*);

5. Pseudocoelomate Body Plan: Aschelminths

General characteristics; classification up to phyla with general features (six phyla); feeding and the digestive system; other organ systems; reproduction

and development of phylum nematoda; Some important nematode parasites of humans (*Ascaris lumbricoides*, *Wuchereria* spp.: the Filarial worms).

6. Molluscan Success

Molluscan characteristics; classification up to class (Table 21.1). The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in bivalves.

7. Annelida: The Metameric Body Form

Metamerism and tagmatization; classification up to class (Table 22.1). External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development in polychaeta.

8. Arthropods: Blueprint for Success

Evolutionary perspective: classification up to class (Table 23.1); metamerism and tagmatization; the exoskeleton; metamorphosis.

9. Hexapods and Myriapods: Terrestrial Triumphs

External structure and locomotion, nutrition and the digestive system, gas exchange, circulation and temperature regulation, nervous and sensory functions, excretion, chemical regulation, reproduction and development in hexapoda; insect behavior; insects and humans.

Practicals

1. Protein digestion by pepsin.
2. Study of *Euglena*, *Amoeba*, *Entamoeba*, *Plasmodium*, *Trypanosoma*, *Paramecium* as representative of animal like protists. (Prepared slides).
3. Study of sponges and their various body forms.
4. Study of principal representative classes of phylum Coelenterata.
5. Study of principal representative classes of phylum Platyhelminthes.
6. Study of representative of phylum Rotifera, phylum Nematoda.
7. Study of principal representative classes of phylum Mollusca.
8. Study of principal representative classes of phylum Annelida.
9. Study of principal representative classes of groups of phylum Arthropoda.
10. Brief notes on medical/economic importance of the following
Plasmodium, *Entamoeba histolytica*, *Leishmania*, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.
10. Preparation of permanent stained slides of the following: *Obelia*, *Daphnia*, Cestode, Parapodia of *Nereis*.

Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.

BS Chemistry 1st Year

Semester-II

Course Title:

Mathematics II

Code: MATH 3012

Credit Hours: 03

Integration: The Indefinite Integral, Estimating with Finite Sums, Sigma Notation and Limits of Finite Sums, Areas as Limits, The Definite Integral, The Fundamental Theorem of Calculus

Applications of Definite Integrals: Area between Two Curves, Volumes by Slicing; Discs and Washers, Volumes by cylindrical Shells, Length of a Plane Curve, Area of a Surface of Revolution
Techniques of Integration: Integration by Parts, Integration of Rational Functions by Partial Fractions, Integrating Powers of Sine and Cosine, , Integrating Powers of Secant and Cosecant, Trigonometric substitutions, Improper Integrals, Evaluating Integral

Infinite Sequences and Series: Sequences, Monotone Sequences, Infinite Series, The Integral Test, Comparison Tests, The Ratio Test, The Root Test, Alternating series, Absolute and Conditional Convergence, Power Series, Taylor and Maclaurin Series, Convergence of Taylor Series; Error Estimates, Applications of Power Series, Fourier Series

Recommended Books:

1. CALCULUS by Howard Anton, 8th Edition, John Wiley & Sons
2. CALCULUS by George B. Thomas, 11th Edition, Pearson Education, India

BS Chemistry 1st Year

Semester-II

Course Title:

Statistics

Code: STAT 100

Credit Hours: 03

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, Editing of Data. 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, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Histogram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

Unit 3. Measures of Central Tendency

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

Unit 4. Measures of Dispersion

Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.

Unit 5. Probability and Probability Distributions.

Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

Unit 6. Sampling and Sampling Distributions

Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.

Unit 7. Hypothesis Testing

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

Unit 8. Testing of Hypothesis- Single Population

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

Unit 9. Testing of Hypotheses-Two or more Populations

Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

Unit 10. Testing of Hypothesis-Independence of Attributes

Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

Unit 11. Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation. r and R^2 . Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. 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.

BS Chemistry 1st Year
Semester-II

Course Title:

Code: CHEM 2061

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.

PRACTICAL (CHEM 2061) (1-Cr. Hr.)

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, (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, (2006).
5. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, 6th ed., Pearson Education Limited, England, (1986).

Organic Chemistry-I

Credit Hours: 04

Outlines BS Chemistry Semester III

Semester - III		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
ENG 2113	English III (Communication skill) (3+0)	3
BOT 2031 / PHYS 2053	Botany III / Physics III (2+1)	3
ZOOL 2023 / MATH 3013	Zoology III (2+1) / Mathematics III (3+0)	3
CHEM 2041	Environmental Chemistry (3+0)	3
CHEM 2071	Physical Chemistry-I (3+1)	4
	Total	16

**BS Chemistry 2nd Year
Semester-III**

Course Title: English III (Communication Skill)

Code: ENG 2113

Credit Hours: 03

Writing of CV and Job Application

Academic Writing: Letter/Memo writing, writing of minute of meetings, Use of Library and Internet

Presentation Skills: Personality development (with emphases on content, style, and pronunciation)

Books Recommended:

1. Practical English Grammar by A.J. Thomson and A.V. Martinet, Oxford University Press, 1986
2. Writing: Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet, Oxford Supplementary Skills
3. Reading: Advanced by Brian Tomlison and Rod Ellis, Oxford Supplementary Skills

BS Chemistry 2nd Year
Semester-III

Course Title:

Botany III

Code: BOT 2031

Credit Hours: 03

Cell Biology, Genetics and Evolution

Specific objectives of course: To understand

1. structure and functions of cell,
2. nature of genetic material and hereditary process
3. Familiarization with evolutionary processes.

Course outline:

a) Cell biology

1. Structures and Functions of Bio-molecules
 - i. Carbohydrates
 - ii. Lipids
 - iii. Proteins
 - iv. Nucleic Acids
2. Cell: Cell theory, Cell types (Prokaryotes and Eukaryotes), basic properties of cell
3. Ultrastructure of plant cell with a brief description and functions of the following organelles
 - i. Cell wall
 - ii. Cell membrane
 - iii. Nucleus
 - iv. Endoplasmic reticulum
 - v. Plastids
 - vi. Mitochondria
 - vii. Ribosomes
 - viii. Dictyosomes
 - ix. Vacuole
 - x. Microbodies (Glyoxysomes and Peroxisomes)
4. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle

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, transcription, translation, protein synthesis, regulation of gene expression (e.g. *lac* operon).
3. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

c) Evolution :Introduction and theories.

Lab Outline:Cell Biology

1. 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.

Genetics

1. Genetical problems related to transmission and distribution of genetic material.
2. Identification of DNA in plant material. Carmine/orcein staining.
3. Study of salivary gland chromosomes of *Drosophila*.

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.

Journals / Periodicals: Theoretical & Applied Genetics, The Cell, Heredity.

BS Chemistry 2nd Year

Semester-III

Course Title:

Physics III

Code: PHYS 2053

Credit Hours: 03

Electricity and Magnetism

Electric charge and electric field, Gauss's law, Electric potential, Capacitance and Dielectrics, Current, Resistance, Electromotive force, Dielectric-current circuits, Magnetic field and magnetic forces, Sources of magnetic field, Electromagnetic induction, Induction, Alternating current, Electromagnetic waves, Maxwell equations

Books Recommended:

1. University Physics with Modern Physics, 12th edition, Hugh D. Young and Roger A. Freedman, Sears and Zemansky
2. Physics vol. I by Resnick, halliday, and Krane, 4th Edition, John Wiley & Sons

PHYS 2073 PHYSICS LAB-III (1 Cr.hr)

LIST OF EXPERIMENTS:

1. Measurement of resistance using a Neon flash bulb and condenser
2. Conversion of a Galvanometer into Voltmeter and Ammeter.
3. To study the characteristics of Photoemission and determination of Plank's constant using a Photo cell.
4. Calibration of an ammeter and a voltmeter by potentiometer.
5. Charge sensitivity of a ballistic galvanometer.
6. Measurement of self/mutual inductance.
7. Study of electric circuit by black box.

BS Chemistry 2nd Year
Semester-III

Course Title:

ZOOLOGY-III

CODE: ZOO 2023

Credit Hours: 2+1

**ANIMAL DIVERSITY-II (Classification, Phylogeny And
ganization)+Principles Of Animal Life- I-C (2+1)**

PRINCIPLES OF ANIMAL LIFE- I-C

5. Ecology I: Individuals and Populations

Animals and their abiotic environment (Energy, Animal inactivity); populations; Population growth; interspecific interactions (only definitions of Herbivory, Predation, Competition, Symbiosis, Parasitism, Commensalism, Mutualism).

6. Ecology II: Communities and Ecosystems

Ecosystems (Trophic structure, Producers, Consumers, Decomposers); ecosystems of the earth (brief account); ecological problems; human population growth, pollution.

ANIMAL DIVERSITY-II

**ANIMAL DIVERSITY-II (Cr. 2+1) (Classification, Phylogeny And
rganization)**

Aims and Objectives:

The course provides knowledge and understanding about the different animal groups, emphasizing their phylogenetic relationships.

Course Contents

1. Echinoderms

Echinoderm characteristics; classification up to class (Table 25.1). Maintenance functions, regeneration, reproduction, and development in asteroidean.

2. Hemichordates and Invertebrate Chordates

Phylogenetic Relationships; Classification up to subphylum or class where applicable (Table 26.1); Class Enteropneusta in detail.

3. Fishes: Vertebrate Success in Water

Phylum Chordata, General characteristics and Classification (Table 26.1); Survey of super class agnatha and gnathostomata (Table 27.1); evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, reproduction and development.

4. Amphibians: The First Terrestrial Vertebrates

Survey of order caudata, gymnophiona, and anura (Table 28.1). Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, reproduction, development, and metamorphosis.

5. Reptiles: The First Amniotes

Survey of order testudines or chelonia, rhychocephalia, squamata, and crocodilian (Table 29.1); evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, reproduction and development.

6. Birds: Feathers, Flight, and Endothermy

Evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, reproduction and development; migration and navigation.

7. Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity

Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, excretion and osmoregulation.

Practicals

1. Ecological notes on animals of a few model habitats.
2. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).
3. Study of a representative of Hemichordate and Invertebrate Chordate.
4. Study of representative groups of class Fishes.
5. Study of representative groups of class Amphibia.
6. Study of representative groups of class Reptilia.
7. Study of representative groups of class Aves.
8. Study of representative groups of class Mammalia.
9. Field trips to study animal diversity in an ecosystem.

Note: Preserved specimen and/or colored projection slide and/or CD ROM projection of computer must be used.

Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International) 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Books Recommended

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
2. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.

BS Chemistry 2nd Year

Semester-III

Course Title:

Mathematics III

Code: MATH 3013

Credit Hours: 03

Partial Derivatives: Functions of Two or More Variables, Limits and Continuity, Partial Derivatives, Differentiability and Chain Rule for Two Variables, Differentiability of Three Variables, Directional Derivatives of Three Variables, Gradients for Functions of Three, Maxima and Minima of Functions of Two Variables

Multiple Integrals: Double Integrals, Double Integrals over Non Rectangular Regions, Double Integrals in Polar Coordinates, Surface Area, Triple Integrals, Centroid, Triple Integrals in Cylindrical and Spherical Coordinates, Change of Variables in Multiple Integrals

Integration in Vector Fields: Line Integrals, Vector Fields, Green's theorem, Parameterized surfaces, Stokes' Theorem, The Divergence Theorem

Recommended Books:

1. CALCULUS by Howard Anton, 8th Edition, John Wiley & Sons
2. CALCULUS by George B. Thomas, 11th Edition, Pearson Education, India

BS Chemistry 2nd Year
Semester-III

Course Title:

Environmental Chemistry

Code: CHEM 2041

Credit Hours: 03

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 the atmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone—the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Water Pollution:

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 of soil, 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 based paints.

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-Wiley & Sons, Inc., (2011).

BS Chemistry 2nd Year
Semester-III

Course Title:

Code: CHEM-2071

Course Objectives:

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

Physical Chemistry-I

Credit Hours: 3+1

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.

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, Le-Chatelier's principle, effect of temperature, pressure and compositions on the equilibrium constants, van't Hoff equation,.

Solution Chemistry:

Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and non-ideal solutions, Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure and its measurement, vapor pressure of non-ideal solutions and Henry's law, abnormal colligative properties, 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 Arrhenius equation.

Practicals (CHEM -2071) (1-Cr. Hr.)

Determination of viscosity and refractive index of liquids.

Determination of percent composition of liquid solutions viscometrically.

Determination of refractive index and molar refractivity.

Determination of percent composition of liquid solutions by refractive index measurements.

Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).

Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).

Determination of heat of solution by solubility method.

Determination of heat of neutralization of an acid with a base.

Kinetic study of acid catalyzed hydrolysis of ethyl acetate.

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., Atkins's Physical Chemistry, 9th ed., Oxford University Press, (2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).
5. Glasstone, S., Textbook of Physical Chemistry, Macmillan London (1960).
6. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York, (1974).
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).

Outlines BS chemistry Semester IV

Semester IV		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
ENG 2114	English IV (Report writing) (3+0)	3
BOT 2041/PHYS 2054	Botany IV / Physics IV (2+1)	3
ZOOL2033/MATH3014	Zoology IV (2+1)/ Mathematics (3+0)	3
CHEM 2011	Analytical Chemistry-I (2+1)	3
CHEM 2081	Industrial Chemistry (2+1)	3
CHEM 2031	Biochemistry (2+1)	3
	Total	18

BS Chemistry 2nd Year

Semester-IV

Course Title:

English IV(Report writing)

Code: ENG 2114

Credit Hours: 03

Academic Writing:

How to write a proposal for research paper,

How to write a research paper (emphasis on style, content, language, form, clarity, consistency)

Technical Writing

Progress Report Writing

Books Recommended:

1. College Writing Skills by John Langan, McGraw-Hill, New York, 2004
2. Patterns of College Writing by Laurie G. Kirszner and Stephen R. Mandell, St. Martin's Press
3. Writing: Advanced by Ron White, Oxford Supplementary Skills

BS Chemistry 2nd Year

Semester-IV

Course Title:

BOTANY IV

Course Code: BOTN 2041

Credit hours: (2+1)

Plant Physiology and Ecology

Specific objectives of course:

1. To provide comprehensive knowledge of functioning of organs, organelles and biomolecules,
2. To enable the students to assess the effects of various environmental factors on plant growth and development.

Course outline:

a) Plant Physiology

1. Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation.
2. Mineral nutrition: Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.
3. Photosynthesis: Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C₃ and C₄ plants. Factors affecting this process, Products of photosynthesis.
4. Respiration: Definition and respiratory substrates. Mechanism-Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and anaerobic respiration, Respiratory quotients.

b) Ecology

1. Introduction, aims and applications of ecology.
2. Soil: Physical and Chemical properties of soil (soil formation, texture, pH, EC, organism and organic matter etc) and their relationships to plants.
3. Light and Temperature. Quality of light, diurnal and seasonal variations. Ecophysiological responses.
4. Water: Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants.
5. Wind: Wind as an ecological factor and its importance.
6. Population Ecology: Introduction. A brief description of seed dispersal, seed bank.
7. Community Ecology
 - i. Ecological characteristics of plant community
 - ii. Methods of sampling vegetation (Quadrat and line intercept)
8. Applied Ecology
 - i. Causes, effects and control of water logging and salinity with respect to Pakistan

Lab Outline:

a) Plant Physiology

1. Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
2. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
3. Measurement of leaf water potential by the dye method.
4. Determination of the temperature at which beet root cells lose their permeability.
5. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a potometer/by cobalt chloride paper method.
6. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
7. Estimation of oxygen utilized by a respiring plant by Winkler's method.

b) Ecology

1. Determination of physical and Chemical characteristics of soil.
2. Measurements of various population variables
3. Measurement of vegetation by Quadrat and line intercept methods.
4. Field trips to ecologically diverse habitats.
5. Measurement of light and temperature.
6. Effect of light and temperature on seed germination.

Recommended Books:

1. IhsanIllahi 1995. *Plant Physiology*, Biochemical Processes in Plants, UGC Press.
2. Witham and Devlin. 1986 *Exercises in Plant Physiology*, AWS Publishers, Boston.
3. Taiz, L. and Zeiger, E. 2006. *Plant Physiology*. 4th Ed. Sinauers Publ. Co. Inc. Calif.
4. Salisbury F.B. and Ross C.B. 1992. *Plant Physiology*. 5th Edition. Wadsworth Publishing Co. Belmont CA.
5. Hopkins, W.B. 1999. *Introduction to Plant Physiology*. 2nd Ed. John Wiley and Sons. New York
6. Schultz, J.C. 2005. *Plant Ecology*. Springer-Verlag, Berlin.
7. Ricklefs, R.E. 2000. *Ecology*. W.H. Freeman and Co., UK.
8. Ricklefs, R.E. 2001. *The Economy of Nature*. W.H. Freeman and Co., UK.
9. Barbour, M. G., J. H. Burke and W.D. Pitts. 1999. *Terrestrial Plant Ecology*, The Benjamin, Cumming Publishing Co. Palo Alto, California, USA.
10. Chapman, J.L. and Reiss, M.J. 1995. *Ecology: Principles and Applications*. Cambridge University Press.
11. Hussain F. 1989. *Field and Laboratory Manual of Plan Ecology*. National Academy of Higher Education, Islamabad.
12. Hussain, S.S. 1989. *Pakistan Manual of Plant Ecology*; National Book Foundation, Islamabad.
13. Larcher, W. 2003 *Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functions Groups* – Springer Verlag.
14. Krebs, C. J. 1997. *Ecology*. Harper and Row Publishers.

BS Chemistry 2nd Year

Semester-IV

Course Title:

Physics IV

Code: PHYS 2054

Credit Hours: 03

Modern Physics

Photons, Electrons, Photoelectric effect, Atomic line spectra, Energy levels, Bohr model, Wave-particle duality, DeBroglie waves, Heisenberg uncertainty principle, Schrodinger equation, Structure of solids, Free-electron model of metals, Semiconductors, Semiconductor devices, Superconductivity, Radioactivity, Nuclear reactions

Books Recommended:

1. University Physics with Modern Physics, 12th edition, Hugh D. Young and Roger A. Freedman, Sears and Zemansky
2. Physics vol. I by Resnick, halliday, and Krane, 4th Edition, John Wiley & Sons

PHYS 3041 LAB-IV (1 Cr.h)

LIST OF EXPERIMENTS

Note:

- (i) The students must perform at least 4 experiments from the list given below.
 - (ii) 50% weight-age must be given to viva-voce about apparatus, theory of experiments and estimation of errors.
1. Measurement of wavelengths of sodium light, difference of wave lengths and thickness of thin film e.g. mica using Michelson interferometer.
 2. To measure Planck's constant by studying photoelectric effect.
 3. To study the characteristic curve of semi-conductor diodes.
 4. To study full-wave and half-wave rectification using oscilloscope.
 5. To determine the ionization of mercury.
 6. To study the characteristic of GM counter and study of fluctuation in random process.

BS Chemistry 2nd Year
Semester-IV

Course Title:

CODE: ZOO 2033

Animal Form And Function (2 + 1) (A Comparative Perspective)

Aims and Objectives:

The course aims to teach the students about:

- a. Animals diversity adapted in different ways for their functions through modifications in body parts.
- b. The diversity in integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory, respiratory, nutritive, excretory, osmoregulatory and reproductive systems according to strategies to survive in their specific conditions.
- c. Organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
- d. The basic structure of each system that determines its particular function.

Course Contents

1. Protection, Support, and Movement

Protection: Integumentary systems

The integumentary system of invertebrates. The integumentary system of vertebrates (no need of details), the skin of mammals. Movement and support: skeletal systems, The skeletal system of invertebrates, Hydrostatic skeletons, Exoskeletons, Endoskeletons. Mineralized Tissues and the invertebrates. The skeletal system of vertebrates; Cartilage, Bone or Osseous Tissue. Movement: Nonmuscular Movement and Muscular Systems; Nonmuscular Movement. Amoeboid Movement, Ciliary and Flagellar Movement. An Introduction to Animal Muscles; The Muscular System of Invertebrates. The Muscular System of vertebrates. Skeletal Muscle Contraction. Control of Muscle Contraction.

2. Communication I: Nerves

Neurons: The Basic Functional Units of the Nervous System. Neuron Structure: The Key to Function. Invertebrate Nervous Systems. Invertebrate and Nervous Systems: The Spinal Cord, Spinal Nerves, The Brain; Hindbrain, Midbrain, Forebrain. Cranial Nerves. The Autonomic Nervous System.

3. Communication II: Senses

Sensory Reception. Hearing and Equilibrium in Air, Skin Sensors of Mechanical Stimuli, Smell, Taste and Vision.

4. Communication III: The Endocrine System and Chemical Messengers

Chemical Messengers: Hormones and Their Feedback Systems, Biochemistry of Hormones Feedback Control System of Hormone Secretion, Mechanisms of Hormone Action; Fixed-Membrane –Receptor Mechanism. Mobile-Receptor Mechanism. Endocrine System of Mammals; Pituitary Gland (Hypophysis), Hormones of the Neurohypophysis, Hormones of the Adenohypophysis, Thyroid Gland, Parathyroid Glands, Adrenal Glands, Adrenal Cortex, Adrenal Medulla. Pancreas, Gonads, Thymus, Other Sources of Hormones.

5. Circulation, Immunity, and Gas Exchange

Internal Transport and Circulatory Systems. Transport Systems in Invertebrates. Transport Systems in Vertebrates; Characteristics of Vertebrate Blood and Blood Cells, Plasma, Formed Elements, Red Blood Cells, White Blood Cells, Platelets, Vertebrate Blood Vessels. The Human Heart, Blood Pressure, The Lymphatic System. Immunity. Gas Exchange. Respiratory Surfaces. Human Respiratory System: Air-Conducting Portion, Gas-Exchange Portion, Ventilation, Gas Transport.

6. Nutrition and Digestion

Evolution of Nutrition; The Metabolic Fates of Nutrients in Heterotrophs; Calories and Energy. Macronutrients; Carbohydrates: Carbon and Energy from Sugars and Starches, Lipids: Highly Compact Energy-Storage Nutrients, Proteins: Basic to the Structure and Function of Cells. Micronutrients: Minerals, Vitamins. Digestion. Diversity in Digestive Structures: Invertebrates, Protozoa, Insects. The Mammalian Digestive System, Gastrointestinal Motility and Its Control, Oral Cavity. Pharynx and

Esophagus, Stomach, Small Intestine: Main Site of Digestion, Large Intestine. Role of the Pancreas in Digestion, Role of the Liver and Gallbladder in Digestion.

7. Temperature and Body Fluid Regulation

Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Birds and Mammals; Heat Production in Birds and Mammals. Control of Water and Solutes (Osmoregulation and Excretion). How the Metanephric Kidney Functions.

8. Reproduction and Development

Asexual reproduction in invertebrates; Fission, Budding, Fragmentation, Parthenogenesis.

Sexual Reproduction in Invertebrates; External Fertilization, Internal Fertilization.

Sexual Reproduction in Vertebrates; Some Basic Vertebrates Reproductive Strategies, Fishes,

Amphibians, Reptiles, Birds, Mammals.

Practicals

1. Study of insect chitin and mammalian skin.

2. Study and notes of skeleton of *Rana tigrina* and rabbit.

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

3. Earthworm ; cockroach, frog, pigeon and rabbits are representative animals for study in dissections.

4. Study of models or preserved brains of representative animals and notes on adaptations.

5. Study of nervous system of earthworm.

6. Study of endocrine system in an insect and a rabbit.

7. Study of different types of blood cells in blood smear of rabbit.

8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative mammals).

9. Study of respiratory system in cockroach and a vertebrate representative (Model). 1. Study of excretory system in an invertebrate and a vertebrate representative (Model).

10. Study of nutritive canal in an invertebrate and a vertebrate representative (Dissection).
11. Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
12. Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
13. Study of hormonal influence of a reproductive function (Model).

Books recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Books Recommended

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
2. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.

BS Chemistry 2nd Year

Semester-IV

Course Title:

Mathematics IV

Code: MATH 3014

Credit Hours: 03

Ordinary Differential Equations

Introduction to Differential Equations: Differential Equation (DE), Classification of DEs by Type, Order, and Linearity; Solutions of DEs: Trivial, Explicit, Implicit, Particular, Singular, and General; Introduction to Initial-Value and Boundary-Value Problems, Existence of a Unique Solution; Introduction to Mathematical Modeling with DEs

First-Order Differential Equations: Solutions of Separable, Homogeneous, Exact, and Linear DEs; Solutions of Bernoulli's, Riccati's, and Clairaut's DEs

Linear Differential Equations of Higher Order: nth Order Homogeneous Linear DEs: Superposition Principle, Linear Dependence, Linear Independence, Wronskian, Fundamental Set of Solutions, General Solution; nth Order Nonhomogeneous Linear DEs: Superposition Principle, General Solution; Constructing a Second Solution from a Known Solution; Homogeneous Linear DEs with Constant Coefficients; Undetermined Coefficients; Applications of Second-Order DEs; Solving DEs with *Maple*, *Mathematica* or *Matlab***Differential Equations with Variable Coefficients:** Cauchy-Euler Equation, Power Series Solutions, Solutions About Ordinary and Singular Points, Solutions of Bessel and Legendre Equations; Finding Power Series Solutions of DEs with *Maple*, *Mathematica* or *Matlab*

Laplace Transform: Laplace Transform, Inverse Laplace Transform, Transforms of Derivatives and Integrals, Solving DEs Using Laplace Transforms; Evaluating Laplace Transforms with *Maple*, *Mathematica* or *Matlab*

Systems of Linear Differential Equations: Operator Method, Laplace Method, Matrices and Systems of Linear First-Order DEs, Homogeneous Linear Systems; Solving systems of DEs with *Maple*, *Mathematica* or *Matlab*

Recommended Books:

1. Differential Equations with Boundary-Value Problems by Dennis G. Zill & Michael R. Cullen, 3rd Edition, PWS Publishing Company

BS Chemistry 2nd Year
Semester-IV

Course Title:

Analytical Chemistry-I

Code: CHEM 2011

Credit Hours: (2+1) 03

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 the classical techniques of analytical chemistry and quality control and quality assurance

Course Contents:

Chemeometrics

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

Classical Analytical Methods:

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

Modern Analytical Methods:

Classifications of Chromatographic Techniques, Paper and Thin Layer Chromatographic Techniques; their instrumentation, applications and limitations, Column Adsorption Chromatography, Introduction to Molecular spectroscopy, absorption in UV and Visible range; Basic principle of Spectrophotometry; Beer-Lambert's law; Deviations; Instrumentation and application.

Practical

Calibration of volumetric glassware, electronic and analytical equipment, statistical evaluation of analytical data including linear regression analysis, constructing a calibration curve from a given analytical data using spreadsheet 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 Scientific Publishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, CHEMOMETRICS-Statistics and Computed applications in Analytical Chemistry, 2nd ed., Wiley-VCH, Germany, (2007).
6. Mitra A., Fundamentals of Quality Control and Improvement, 3rd ed., John Wiley & Sons, (2008).
7. Miller, J. and Miller, J., Statistics and Chemometrics for Analytical Chemistry, 5th ed., Prentice Hall, (2005).

BS Chemistry 2nd Year
Semester-IV

Course Title:

Code: CHEM 2081

Course Objectives:

Industrial Chemistry

Credit Hours: 2+1

The objectives of the course are to educate the students about the fundamentals of chemical industry, 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.

Practicals:

1. Determine the total acidity by mass of HNO₃, HCl and H₂SO₄.
2. Determination of oxalic acid content.
3. Determination of the initial and final setting time of the hydraulic cement by Vicat needle apparatus.
4. Determine the tensile strength of cement.
5. Design an apparatus to cook food with energy from the sun.
6. Synthesis of fluorescein and indophenol blue dyes.
7. Dyeing of cotton using aniline black dye.
8. Preparation of Novalac (linear polymer) from ortho-hydroxy, benzyl alcohol.
9. Preparation of urea-formaldehyde resin, polystyrene and nylon 6-6.
10. Preparation of soap from animal fat.
11. Preparation of sodium lauryl sulphate detergent.

Recommended Books:

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

BS Chemistry 2nd Year

Semester-IV

Course Title:

Biochemistry

Code: CHEM 2031

Credit Hours: 03

Course Objectives:

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

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 quaternary structure of proteins, denaturation of proteins.

Nucleic Acids:

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

Practical

Qualitative and quantitative analysis of carbohydrates, lipids and proteins.

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.

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

Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

Outlines BS Chemistry Semester V

Semester – V		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
CHEM 3051	Inorganic Chemistry-II (3+1)	4
CHEM 3061	Organic Chemistry-II (3+1)	4
CHEM 3071	Physical Chemistry-II (3+1)	4
CHEM3011/CHEM 3031	Analytical Chemistry-II (3+1)	4
MATH 2044	Mathematics for Chemist (3+0)	3
	Total	18

BS Chemistry 3rd Year
Semester-V

Course Title:

Code: CHEM 3051

Course Objectives:

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

Course Contents:

Chemistry of d-block elements and coordination complexes:

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

Chemistry of f-block elements:

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.

PRACTICAL (CHEM3051) (1-Cr. Hr.)

Preparations of following Inorganic Complexes;

Tetraamminecopper (II) sulphate.

Potassiumtrioxalatochromate (III).

Potassiumtrioxalatoaluminate (III).

cis-Potassium dioxalatoaquachromate (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 Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).
2. Housecraft, C. and Sharpe, A. G., Inorganic Chemistry, 4th ed., Prentice Hall, (2012).
3. Miessler, G. L. and Tarr, D.A., Inorganic Chemistry, 4th ed., Pearson-Prentice Hall International, (2010).

BS Chemistry 3rd Year
Semester-V

Course Title:

Organic Chemistry-II

Code: CHEM 3061

Credit Hours: 04

Course Objectives:

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

Course Contents:

Stereochemistry:

Types of stereoisomers, DL Conventions, RS, Cis-Trans, EZ notation Syn-Anti configuration, optical activity, stereoselectivity and stereospecificity, Felton Ahn model, chiral compounds having no chiral centre e.g. spiro compounds and biphenyls, conformational analysis of ethane, propane, butane, cyclohexane, mono and di substituted cyclohexane, decaline.

Organic Reactions and Mechanism:

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

PRACTICAL (CHEM 3061) (1 Cr. Hr.)

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

Recommended Books:

1. Robert, T. M., and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).
2. John, E. M., Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Younas, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2006).
4. Morris, D. G., Stereochemistry (Basic Concepts in Chemistry), Wiley-RSC, (2002).
5. Mislow, K., Introduction to Stereochemistry, Dover Publications Inc., (2003).
6. David M., Stereochemistry (Tutorial Chemistry Texts), Royal Society of Chemistry, (2002).
7. Furniss, B. S, Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th ed., Longman, UK, (1989).
8. Mohan J., Organic Analytical Chemistry, Theory and Practice, 1st ed. Alpha Sci. Int., Ltd. (2003).
9. Seiler, J. P., Good Laboratory Practice: The Why and the How, 2nd ed., Springer, (2005).
10. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed., Brooks/Cole Cengage Learning, (2012).
11. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John-Wiley & Sons, Inc., (2011).
12. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/ Cole Cengage Learning, (2013).
13. Eames, J. and Peach, J. M., Stereochemistry at a Glance, Blackwell Science, Ltd., (2003).
14. Eliel, E. L., Wilen, S. H. and Doyle, M. P., Basic Organic Chemistry, John-Wiley & Sons, Inc., (2001).
15. Eliel, E. L. and Wilen, S. H., Stereochemistry of Organic Compounds, John-Wiley & Sons, Inc., (1994).

BS Chemistry 3rd Year
Semester-V

Course Title:

Physical Chemistry-II

Code: CHEM 3071

Credit Hours: 04

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, eigen functions and eigen values, Schrödinger wave equation, Hamiltonian operator, wavefunctions for hydrogen-like atomic orbitals, radial distribution functions, shielding and penetration, effective nuclear charge, orbital energies.

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 (N_A), 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.

PRACTICALS (CHEM-3071) (1Cr. Hr.)

Equilibrium constant of the $KI + I_2 = KI_3$ reaction.

Kinetics of saponification of ethyl acetate.

Acid catalyzed hydrolysis of sucrose. Determination of partial molar volumes.

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. 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., John-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., Atkins'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. Helpert, 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 Group Limited, New York, (1974).

BS Chemistry 3rd Year
Semester-V

Course Title: Analytical Chemistry-II

Code: CHEM 3011 **Credit Hours: 04**

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:

Cation Exchange resin, Anion Exchange resin, Cross-linkage, Separation of metal ions on Anions Exchange Columns, Applications of ion Exchange Chromatography. Basic principle of solvent extraction, The Distribution Coefficient, The Distribution Ratio, Solid-Phase Extraction, Solvent Extraction by Flow Injection Analysis. Capillary Zone Electrophoresis, Application of traditional Electrophoresis, Gel Chromatography.

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.

PRACTICAL (CHEM 3011) (1-Cr. Hr.)

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 λ_{\max} of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ solutions and verification of Beer-Lambert's law.

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., Bios Science Publisher Ltd. Oxford UK. (2002)
5. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. A., Introduction to spectroscopy, 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).

BS Chemistry 3rd Year
Semester-V

Course Title:

Mathematics for Chemist

Code: MATH 2044

Credit Hours: 03

Specific Objectives of 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 Numbers and the Real Line,

Functions and their graphs: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities.

Limits and Continuity: Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions.

Derivatives and its Applications: Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions.

Integration and Indefinite Integrals: Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A.Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4th edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

Outlines BS Chemistry Semester VI

Semester – VI		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
CHEM 3052	Inorganic Chemistry-III (3+1)	4
CHEM 3062	Organic Chemistry-III (3+1)	4
CHEM 3072	Physical Chemistry-III (3+1)	4
CHEM 3012/ CHEM 3013/ CHEM 3014/-----	Applied Chemistry/ Biochemistry / Fuel Chemistry/-----etc (3+1)	4
	Total	16

BS Chemistry 3rd Year
Semester-VI

Course Title:

Inorganic Chemistry-III

Code: CHEM 3052

Credit Hours: 04

Course Objectives:

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

Course Contents:

Inorganic materials:

Crystalline and amorphous states, design of inorganic materials and characterization, X-ray spectra and $n(E)$ curves, $n(E)$ curves. Metallic bond on the basis of band model, Binding energy in metals, conductors, semi-conductors and insulators. Effect of temperature and impurities on conductivity. Doping and purification of silicone, chemical vapour deposition and sputtering, introduction to nano materials.

Pi- acceptor Ligands:

Transition metal carbonyls (Mononuclear, Binuclear, Polynuclear), synthesis, bonding situation based on spectroscopic evidences; Theoretical rationalization of molecular structures, (close, nido, erachno), Synthesis. Characteristics and reactivity of derivatives of metal carbonyls (carbonylate anions, carbonyl hydrides and carbonyl halides); Metal nitrosyls including halonitrosyl and their derivatives.

PRACTICAL (CHEM 3052)

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 AgNO_3 using Fluorescein as indicator.

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

c) Determination of % composition of mixture of KI & KNO_3 using Eoscein as indicator.

5. Spectrophotometric determination of cerium.

6. Separation of heavy metals using solvent extraction technique.

Recommended Books:

1. J H Huheey, Inorganic Chemisry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (2008)
2. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
3. Chemical Bonds, and introduction to atomic and molecular structure by H.B. Gray 1973, W.A. Benjamin, Inc., London
4. Advanced Inorganic Chemistry F.A. Cotton and G.Wilkinson 6th Ed. 2001, Interscience, Publishers, London.
5. Coordination Compounds by S.F.A. Kettle, 1999, Nelson, (Nauohi Kenya).
6. Xu, R., Pang, W., Huo, Q., Modern Inorganic Synthetic Chemistry, 1st ed.,Elsevier, (2011).
7. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., Vogel's Quantitative Chemical Analysis, 6th ed., Prentice Hall, (2000).
8. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).
9. Housecraft, C. and Sharpe, A. G., Inorganic Chemistry, 4th ed., Prentice Hall, (2012).
10. Rodgers G. E., Descriptive Inorganic, Coordination, and Solid State Chemistry, 3rd ed., Brooks- Cole, (2012).

BS Chemistry 3rd Year
Semester-VI

Course Title: **Organic Chemistry-III**

Code: CHEM 3062 **Credit Hours: 04**

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 like nitration, sulphonation, halogenation, alkylation, acylation, formylation, caboxylation and nucleophilic substitutions, effect of substituents on orientation and reactivity.

Oxidation-reductions Reactions:

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

Pericyclic Reactions:

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

PRACTICAL(CHEM 3062)

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, 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-Wiley & Sons, Inc., New York, (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 Pearson Edu. (1986).

BS Chemistry 3rd Year
Semester-VI

Course Title:

Physical Chemistry-III

Code: CHEM 3072

Credit Hours: 04

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, Latimer Diagram, Frost Diagram, electrolytic cells, potentiometry, reference and indicator electrodes, 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 their industrial 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.

PRACTICALS CHEM 3072

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 Extraction method. Determination of molecular weight of a polymer by viscosity method. Determination of percentage composition of KMnO₄/ K₂Cr₂O₇ in a given solution by spectrophotometry. Evaluation of pK_a value of an indicator by spectrometric method. Conductometric determination of hydrolysis constant (K_h) of conjugate base of a weak acid.

Recommended Books:

1. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley & Sons, (2005).
2. Ball D. W., Physical Chemistry, Brooks/Cole Co. Inc., (2003).
3. Vertes, A., Nagy, S. and Klencsar, Z., Handbook of Nuclear Chemistry. Volume 1: Basics of Nuclear Science, 1st ed., Springer, (2003).
4. Choppin, G., Liljenzin, J. O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth-Heinemann, (2002).
5. Loveland, W., Morrisey, D. J. and Seaborg, G. T., Modern Nuclear Chemistry, John-Wiley & Sons, Inc., (2006).
6. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).
7. Somorjai, G. A. and Li, Y., Introduction to Surface Chemistry and Catalysis, 2nd ed., John-Wiley & Sons, Inc., (2010).
8. 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 Group Limited, New York, (1974).

BS Chemistry 3rd Year
Semester-VI

Course Title:

Applied Chemistry

Code: CHEM 3012

Credit Hours: 04

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 of equilibrium diagram, designing of distillation column, reflux ratio and its importance.

Composite Materials:

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

Practicals CHEM 3012

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. Silbey, R. J., Alberty, R. A. and Bawendi, M. G., Physical Chemistry, 4th ed., John-Wiley & Sons, (2005).
2. Ball D. W., Physical Chemistry, Brooks/Cole Co. Inc., (2003).
3. Vertes, A., Nagy, S. and Klencsar, Z., Handbook of Nuclear Chemistry. Volume 1: Basics of Nuclear Science, 1st ed., Springer, (2003).
4. Choppin, G., Liljenzin, J.- O. and Rydberg, J., Radiochemistry and Nuclear Chemistry, 3rd ed., Butterworth- Heinemann, (2002).
5. Loveland, W., Morrissey, 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 Group Limited, New York, (1974).

Recommended Books:

1. Erwin D. L., Industrial Chemical Process Design, McGraw-Hill, (2002).
2. Chawla, K. K., Composite Materials: Science and Engineering, 3rd ed., Springer, (2012).
3. Methews, F. L., Rawlings, R. D., Composite Materials: Engineering and Sciences, CRC Press, (2003).
4. Deborah, D. L., Composite Materials: Science and Applications, 2nd ed., Springer, (2010).
5. Gay, D. and Hoa, S. V., Composite Materials: Design and Applications, 2nd ed., CRC Press, LLC, (2007).
6. Kister, H., Distillation Operation, 1st ed., McGraw-Hill Professional, (1990).
7. Kister, H., Distillation Design, 1st ed., McGraw-Hill Professional, (1992).
8. Tchobanoglous, G., Burton, F. L. and Stensel, H. D., Wastewater Engineering: Treatment and Reuse, 4th ed., McGraw-Hill, (2003).
9. Callister, W. D. Jr., Materials Science and Engineering: An Introduction, 7th ed., John-Wiley & Sons, Inc., (2007).
10. Roussak, O. V. and Gesser, H. D., Applied Chemistry: A Textbook for Engineers and Technologists, 2nd ed., Springer, (2013).
11. Mizrahi, J., Developing an Industrial Chemical Process: An Integrated Approach, CRC Press, (2002).

BS Chemistry 3rd Year
Semester-VI

Course Title:

Biochemistry

Code: CHEM 3013

Credit Hours: 04

Course Objectives:

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

Course Contents:

Intermediary Metabolism and Bioenergetics:

Biological oxidation-Reduction including respiratory carriers, cell bioenergetics, Oxidative phosphorylation, free energy change and redox system.

Enzymes:

Enzyme-substrate interactions and nature of active site, mechanism of enzyme action with specific reference to chymotrypsin and ribonuclease, kinetics of single substrate reactions, enzyme inhibition, regulatory enzymes, Allosteric enzymes, Multienzyme system, zymogens, and isozymes, enzymatic control of metabolic pathways, immobilized enzymes, synthesis, properties and uses.

Metabolism of Carbohydrates:

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

Metabolism of Lipids:

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

Metabolism of Proteins:

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

Metabolism of Nucleic Acids:

Biosynthesis and catabolism of purines and pyrimidines and their regulation, synthesis, catabolism of nucleosides, DNA polymerases and other enzymes involves in metabolism.

Practical CHEM 3013

Separation of proteins by Electrophoresis.

Separation of Nucleic Acids by Electrophoresis.

Column chromatographic separations of protein Resolution.

Blood Glucose estimation, RFT, LFT, Lipid Profile, Cardiac Markers, Bone Markers, Pancreatic Markers, Anemia profile, Trace Elements, Urine CSF.

Immunochemical Techniques.

Determination of type of inhibition.

Determination of Michaelis constant in the presence and absence of inhibitors.

Recommended Books:

1. Voet, D. and Voet, J. D., Biochemistry, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
2. Nelson, D. L. and Cox, M. M., Lehninger's Principles of Biochemistry, 6th ed., Freeman, (2012).
3. Murray, R., Bender, D., Botham, K.M., Kennely, P. J., Rodwall, V. and Weil, P.A., Harper's Biochemistry, 29th ed., (2012).
4. Zubay, G. L., Biochemistry, 4th ed., illustrated. Publisher: WMC. Brown Publishers, (1998), digitized, (2008). ISBN: 0697219003. 9780697219008.
5. Guyton, A. C. & Hall, J. E., Guyton & Hall Text Book of Medical Physiology, 12th ed., Publishers: Saunders Elsevier, (2011).
6. Plummer, D.T., An Introduction to Practical Biochemistry, 3rd ed., TATA MCGraw-Hill Publishing Company LTD, (2010).
7. Sawhney, S. K. and Sing, R., Introductory Practical Biochemistry, 2nd ed., Narosa Publishing House, New Delhi, (2005).
8. Robert A. Copeland, Enzymes: A Practical Introduction to Structure, Mechanism, and Data analysis, 2nd ed., Publishers: John-Wiley & Sons, (2000) ISBN: 0-471-35929-7
9. R. C. Alkire, D. M. Kolb, J. Lipkowski, Biselectro chemistry, volume 13, 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
10. Nelson, D.L., Lehninger's Principles of Biochemistry, 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
11. Voet, D. and Voet, J.D., Biochemistry, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
12. Murray, R.M. and Harper, H.A., Harper's Biochemistry, 25th ed., Publisher: Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.

BS Chemistry 3rd Year
Semester-VI

Course Title:

Fuel Chemistry

Code: CHEM 3014

Credit Hours: 04

Course Objectives:

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

Course Contents:

Chemistry of fossil fuels:

Classification of fossil fuels. Origin of coal, petroleum and natural gas. Preliminary treatment of crude oil. Fractionation of crude oil. Properties of petroleum products i.e. CNG, LPG, gasoline, kerosene, dieselfuels and lubricating oils. Coal storage and cleaning. Carbonization of coal: Low temperature and high temperature carbonization, Coking and non-coking coals, Separation of tar from coke oven gas, Hydrogen sulfide removal from coke oven gas

Introduction to alternate sources of energy: Biomass as energy resources: Biogas technology. Alcohols: Alcohols and its uses as alternative fuel. Hydrogen: Hydrogen production, storage, handling and its uses as alternative fuel. Fuel Cells and its application, Solar Energy: Solar energy collectors. Nuclear fuels: fission and fusion, nuclear reactors and introduction to Hydel energy.

Practical CHEM 3014

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

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

Determination of Volatile matter of coal.

Determination of fixed carbon contents of coal.

Determination of hydrogen and nitrogen contents of the coal.

Determination of chlorine and oxygen in coal.

Determination of various forms of sulfur in coal.

Determination of specific and API gravity of petroleum fractions.

Estimation of carbon residue in petroleum products (Conradson method).

Determination of ash content in petroleum products.

Determination of sulfated ash in lube oil.

Estimation of water, sediments and oil in crude oil by centrifuge method.

Determination of cloud and pour point of Lube-oil.

Estimation of asphalt in road samples

Recommended Books:

1. Gyngell, E.S. Applied Chemistry for Engineers, Edward Arnold Publisher, Ltd. London. (1989).
2. Harker, J.H. and Backurst, J.R. Fuel and Energy, Academic Press, London and New York (1988).
3. Wilson, P.J. and Wells, J.H. Coal Coke and Coal Chemicals, McGraw-Hill Book Company, London, (1980).
4. Hobson, G.D. Modern Petroleum Technology, part-I. John Wiley & Sons, Toronto, (1984).
5. Goodger E.M. Alternative Fuels (chemical energy resources), The Macmillan press Ltd, London, (1980).
6. Twidell, J. and Weir, T. Renewable Energy Resources, Spon London, New York, (1986).
7. Matar, S. and Hatch, L.W. Chemistry of Petrochemical Processes, 2nd Ed. Gulf Publishing Company. Houston, Texas, USA (2002).

Outlines BS Chemistry Semester VII

Semester – VII		
Specialization (Inorganic/ Organic/ Physical/ Applied/ Analytical/ Bio–Chemistry) or any other subject depending upon the availability of Faculty		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
CHEM XXXX	Paper-I & Practical-I (3+1)	4
CHEM XXXX	Paper-II (3+0)	3
CHEM XXXX	Paper-IV (3+0)	3
CHEM 3041	Elective course- I (other than the field of specialization) (3+0)	3
CHEM4119R CHEM4119A CHEM4119P	Research thesis/ Research project Advanced Practical Position Paper (Literature Survey) (0+3)	3
	Total	16

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Inorganic Chemistry

Paper: I

Code: CHEM 4051

Cr.Hrs : 3+1

INORGANIC REACTION MECHANISM & PERIODICITY

Course Objective:

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

Course Contents:

Kinetics and Reaction Mechanisms of Coordination Compounds:

Reaction mechanisms and rate laws; inert and labile complexes; substitution reactions in octahedral complexes and square planar complexes, trans effect, Mechanism of electron transfer reactions including outer and inner sphere mechanisms.

Periodicity:

First and second row anomalies. The use of d-orbitals by non metals, reactivity and d-orbital participation, the use of p-orbitals in pi bonding, periodic anomalies of the non metals and post transition metals.

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).

Inorganic Chemistry Practical

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-hydroxyquinoline. 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 K_a 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 AgNO₃ 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).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Inorganic Chemistry

PAPER: II

Code: CHEM 4052

Cr.Hrs : 3

ORGANIC REAGENTS AND INORGANIC POLYMERS

Course Objective:

Student will acquire sound knowledge about organic reagents used in inorganic analysis and synthesis, properties and applications of inorganic polymers.

Course Contents:

Organic Reagents Used in Inorganic Analysis:

Classification of organic reagents, their selectivity and specificity, typical reagents used in complexometric titrations, chelates, their classification, stability, preparation and properties and role of organic reagents in different analytical techniques.

Inorganic Polymers:

Introduction to homoatomic and heteroatomic inorganic polymers, chains and cages of boron, silicon, nitrogen, phosphorous and sulphur, synthesis and applications.

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., McDaniel, 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).

BS Chemistry 4th Year
Semester-VII

Title of the Course : Inorganic Chemistry

PAPER: III

Code: CHEM 4053

Cr.Hrs : 3

INORGANIC ELECTRONIC SPECTROSCOPY

Course Objectives:

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

Course Contents:

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

Recommended Books:

1. Yarwood, J., Bazin, P., and Douthwaite, R., Spectroscopic Properties of Inorganic and Organometallic Compounds, Volume 42, The Royal Society of Chemistry, UK, (2011).
2. Lever, A.B.P., Inorganic Electronic Spectroscopy, 2nd ed., Elsevier, UK, (1984).
3. Brisdon, A. K., Inorganic Spectroscopic Methods, Oxford Uni.Press, UK, (1998).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Organic Chemistry

PAPER: I

Code: CHEM 4061

Cr.Hrs : 3+1

HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS

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. Clayden, 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).

Organic Chemistry Practical

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.

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Organic Chemistry

PAPER: II

Code: CHEM 4062

Cr. Hrs : 3

REACTIVE INTERMEDIATES

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&arynes, their generation, stability, reactions and synthetic applications. Chemistry of Enolates and Enols: Acidity of carbonyl compounds, enolization of carbonyl compounds, a-halogenation of carbonyl compounds; aldol-addition & 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 Chemistry 4th Year
Semester-VII**

Title of the Course: Organic Chemistry

PAPER: III

Code: CHEM 4063

Cr.Hrs : 3

ORGANIC SPECTROSCOPY

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.

¹H-NMR and ¹³C-NMR:

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

Mass Spectrometry:

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

Recommended Books:

1. Mohan, J., Organic Analytical Chemistry: Theory and Practice, 1st ed., Alpha Science Int. Ltd., (2003).
2. Kalsi, P. S., Spectroscopy of Organic Compounds, 6th ed., New Age International, New Delhi, India, (2007).
3. Yadav, L. D. S., Organic Spectroscopy, Springer, UK, (2005).
4. Kemp, W., Organic Spectroscopy, 3rd ed., W. H. Freeman & Company, New York, USA, (1991).
5. Younas, M., Organic Spectroscopy, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).
6. Hollas, J. M., Modern Spectroscopy, 4th ed., John-Wiley & Sons, Inc.,(2004).
7. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., Introduction to Spectroscopy, 4th ed., Brooks/Cole Cengage Learning, (2009).
8. Silverstein, R. M., Webster, F. X. and Kiemle, D., Spectrometric Identification of Organic Compounds, 7th ed., John-Wiley & Sons, Inc.,(2005).
9. Williams, D. H. and Flemming, I., Spectroscopic Methods in Organic Chemistry, 6th ed., McGraw-Hill Higher Education, (2008).
10. 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).
11. 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).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Physical Chemistry

PAPER: I

Code: CHEM 4071

Cr.Hrs : 3+1

ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS

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 Helmholtz Plane) and IHP (Inner Helmholtz 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, 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, 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, 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).

Physical Chemistry Practical

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 - $\text{K}_2\text{Cr}_2\text{O}_7$ 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).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Physical Chemistry

PAPER: II

Code: CHEM 4072

Cr.Hrs : 3

POLYMER CHEMISTRY

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, (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 Press (1953)

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Physical Chemistry

PAPER : III

Code: CHEM 4073

Cr.Hrs : 3

QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY

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 for particle in 1D and 3D box, 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, Huckel 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 Comp. (1996).
8. Straughan, B. P., and Walker, S., Spectroscopy, Vol. 1 & 2. Chapman and Hall Ltd., (1976).
9. Coulson C. A., Valence, Oxford University Press (1980).
10. Sathyanarayana, D. N., Vibrational Spectroscopy, Theory and Applications, New Age International Publishers (2004).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Applied Chemistry

PAPER: I

Code: CHEM 4041

Cr.Hrs : 3+1

COMMON INDUSTRIES-I

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 Management and Agro-Industrial Imperatives, Ibdc Publisher, (2005).
2. Covington, A. D., Tanning Chemistry: The Science of Leather, Royal Society of Chemistry, (2009).
3. Kent, J. A., Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/Plenum Publishers, (2003).

Applied Chemistry Practical

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. Reigel's Handbook of industrial chemistry. Von Norstand Reeinhold Co. N.Y.
2. Chemical Process Industries by Shreve and Dum. McGraw Hill.
3. An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.
4. Practical chemistry by O.P. Pandey , D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.
5. Concise Engineering Chemistry, Neetu Goel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, Delhi.).
7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBN0-07112721
8. Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.
9. 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.

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Applied Chemistry

PAPER: II

Code: CHEM 4042

Cr.Hrs : 3

AGRO BASED INDUSTRIES AND POLLUTION CONTROL

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 Warner, 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 Chemistry 4th Year
Semester-VII**

Title of the Course: Applied Chemistry

PAPER: III

Code: CHEM 4043

Cr.Hrs : 3

COMMON INDUSTRIES-II

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).

BS Chemistry 4th Year
Semester-VII

Title of the Course:

PAPER: I Analytical Chemistry

Code CHEM 4011

Cr. Hr. 3+1

ATOMIC SPECTROSCOPY

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).

Analytical Chemistry Practical

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

**BS Chemistry 4th Year
Semester-VII**

Title of the Course:

PAPER: II Analytical Chemistry

Code CHEM 4012

Cr. Hr. 3

ELECTROANALYTICAL TECHNIQUES

Course Objectives:

Students will acquire sound knowledge regarding the theoretical, instrumental as well as application related aspects of different electro analytical 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).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course:

PAPER: III Analytical Chemistry

Code CHEM 4013

Cr. Hr. 3

ADVANCED SEPARATION TECHNIQUES

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, 1 st 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, WileyVCH, (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., JohnWiley & 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., JohnWiley & Sons, Inc., (2005).
11. Camilleri, P., Capillary Electrophoresis: Theory and Practice, 2nd ed., CRC Press, (1998).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Bio-Chemistry

PAPER: I

Code CHEM 4031

Cr. Hr. 3+1

BIOMEDICAL CHEMISTRY

Course Objectives:

Students will acquire knowledge about the fundamental biochemical and molecular aspects of endocrinology and chemistry of blood and other Extra cellular 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:

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

Bio-Chemistry Practical

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.

Recommended Books:

1. Boyer, R., Modern Experimental Biochemistry, 3rd ed., Pearson Education Inc., (2009). ISBN: 978-81-7758-884-2.
2. Shankara, Y. M.S., Laboratory Manual for Practical Biochemistry, 1st ed., Jaypee Brothers Medical Publishers (P) Ltd., India, (2008). ISBN: 978-81-8448-259-1.

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Bio-Chemistry
Code CHEM 4032
MOLECULAR BIOLOGY

PAPER: II
Cr. Hr. 3

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.

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Bio-Chemistry

PAPER: III

Code CHEM 4033

Cr. Hr. 3

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 Macromolecules:

Homogenization, solubilization and concentration including ultrasonication, lyophilization and ultracentrifugation, 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 and applications.

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).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Fuel Chemistry

PAPER: I

Code CHEM 4081

Cr. Hr. 3+1

CHEMISTRY OF COAL CONVERSION

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. Probststein, 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).

Fuel Chemistry Practical

Determination of the electrical conductivity of aviation and distillate fuels, containing static dissipator additives. Determination of the total base number of 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 combustion of liquid hydrocarbon fuels. Determination of neutralization number of lubricating 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.

Recommended Books:

1. Speight, J. G Handbook of Petroleum Analysis Wiley-Interscience, (2002)

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Fuel Chemistry

Code CHEM 4082

PAPER: II

Cr. Hr. 3

PETROLEUM AND 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).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course: Fuel Chemistry

Code CHEM 4083

PAPER: III

Cr. Hr. 3

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, Aniline 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. Christion, G.D. Instrumental Analysis, Allyn and Bacon, Boston, London. (1986).

**BS Chemistry 4th Year
Semester-VII**

Title of the Course:

Research Thesis/ Research Project/ Advanced Practical/ Position Paper

Cr. Hr. 3

RESEARCH THESIS/ RESEARCH PROJECT

Code CHEM 4119R

Will be offered on the basis of availability of faculty, lab facilities, and research interest of the available faculty and their skills.

OR

ADVANCED PRACTICAL

Code CHEM 4119A

Will be offered on the basis of availability of faculty and their skills, and also availability of lab facilities. Advance level practicals will be carried out to give the students know-how about using the advance and latest instruments and to develop their interest toward the latest research in the field of chemistry.

OR

POSITION PAPER

Code CHEM 4119P

Will be offered on the basis of availability of faculty, and research interest of the available faculty and their skills. Topic will be awarded to the students to test their knowlge and to give know-how about research work and literature servay to develop their interest toward the latest research in the field of chemistry.

BS Chemistry Semester VIII

Semester - VIII		
Specialization (Inorganic/ Organic/ Physical/ Applied/ Analytical/ Bio-Chemistry or any other subject depending upon the availability of Faculty)		
Course Code	Course Title (Theory+Practical)	Cr. Hr.
CHEM XXXX	Paper - IV & Practical – II (3+1)	4
CHEM XXXX	Paper - V	3
CHEM XXXX	Paper - VI	3
CHEM 3081	Elective course - II (other than the field of specialization) (3+0)	3
CHEM4119R/A/P	Research project / Advanced practical / Position paper (write-up) (0+3)	3
	Total	16

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Inorganic Chemistry

Code CHEM 4054

PAPER: IV

Cr. Hr. 3+1

ORGANOMETALLICS & MAGNETOCHEMISTRY

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:

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 p-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.

Magnetochemistry:

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

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-Interscience, 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).

Inorganic Chemistry Practical

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., & Ezbiasky, 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.

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Inorganic Chemistry

PAPER: V

Code CHEM 4055

Cr. Hr. 3

STEREOCHEMISTRY IN MAIN GROUP COMPOUNDS AND BIO-INORGANIC CHEMISTRY

Course Objectives:

Students will acquire knowledge about stereochemical aspects and bonding of main group compounds along with the role of inorganic chemistry in biological systems.

Course Contents:

Stereochemistry and bonding in main group compounds:

Introduction, directed valence theory, three centre bond model, correlation diagram approach, some qualitative failures of the simple theories criticism and comparison of simple models, d-pi p-pi bonds.

Bio-Inorganic chemistry:

Energy sources for life, metalloporphyrins, photosynthesis and respiration, nitrogen fixation, the biochemistry of Iron essential and trace elements in biological systems, biochemistry of non metals, medicinal chemistry, organometallics in bio-inorganic chemistry.

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-Interscience, 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 Ltd, (2001).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Inorganic Chemistry

Code CHEM 4056

PAPER : VI

Cr. Hr. 3

RADIO AND NUCLEAR CHEMISTRY

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

**BS Chemistry 4th Year
Semester-VIII**

Title of the Course: Organic Chemistry

Code CHEM 4064

NATURAL PRODUCTS

Course Objectives:

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

Course Contents:

Alkaloids:

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

Terpenoids:

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

Steroids:

Study of cholesterol and steroidal hormones like testosterone, oestrone and progesterone with emphasis on their structure and biosynthesis.

Flavonoids:

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

Recommended Books:

1. Dewick, P. M., Medicinal Natural Products: A Biosynthetic Approach, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd., (2009).
2. Sell, C. S., A Fragrant Introduction to Terpenoid Chemistry, The Royal Society of Chemistry, UK, (2003).
3. De la Rosa, L. A., Parrilla, E. A. and Aguitar, G. A. G., Fruit and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability, Wiley-Blackwell, (2009).
4. Shahidi, F. and Naczki 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).

Organic Chemistry Practical

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).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Organic Chemistry

PAPER: V

Code CHEM 4065

Cr. Hr. 3

ORGANIC SYNTHESIS

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 retrosynthesis and disconnection approach, synthesis of aromatic compounds; one and two group carbon C-X disconnections, donor and acceptor synthons, C-C disconnections and 1,1-, 1,2-, 1,3-, 1,4-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 Chemistry 4th Year
Semester-VIII

Title of the Course: Organic Chemistry

Code CHEM 4066

PAPER: VI

Cr. Hr. 3

MEDICINAL CHEMISTRY

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. Vogeewari, 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)

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Physical Chemistry

Code CHEM 4074

REACTION DYNAMICS

PAPER: IV

Cr. Hr. 3+1

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, 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, 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).

Physical Chemistry Practical

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).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Physical Chemistry

Code CHEM 4075

PAPER: V

Cr. Hr. 3

RADIATION AND PHOTOCHEMISTRY

Course Objectives:

Students will learn about the mechanisms of radiation induced chemical changes in molecules, radiation dosimetry and applications of the radiation chemistry. They will also learn about radioactive decays, and how radio isotopes 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).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Physical Chemistry

PAPER: VI

Code CHEM 4076

Cr. Hr. 3

COLLOID AND SURFACE CHEMISTRY

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, physisorption 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. Kolunsi, 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 Chemistry 4th Year
Semester-VIII

Title of the Course: Applied Chemistry

PAPER: IV

Code CHEM 4044

Cr. Hr. 3+1

ORGANIC BASED INDUSTRIES

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).

Applied Chemistry Practical

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 from 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, Delhi.).
7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBN0-07-112721-6 Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.
8. Vogel's Textbook of Quantitative chemical analysis 6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Applied Chemistry

PAPER: V

Code CHEM 4045

Cr. Hr. 3

INDUSTRIAL PROCESSES

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., Auckland. 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. Cairns, 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).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Applied Chemistry

PAPER: VI

Code CHEM 4046

Cr. Hr. 3

METALLURGY AND EXPLOSIVES

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. Campbell, 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., Lijenzin, 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 Chemistry 4th Year

Semester-VIII

Title of the Course: Analytical Chemistry

PAPER: IV

Code CHEM 4014

Cr. Hr. 3+1

LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS

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).

Analytical Chemistry Practical

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).

Books Recommended (Theory)

1. Analytical Chemistry by Gary D. Christian; 6th ed. 2004; John Wiley & Sons, .

2. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M.

West, F. James Holler, Stanley R. Crouch; 8th ed. 2003; Saunders College Publishing, Philadelphia.

BS Chemistry 4th Year

Semester-VIII

Title of the Course: Analytical Chemistry

PAPER: V

Code CHEM 4015

Cr. Hr. 3

MOLECULAR ABSORPTION SPECTROSCOPY & MASS SPECTROMETERY

Course Objectives:

Students will acquire knowledge about different molecular absorption techniques including laser spectroscopy, nuclear magnetic resonance and mass spectrometry with special emphasis on theoretical and instrumental aspects along with their applications

Course Contents:

Laser Spectroscopy:

Principle of laser operation, stimulated emission population inversion, single and multilevel laser systems, properties of laser light and its general and analytical applications, ruby laser, nitrogen laser, laser dye, use of laser radiation in absorption and fluorescence spectroscopic methods.

Nuclear Magnetic Resonance Spectroscopy:

Basic principles, properties of nuclei, chemical shifts, spin-spin coupling, pulsed fourier transform NMR spectrometry, identification of structural features, use of NMR in imaging and analytical applications.

Mass-Spectrometry:

Principle of mass spectrometry, ionization acceleration, detection systems, advancements in the equipment, analytical uses of mass spectrometry, quadrupole mass analyzer, interpretation of mass spectra, correlation of the mass spectra and molecular structure.

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 Verlag Dr. Muller, (2010).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Analytical Chemistry

PAPER: VI

Code CHEM 4016

Cr. Hr. 3

FOOD AND DRUG ANALYSIS

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).
9. Jackson, A. R. W. and Jackson, J. M., Forensic Science, 2nd ed., Pearson Education, (2008).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry

PAPER: IV

Code CHEM 4034

Cr. Hr. 3+1

MICROBIOLOGY AND 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 IgE-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).

Bio-Chemistry Practical

- 1) Estimation of Na⁺ ions in blood, 2) Estimation of K⁺ ions in blood, 3) Determination of blood group of the patient, 4) Determination of serum aldolase in heart patient, 5) Determination of protease activity of bacterial enzymes, 6) Enzyme purification by ion-exchange chromatography 7) Synthesis of silver nanoparticles by using plant extracts, 8) Synthesis of nanoparticles and study of surface plasmon response by UV-Visible Spectrophotometry

Recommended Books:

- Sawhney, S. K. and Sing, R. Introductory Practical Biochemistry, 2nd ed., Narosa publishing House, New Delhi, (2005).
- Gosling, J. P. and Basso, L., Imunoassay: Laboratory Analysis and Clinical Application, 1st ed., CRC Press, (1994).
- Cameron, A. T. and White, F. D., A Course in Practical Biochemistry, J. and A. Churchill Limited, (2005).
- Shankara, Y. M. S., Practical Biochemistry, Jaypee Brothers Medical Pub., (2008).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry

PAPER: V

Code CHEM 4035

Cr. Hr. 3

BIONANOTECHNOLOGY

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 assembly of 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).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Bio-Chemistry

PAPER: VI

Code CHEM 4036

Cr. Hr. 3

NUTRITIONAL CHEMISTRY

Course Objectives:

Students will acquire knowledge about dietary components; energy needs based nutritional requirements of different age groups as well as their importance of minerals and vitamins.

Course Contents:

Major Dietary Constituents:

Nutritional importance of carbohydrates, proteins and amino acids, 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, Biotin and 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).
7. Nelson, D. L. and Cox, M. M., Lehninger's Principles of Biochemistry, 6th ed., W. H. Freeman, (2012).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Fuel chemistry

PAPER: IV

Code CHEM 4084

Cr. Hr. 3+1

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 & 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. Probst, 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).

Fuel Chemistry Practical

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 of diesel 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 for Testing and Materials, West Conshohockm, PA, USA

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Fuel chemistry

PAPER: V

Code CHEM 4085

Cr. Hr. 3

PETROLEUM AND 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.. 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).

BS Chemistry 4th Year
Semester-VIII

Title of the Course: Fuel chemistry

PAPER: VI

Code CHEM 4086

Cr. Hr. 3

ALTERNATE ENERGY RESOURCES

Course objectives:

This course will enable students to know about the challenging sources of alternate sources of energy. 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 traditional methods of alcohol production. Alcohols and its uses as alternative fuel.

Biofuels: Production of Bio-ethanol and biodiesel, uses of bio ethanol as supplement with petroleum 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. Gynge, 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, New York, (1986).

**BS Chemistry 4th Year
Semester-VIII**

Title of the Course:

Research Thesis/ Research Project/ Advanced Practical/ Position Paper

Cr. Hr. 3

RESEARCH THESIS/ RESEARCH PROJECT

Code CHEM 4119R

Will be offered on the basis of availability of faculty, lab facilities, and research interest of the available faculty and their skills.

OR

ADVANCED PRACTICAL

Code CHEM 4119A

Will be offered on the basis of availability of faculty and their skills, and also availability of lab facilities. Advance level practicals will be carried out to give the students know-how about using the advance and latest instruments and to develop their interest toward the latest research in the field of chemistry.

OR

POSITION PAPER

Code CHEM 4119P

Will be offered on the basis of availability of faculty, and research interest of the available faculty and their skills. Topic will be awarded to the students to test their knowlge and to give know-how about research work and literature servay to develop their interest toward the latest research in the field of chemistry.