

**CURRICULUM  
FOR UNDERGRADUATE PROGRAMS  
BS (4-YEAR)  
IN  
CHEMISTRY**

**Effective From Fall 2023**



**INSTITUTE OF CHEMICAL SCIENCES  
BAHAUDDIN ZAKRYIA UNIVERSITY MULTAN**

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## PREFACE

Curriculum design for undergraduate program is an essential and crucial component of educational advancement, particularly in the field of chemistry. The process of designing a curriculum involves a strategic, systematic, and diligent approach to develop educational contents to meet the academic and professional needs of students at national and international level. The Higher Education Commission is continually performing curriculum revision in collaboration with universities. According to the latest decision new Undergraduate Policy has been introduced since 2023 to meet the demands of latest advancements and technologies globally.

Therefore, a committee of experts at departmental level was constituted to develop a unified template of scheme of study to standardize chemistry degree program for Institute of Chemical Sciences and BZU Affiliated Colleges, thereby aligning the curriculum with international standards. The whole curriculum is designed to promote the interdisciplinary and collaborative approach across various fields of study.

The present scheme of study for each semester consists of all courses with contents in following categories (Undergraduate Policy 2023 available at HEC, Pakistan website) and will be offered by Institute of Chemical Sciences and BZU Affiliated Colleges for Chemistry:

1. General Education Courses
2. Interdisciplinary Courses
3. Disciplinary/ Major Courses

The present proposed curriculum emphasizes the development of critical thinking and problem-solving skills, creating an environment in which students are encouraged to question, analyze, and apply their knowledge to real-world situation. This not only enhances their scientific approach but also promotes a sense of curiosity and a passion for continuous learning.

The curriculum is designed to be dynamic and adaptable, allowing for continuous updates and improvements in response to new scientific innovations and technological advancements. The curriculum will be regularly reviewed and revised in response to input from students, teachers, industrialists, and subject experts/ professionals to make sure it remains effective, needful, and innovative under the guidelines of Higher Education Commission of Pakistan and Bahauddin Zakaryia University Multan, Pakistan.

The development of this curriculum (comprises of Major, General, Interdisciplinary Courses for Chemistry undergraduates) has been a collaborative effort involving contributions from a diverse group of chemistry and interdisciplinary experts. Their collective expertise and insights have been crucial in developing a curriculum that is both comprehensive and innovative. We extend our gratitude to all those who have participated in this process and have shared their knowledge, perspectives, and expertise.

The final draft prepared by Committee is duly approved, is being circulated (also available at ICS home page) for implementation in the Institute of Chemical Sciences and concerned BZU Affiliated Colleges for Chemistry for undergraduates with effect from Fall 2023.

**Prof. Dr. Muhammad Najam ul Haq**  
**Director, ICS**

## INTRODUCTION

A. The Final meeting of Chemistry was held at Institute of Chemical Sciences on July 10, 2024. This Meeting was a follow up of the previous meetings held on March 15, 2024 at Institute of Chemical Sciences, BZU Multan. The following attended the meetings.

1. Professor Dr. Muhammad Naeem Ashiq	Convener
2. Dr. Saadat Majeed (Associate Professor, ICS)	Member/Secretary
3. Dr. Adeel Hussain Chughtai (Associate Professor, ICS)	Member
4. Dr. Naseem Abass (Associate Professor, ICS)	Member
5. Dr. Muhammad Ali (Assistant Professor, ICS)	Member
6. Dr. Muhammad Sajid (Assistant Professor, ICS)	Member
7. Dr. Fahmida Jabeen (Assistant Professor, ICS)	Member

The meeting on 15<sup>th</sup> March 2024, started with recitation of a few verses from the Holy Quran by Dr. Muhammad Sajid Hussain. The meeting was chaired by Prof. Dr. Muhammad Naeem Ashiq convener Curriculum Committee. The Member briefed the participants about the overall structure of template / framework of Undergraduate Policy-2023 being introduced by HEC in Basic/ Natural Sciences for four year Bachelor Degree Program and ADS (5<sup>th</sup> Semester). He emphasized the participants to revise / finalize the curriculum for Undergraduate program in Chemistry in the light of the approved template in three categories General Education Courses, Interdisciplinary Courses, Disciplinary/ Major Courses. He pointed out to follow guidelines of Director ICS, Deans' office so as to fulfill the needs of the students, faculty and industry, and also to include the fundamentals of creativity, independent skilled based learning and problem solving approach.

The following agenda items were studied thoroughly and were discussed in detail:

1. Development of Scheme of Studies for Undergraduate program in Chemistry according to new policy.
2. Assignment of task to prepare course of contents according to specializations.
3. To collect the course contents for General Education Courses, Interdisciplinary Courses categories from various departments
4. To finalize the course contents prepared in each three categories (Disciplinary/Major, General, Interdisciplinary)
5. To assign Course Codes to all courses in each three categories semester wise.

**It was decided that the Convener will coordinate with the other departments by the help of Director, ICS for general education and interdisciplinary courses. The course contents for all categories will be edited by Dr Saadat Majeed to convert in approved unified template. After structuring the contents each member will proof read the contents according to the Specialization/ Division. Prof. Dr Naeem Ashiq will proof the final prepared/ approved course outlines which will be than presented to the next meeting to be held at an appropriate time and date for approval of these courses. The meeting was concluded with the closing remarks of thanks by Prof. Dr Naeem Ashiq.**

**B. The Final meeting for Curricula development took place on 10 July 2024 at 10 am. The course outlines prepared by the divisions were reviewed, finalized and**

approved by the Committee. Following components were also discussed and elaborated. Final Version of course contents is detailed below:

- a. **Requirement of Curricula:** The primary objective of the present revised/ designed curriculum according is to promote the student success which is envisioned as the ability to comprehend and apply conceptual knowledge, acquire professional skills and competencies, and act as an individual having strong civic and ethical values of tolerance and inclusiveness. **(HEC Undergraduate Policy 2023)**
- b. **Curricula Consideration:** During the designing and revision of the Chemistry Curricula two major guidelines have been considered **(UG Policy HEC, Pakistan and Dean of Science's Office)**. However, in some cases the main focus of these guidelines is mostly combination of traditional and advanced Chemistry contents to recognize the students with Chemical Sciences and affiliated fields.
- c. **Internship:** The students must be provided with 6-8 weeks (3Cr.H) internship opportunity from 4<sup>th</sup> semester to 8<sup>th</sup> Semester any time preferably during summer break for filed experience in any teaching/ research institution / company/ industry/ field/ hospital/ laboratory etc. The internship report must be submitted as directed by the Director Institute announced by Institute examination office. The report will be graded by a faculty member in collaboration with the supervisor in the field. This is a mandatory degree award requirement of 3 credit hours for undergraduate program. **(HEC Undergraduate Policy 2023)**
- d. **Capstone Project:** A capstone project is multifaceted body of work that serves as a culminating academic and intellectual experience for students. A capstone project allows students to bring together the concepts, principles and methods that they have learned in their course of study and to apply their knowledge and acquired competencies to address the real world problems. The capstone project (preferably undertaken after the sixth semester) will be supervised and graded by a faculty member as per the protocols prescribed by the Institute of Chemical Science. This is a mandatory degree award requirement of 3 credit hours for undergraduate degree program. **(HEC Undergraduate Policy 2023)** The capstone project must have following aspects.
  - **The capstone project should focus and cover the Sustainable Development Goals (SDGs).** <https://sdgs.un.org/goals>
  - **The student will select specific SDGs that align with chemistry and will incorporate sustainability in terms of environmental, economic, and social impacts.**
  - **The students must engage him/ her during project execution with other disciplines and stakeholders, including environmental scientists, policy makers, and industry partners, to ensure a holistic approach and broader impact.**
  - **At the end of project students must build link to contribute meaningfully to the global quest of sustainable development through presentation, report and/or publication, as well as outreach to relevant stakeholders to promote the adoption of sustainable practices.**

**THE FOLLOWING SCHEME OF STUDIES WAS DULY APPROVED BY ICS AND VARIOUS BODIES**

**Scheme of Studies (Course Outline) for Undergraduate Chemistry 2023**

<b>1<sup>st</sup> Semester</b>			
<b>S No</b>	<b>Course Title</b>	<b>Course Codes</b>	<b>Credit Hours</b>
1	Quantitative Reasoning-I	QANR-100	3
2	Functional English <i>(Science Faculty Dean's Office Course Contents)</i>	ENGL-100	3
3	Applications of Information and Communication Technologies (ICT) <i>(Science Faculty Dean's Office Course Contents)</i>	AICT-100	2+1
4	Islamic Studies ** (OR) Religious Education/Ethics in lieu of Islamic Studies (only for non-Muslim students) <i>(Science Faculty Dean's Office Course Contents)</i>	ISLS-100/ETHC-100	2
5	Inorganic Chemistry	CHEM-151	3+1
6	Translation of Holy Quran-1/ Ethics-I	ARAB-151/ETHC-151	0
	<b>Sub. Total</b>		<b>15</b>

<b>2<sup>nd</sup> Semester</b>			
<b>S No</b>	<b>Course Title</b>	<b>Course Codes</b>	<b>Credit Hours</b>
1	Quantitative Reasoning-II	QANR-101	3
2	Expository Writing <i>(Science Faculty Dean's Office Course Contents)</i>	ENGL-101	3
3	Ideology and Constitution of Pakistan	IDCP-100	2
4	Art & Humanities	XXXX*-101	2
5	Biochemistry	BCHM-131	2
6	Bioanalytical Techniques	BATS-111	2+1
7	Translation of Holy Quran-II/Ethics-II	ARAB-152/ETHC-152	0
	<b>Sub. Total</b>		<b>15</b>

<b>3<sup>rd</sup> Semester</b>			
<b>S No</b>	<b>Course Title</b>	<b>Course Codes</b>	<b>Credit Hours</b>
1	Physical Chemistry	CHEM-271	3+1
2	Organic Chemistry	CHEM-261	3+1
3	Natural Science	NASC-221	2+1
4	Civics and Community Engagement	CCES-201	2
5	Material Science/Everyday Science/Forensic Science	MTSC-251/EVSC-251/FRSC-251	2
6	Translation of Holy Quran-III/ Ethics-III	ARAB-251/ETHC-251	0
	<b>Sub. Total</b>		<b>15</b>

<b>4<sup>th</sup> Semester</b>			
<b>S No</b>	<b>Course Title</b>	<b>Course Codes</b>	<b>Credit Hours</b>
1	Physical Chemistry	CHEM-272	2
2	Analytical Chemistry	CHEM-212	2
3	Organic Chemistry	CHEM-262	2
4	Environmental Science	ENSC-241	2
5	Fundamental of Physics/Fundamental of Biology/Biotechnology/Microbiology	PHYS-200/BIOL-200 /BTCH-200/MICB-200	3
6	Social Science	XXXX*-200	2
7	Entrepreneurship	MNGT-200	2
8	Translation of Holy Quran-IV/ Ethics-IV	ARAB-252/ETHC-252	0
	<b>Sub. Total</b>		<b>15</b>
	<b>TOTAL</b>		<b>60</b>

<b>5<sup>th</sup> Semester</b>			
<b>S No</b>	<b>Course Title</b>	<b>Course Codes</b>	<b>Credit Hours</b>
1	Analytical Chemistry	CHEM-311	3+1
2	Inorganic Chemistry	CHEM-351	3+1
3	Organic Chemistry	CHEM-361	3+1

4	Physical Chemistry	CHEM-371	3+1
5	Translation of Holy Quran-V/ Ethics-V	ARAB-351/ETHC-351	0

#### 6<sup>th</sup> Semester

S No	Course Title	Course Codes	Credit Hours
1	Applied Chemistry	CHEM-321	3+1
2	Inorganic Chemistry	CHEM-352	3+1
3	Organic Chemistry	CHEM-362	3+1
4	Physical Chemistry	CHEM-372	3+1
5	Translation of Holy Quran-VI/ Ethics-VI	ARAB-352/ETHC-352	0

#### 7<sup>th</sup> Semester

S No	Course Title	Course Codes	Credit Hours
1	Major-I	CHEM-4X1-I	3
2	Major-II	CHEM-4X1-II	3
3	Major-III	CHEM-4X1-III	3
4	Minor-I	CHEM-4X1-I	3
5	Laboratory	CHEM-4X1-IV	2
6	Translation of Holy Quran-VII/ Ethics-VII	ARAB-451/ETHC-451	0

#### 8<sup>th</sup> Semester

S No	Course Title	Course Codes	Credit Hours
1	Major-I	CHEM-4X2-I	3
2	Major-II	CHEM-4X2-II	3
3	Major-III	CHEM-4X2-III	3
4	Minor-I	CHEM-4X2-I	3
5	Laboratory	CHEM-4X2-IV	2
6	Translation of Holy Quran-VIII/ Ethics-VIII	ARAB-452/ETHC-452	0
	Sub. Total		118
	Field Experience/Internship (open for 5 <sup>th</sup> to 8 <sup>th</sup> semester)	ICHM-500	3
	Capstone Project (open for 5 <sup>th</sup> to 8 <sup>th</sup> semester)	PCHM-500	3
	TOTAL		124

\* XXXX-100, for Arts & Humanities any course from list may be offered, XXXX-100 will be taken as

\* XXXX-200 for Social Sciences any course from list may be offered, XXXX-200 will be taken as

Note: For ADS (2-Year) Program course outline up to first four Semesters will be followed.

In Semesters VII & VIII, the field of specialization will be Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Analytical Chemistry and Applied Chemistry depending upon the availability of teaching faculty.

Any future changes/ amendments in the scheme and courses of reading will be incorporated by the approval of respective bodies.

List of Arts & Humanities Courses : *Fine Arts (FA-100), Economics (ECON-100), Philosophy (Phil-100), Sociology (Soci-100)*

List of Social Sciences Courses : Public Administration (PADM-200), Journalism(JOUR-200), Introduction to Mass Communication (MCOM-200), Law and Legislature (LALA-200), Education (EDU-200), History (HIS-200), International Relations (IR-200)

THE FOLLOWING SCHEME OF STUDIES IS DULY APPROVED FROM INSTITUTE OF CHEMICAL SCIENCES AND VARIOUS BODIES OF BZU, MULTAN  
Scheme of Studies (Course Outline) for BS 4 YEAR PROGRAMM IN Chemistry Fall 2023 and Onwards

## Scheme of Studies (Course Outline)

### BS 1<sup>st</sup>Year

#### Semester-I

**Course Title:** INORGANIC CHEMISTRY-I

**Code:** CHEM-151

**Credit Hours:** 3+1

**Marks**

**100**

#### Course Objectives:

Students will acquire knowledge about basic as well as in orbital approach chemical bonding, ionic solids, acid-base chemistry and functioning of indicator.

#### Course Content:

##### Chemical Bonding: Covalent Bonding: Orbitals

The localized electron model and hybrid orbital, the molecular orbital model, Linear combination of atomic orbitals and application approach on heteroatomic molecules/ions like CO, NO, NO<sup>+</sup>, NO<sup>-</sup>, CN<sup>-</sup>, Hybridization approach to find out electron pair and molecular geometry of molecules like XeF<sub>2</sub>, XeF<sub>4</sub>, XeF<sub>6</sub>, SF<sub>4</sub>, SF<sub>6</sub>, IF<sub>3</sub>, IF<sub>5</sub>, IF<sub>7</sub>

##### Acid Base Concepts:

Acid-Base concepts i.e Arrhenius, Lowry-Bronsted, Lewis, Soft and hard acids and bases (SHAB), Lux-Flood, Usanovich Concept, Common ion effect, Application of common ion effect in salt analysis, Buffer Solution and solubility.

##### Theories of Indicators:

Ostwald's and Quinonoid theories of indicators to explain functioning of phenolphthalein, methyl orange etc.

##### p-Block Elements:

Physical and chemical properties of p-block elements with emphasis on some representative compounds such as Boric Acid, Alums, Carbides, Silicates, Nitric Acid, orthophosphoric acid, Sulfuric Acid, inter-halogens, pseudo-halogens and Polyhalides.

##### CHEM-151 Lab.

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD), disposal of chemical waste and first-aid practices.

1. Qualitative analysis of inorganic salt (one acidic & one basic radical).

2. Quantitative analysis.

Acid-base titrations

Redox titrations

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

##### Recommended Books:

**Note: Updated version of following reference books may be consulted from library or available online.**

- Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, 6th ed., John-Wiley &

- Sons, New York, (2007).
- Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity*, 3rd ed., Harper International SI Edition, (2006).
  - House, J. E., *Inorganic Chemistry*, Academic Press. USA, (2008).
  - Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Chapman and Hall, (1996).
  - Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3rd ed., Pearson Education, India, (2008).
  - Huheey, J. E., Keiter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Benjamin-Cummings Pub Co., (1993).
  - Sharpe, A. G., *Inorganic chemistry*, 3rd ed., Pearson Education India, (1981).
  - G.S. Sodhi, "Principle of Inorganic Chemistry" 1<sup>st</sup> edition 2013. R.L.Madan, *Inorganic Chemistry*, 2010
  - Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi KitabKhana, Lahore, (2013).
  - Catherine E. House crdft, Alan G. Sharpe, *Inorganic Chemistry*, 3rd ed., Prentice Hall, (2008).
  - Kathleen A. H., James E. H., *Descriptive Inorganic Chemistry*, 2nd ed., Brooks Cole, (2010).
  - Wulfsberg G., *Principles of Descriptive Inorganic Chemistry*, 1st ed., University Science Books, (1991).
  - G.D. Tuli, *Advanced Inorganic Chemistry, Volume I*, 2014,
  - Mala Nath, *Inorganic Chemistry-A laboratory Manual*, 2016.
  - 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).
  - Svehla, G., *Vogel's Qualitative Inorganic Analysis*, 7th ed., (7th imp.), Pearson Education, Ltd., (2009).

## BS 2<sup>nd</sup> Year

### Semester-III

**Course Title:** PHYSICAL CHEMISTRY-I

**Code:** CHEM-271

**Credit** 3 +1

**Marks**

**100**

**Hours:**

**Course Objectives:**

Students will learn about thermodynamics, state of matters and different phenomena of solution chemistry.

#### **Course Content:**

**Chemical Thermodynamics:** Introduction to thermodynamics, Three laws of thermodynamics (Zeroth, first and second law) and their applications, Entropy, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes, spontaneous and non-spontaneous processes, relationship of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation and its applications, Clausius Clapeyron equation

**States of Matters:** Introduction to physical states of matter, Physical properties of liquids, intermolecular forces, surface tension, viscosity, refractive index, dipole moment etc. and their applications, Properties of gases, Kinetic theory of gases, Equation of state, Ideal and Non-ideal gases, Vander Waal's equation and its relationship with critical phenomenon, derivation of kinetic equation, Properties of Solids, Crystal structure, Bragg's Law, X-ray diffraction and its application

**Solution Chemistry:** Introduction to solutions, Types of solution, concentration units (percentage solution, mole fraction, molarity, normality, molality, ppm and their interconversion), Solute-solvent

interaction, Ideal and non-ideal solutions, Raoult's law and its applications, Colligative Properties (lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure) and their applications, abnormal colligative properties.

#### **CHEM-271 Lab.**

1. Laboratory security, safety and preparation
2. Determination of surface tension, viscosity and refractive index of liquids.
3. Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
4. Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
5. Determination of molecular weight of polymer by viscosity method.
6. Determination of heat of solution by solubility and calorimetric methods.
7. Determination of heat of neutralization of an acid with a based

#### **Recommended Books:**

- *McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1st ed., University Science Books, (1997).*
- *Atkins, P. and Paula, J.D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).*
- *Shoemaker, D., Experiments in Physical Chemistry, 8th ed., McGraw Hill Publishing Company Limited, (2003).*
- *Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).*
- *Glasstone, S., Textbook of Physical Chemistry, Macmillan London (1960).*
- *James, A. M., Prichard, F. E., Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York, (1974).*
- *Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi Kitab Khana, Lahore, (2013).*
- *Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5th ed., W. H. Freeman, New York, (2010).*
- *Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Pvt. Ltd., (2011).* 10.  
*Davis, W. M., Dykstra, C. E., Physical Chemistry: A Modern Introduction, 2 nd ed., CRC Press, (2011).*

### **BS 2<sup>nd</sup> Year**

#### **Semester-III**

**Course Title:** ORGANIC CHEMISTRY -I

**Code:** CHEM-261

**Credit Hours:** 3+1

**Marks**

**100**

#### **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:

Chemical 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 Functional Groups:

Introduction and general reactions and properties of Saturated hydrocarbons, unsaturated

hydrocarbons, aromatic hydrocarbons, alcohols, phenols, ethers, amines, aldehydes, ketones and carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydride.

CHEM-261 Lab.

Qualitative analysis of compounds with different functional groups like Carboxylic acids, Phenols, Amines, Anilines, Carbohydrates, Carbonyl Compounds, Hydrocarbons, Amides, Esters and use of purification techniques like sublimation, reflux, distillation, filtration, recrystallization.

Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility

**Recommended Books:**

- *Brown, W. and Poon, T., Introduction to Organic Chemistry, 3rd ed., John- Wiley & Sons, Inc., (2005). 16*
- *John, E. M. Organic Chemistry, 8 th ed., Brooks/Cole Publishing Co, USA,(2012).*
- *Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).*
- *Younus, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006). 5. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, 6th ed., Pearson Education Limited, England, (1986).*
- *Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John- Wiley & Sons, Inc., (2011).*
- *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).*
- *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).*
- *Mayo, D. W., Pike, R. M. and Forbes, D. C., Microscale Organic to Laboratory with Multistep and Multi-sacle Syntheses, 5 th ed., John-Wiley & Sons, Inc.,(2011).*
- *Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale and Microscale Approach, 5 th ed., Brooks/ Cole Cengage Learning, (2010).*
- *Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6 th ed., Brooks/ Cole Cengage Learning, (2012).*

**BS 2<sup>nd</sup> Year**

**Semester-IV**

**Course Title: PHYSICAL CHEMISTRY-II**

**Code: CHEM-272**

**Credit Hours: 2**

**Marks**

**100**

**Course Objectives:**

Students will gain knowledge about the chemical kinetics, rates of reactions, Rate laws and various phenomena about photochemical decomposition.

**Course Content:**

**Chemical Kinetics:**

Introduction to chemical kinetics, The rates of reactions, Rate law, Molecularity and order of reaction, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, determination of order of reaction (integration, half-life, initial rate, and graphical methods), Simultaneous reactions, Opposing reactions, Consecutive reactions, Parallel or side reactions, effect of temperature on reaction rate, Theories of reaction rate (Arrhenius theory, Collision theory, Transition state theory), Unimolecular and bimolecular reactions, Photochemical reactions, Kinetics of photochemical reactions (formation of HBr, HCl, HI), Photochemical decomposition of chloroform, acetaldehyde, kinetics of thermal decomposition of acetaldehyde

**Chemical Equilibrium:**

General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van't Hoff equation, Le-Chatelier's principle, 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, vapor-liquid equilibrium of binary liquid mixtures, binary phase diagrams and lever rule

**Recommended Books:**

- *Atkins, P. and Paula, J.D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).*
- *Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4th ed., (2005).*
- *Glasstone, S., Textbook of Physical Chemistry, Macmillan London (1960).*
- *Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Pvt. Ltd., (2011)*
- *Noor, A., Chemical Kinetics, University Grant Commission (1983)*
- *Laidler K.J. "The World of Physical Chemistry" 1st ed., Oxford University Press (1993).*
- *Laidler K.J., John H.M. and Bryan C.S. "Physical Chemistry" 4th ed., Houghton Mifflin Publishing Company Inc.(2003).*
- *Barrow G.M. "Physical Chemistry" 5th ed., McGraw Hill (1992).*

**BS 2<sup>nd</sup> Year**

**Semester-IV**

**Course Title:**

**ANALYTICAL CHEMISTRY -I**

**Code:**

**CHEM-212**

**Credit Hours:**

**2**

**Marks**

**100**

**Course Objectives:**

Students will acquire knowledge about sampling and their handling, standards, good laboratory practices, quality control and quality assurance. In addition they will learn and develop understanding about the chemical equilibria and gravimetry.

**Course Content:**

**Introduction to Analytical Chemistry**

Analytical chemistry, Quantitative and qualitative analysis, Non-destructive analysis, Analytical process, Calibration (Calibration standards, reference standards, S/N ratio, ), Trace and Ultra trace analysis

**Sampling and Sample Preparations Techniques**

Different types of samples (solids, liquids/solutions, gaseous/volatile), Representative sample (gross and analytical sample), Minimization of contamination and interferences, Physical techniques (grinding and milling, sieving and particle size reduction), Chemical techniques (wet digestion methods, microwave digestion and acid extraction), Dry ashing and combustion, Solvent extraction techniques, Automation in sample preparation, Sample storage

**Approach to Equilibrium**

General concepts (Types, Activity and activity coefficient, Systematic treatment of equilibria), Acid-base equilibria (Acid-base theories, pH scale), Complexation equilibria (Complex mixtures, complex ion formation), Precipitation equilibria (Solubility product,  $K_{sp}$  and activity coefficients, Factors affecting precipitation), Gravimetric analysis (Selective precipitation techniques, Filtration techniques)

**Good Laboratory Practice: Quality Assurance and Validation**

Definitions, Seven tools for quality control, The concept of quality assurance, Quality control, Quality Assurance, Validations, Six sigma and ISO standards, Introduction to Process Analytical Technology, Quality Risk Management

**Recommended Books:**

- J. M. Andrade-Garda, *Problems of Instrumental Analytical Chemistry, Essential Textbooks in Chemistry*. 2017, ISBN: 978-1-78634-181-5. <https://doi.org/10.1142/q0053>
- G. D. Christian, *Analytical Chemistry, 7<sup>th</sup> Edition*, Wiley, 2020, ISBN 9781119770817
- D. C. Harris, *Quantitative Chemical Analysis, 9<sup>th</sup> Edition*, Freeman Custom Publishing, New York, NY, 2016
- D. A. Skoog, *Fundamentals of Analytical Chemistry, 9<sup>th</sup> Edition*, Singapore: Cengage Learning, 2014.
- D. S. Hage, *Analytical chemistry and quantitative analysis*, Prentice Hall, Boston, 2011, ISBN 9780321705518

**BS 2<sup>nd</sup> Year****Semester-IV****Course Title: ORGANIC CHEMISTRY-II****Code: CHEM-262****Credit Hours: 2****Marks****100****Course Objectives:**

Students will gain knowledge about the stereo-chemical behavior of organic molecules and 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 Content:****Stereochemistry:**

Introduction, classification, optical activity, chirality and symmetry elements, relative and absolute configuration, R,S notation, method of determining configuration, racemic mixtures and their resolution, asymmetric synthesis, optical activity in biphenyls, allenes and spiro compounds, stereospecific and stereoselective reactions; geometrical isomers and methods of determination of their configuration, E/Z notation and *cis trans* isomerism in cyclic systems; conformational isomers, conformational analysis of open chain system, substituted cyclohexanes and decalin systems.

**Aromatic Heterocycles:**

Introduction; nomenclature; structure and aromaticity, occurrence of heterocyclic compounds, basicity and acidity of the nitrogen heterocycles; chemistry of furan, pyrrole and thiophene; synthesis of indoles and isoindoles; chemistry of pyridine, quinoline and isoquinoline.

**Recommended Books:**

- Norman, R. O.C. and Coxon, J. M., "*Principles of Organic Synthesis*", Nelson Thornes, Cheltenham.
- Rinehart Jr., K. L., "*Oxidation and Reduction of Organic Compounds*", Prentice-Hall, London.
- Loudon, G. M., "*Organic Chemistry*", Oxford University Press, New York.
- Smith, M. B., "*Organic Synthesis*", McGraw-Hill, New York.
- March, J., "*Advanced Organic Chemistry*", John Wiley & Sons, New York.
- Sykes, P., "*A Guide Book to Mechanism in Organic Chemistry*", Longman, London.
- Clayden, J., Greeves, N., Warren, S. and Wothers, P., "*Organic Chemistry*", Oxford University Press, New York.
- Carey, F. A. and Sundberg, R. J. "*Advanced Organic Chemistry Part B: Reactions and Synthesis*", Plenum Press, New York.
- Morrison, R. T. and Boyd, R. N., "*Organic Chemistry*", Prentice-Hall of India, New Delhi.

- Bansal, R. K., "Heterocyclic Chemistry", Wiley Eastern Ltd., New Delhi.
- I.L. Finar Vol. I Organic Chemistry

### BS 3<sup>rd</sup> Year

#### Semester-V

**Course Title:** ANALYTICAL CHEMISTRY

**Code:** CHEM-311

**Credit Hours:** 3+1

**Marks** 100

#### Course Objectives:

This course aims to provide a comprehensive understanding of the principles, applications, and implications of nanotechnology, nanomaterials, and green chemistry. By the end of the course, students will have acquired theoretical knowledge and practical skills to harness nanotechnology and nanomaterials in sustainable and environmentally conscious ways.

#### Course Content:

##### Nanoscience and Nanotechnology:

Introduction to Nanotechnology, Classification of nanomaterials and examples

**Physical Methods of Nanofabrication:** Inert gas condensation, Arc discharge, RF- plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy (MBE), Chemical vapor deposition (CVD) method, Template assisted synthesis, Catalyst assisted chemical vapor deposition (CCVD), patterning and self-assembly, Etching

**Chemical Methods of Nanofabrication:** Chemical precipitation and co-precipitation, Sol-Gel synthesis; Microemulsions synthesis, Hydrothermal synthesis, Solvothermal synthesis, Microwave assisted synthesis; Sonochemical assisted synthesis, Core-Shell nanostructures, Organic-Inorganic hybrid nanocomposites, Quantum dots

**Properties of Nanomaterials:** (i) Size effect of nanomaterials: Size, shape, density, melting point, wettability and specific surface area; (ii) Mechanical behavior: Stress – strain behaviour, tensile strength, microhardness, wear resistance, and corrosion resistance behavior; (iii) Thermal properties: Thermal conductivity, thermal expansion; (iv) Electrical properties: Electrical conductivity, band gap tuning - band gap determination; (v) Dielectric properties: Dielectric constant and its significance – Piezo electric and ferro electric materials and their behaviour and applications; (vi) Magnetic properties: Magnetic hysteresis – Superparamagnetism; (viii) Optical properties: Photoconductivity, Electroluminescence, Photoluminescence

**Nano-measurements and Characterization Tools:** Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy, Transmission Electron Microscopy, Atomic Force Microscopy, X-ray Photoelectron Spectroscopy, X-ray Diffraction

#### Applications of Nanotechnology in Analytical Chemistry

##### Green Analytical Chemistry

Introduction to Atom Economy, fundamentals of green chemistry, Sustainable Development Goals (SDGs), Alternative solvents/energy efficiency, Catalysis/biocatalysis, Abiotic depletion of elements, Biomimetic, Multifunctional reagents, Combinatorial green chemistry, Proliferation of solventless reactions; co crystal controlled solid state synthesis, Biodegradation, Introduction to Toxicology, Designing safer chemicals, Metrics (E-factor and PMI), Environmental Laws/Policies and Regulations, Real world Green Chemistry solutions: selected examples

##### CHEM-311 Lab.

- Synthesis of Manganese Dioxide nanoparticle by co-precipitation method.
- Synthesis of Nano-Calcium Oxide from waste eggshell by sol-gel method.
- Green synthesis of Iron Oxide nanoparticles from orange peel extract.
- Synthesis of Zinc Oxide nanoparticles by Sol Gel method.
- Synthesis of Magnesium Oxide nanoparticles by Sol Gel method.
- Biogenic synthesis of Silver nanoparticles.
- Biogenic synthesis of Aluminum Oxide nanoparticles.
- Synthesis of Chromium Oxide nanoparticles by precipitation method.
- Simultaneous Potentiometric Determinations of Ions (Cations and Anions).
- Titrations of a strong acid against a strong base by conductometry.
- Titrations of a strong acid against a strong base by potentiometric.
- Potentiometric determination of  $K_1$ ,  $K_2$ ,  $K_3$  for  $H_3PO_4$ .
- Determination of heavy metals in biological samples.
- Determination of moisture and ash contents of animal feed.
- Determination of organic matter in soil.

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

**Recommended Books:**

- WM Breck., *Nanotechnology*. CBS Publishers and Distribution.
- 2. Schmid., *Nanotechnology Assessment and Perspective*. Springer.
- 3. Geoffrey A Ozin and Andre C Arsenault., *Nanochemistry, A Chemical Approach to Nanomaterials*. RSC Publishing.
- 4. Parg Diwan. *Hand book of Nanotechnology*. Pentagon Press.
- 5. K. Vinod K, *Green Chemistry Introduction, Application and Scope*, 1<sup>st</sup> Edition, Springer Singapore, 2022, <https://doi.org/10.1007/978-981-19-2734-8>

### BS 3<sup>rd</sup> Year

**Semester-V**

**Course Title: INORGANIC CHEMISTRY-II**

**Code: CHEM-351**

**Credit Hours: 3+1**

**Marks**

**100**

**Course Objectives:**

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

**Course Content:**

**Periodic Anomalies and Bonding in Electron Deficient Compound:**

First and second row anomalies; the use of d-orbital by non-metals; reactivity and d-orbital participation:  $p\pi-d\pi$  bonds; the use of p-orbitals in p-bonding: periodic anomalies of non- metals and post-transition metals. Multicenter bonding in electron deficient molecules, three center two electron bond (3c-2e) and three-center, four-electron (3c-4e) bond model.

**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.

### **CHEM-351 Lab**

#### **1. Preparations of Coordinated Complexes;**

- i. Tetraamminecopper (II) sulphate.
- ii. Potassium trioxalatochromate (III).
- iii. Potassium trioxalatoaluminate (III).
- iv. Cis-Potassium dioxalato diaquachromate (III)
- v. Trans-Potassium dioxalato diaquachromate (III)
- vi. Potassium trioxalato ferrate (III)

#### **2. Preparations of Alum/Double/Simple Salts**

- i. Synthesis of Potassium Chromium Alum
- ii. Synthesis of Potassium aluminium alum
- iii. Preparation of Mohr's Salt
- iv. Preparation of Microcosmic salt
- v. Preparation of Ammonium alum

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

#### **Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Housecraft, C. and Sharpe, A. G., *Inorganic Chemistry*, 4th ed., Prentice Hall, (2012).
- Miessler, G. L. and Tarr, D.A., *Inorganic Chemistry*, 4th ed., Pearson-Prentice Hall International, (2010).
- Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons, New York, (1994).
- Shriver, D. and Atkins, P., *Inorganic Chemistry*, 5th ed., W. H. Freeman & Company, (2010).
- Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Blackwell Science Ltd., (1996).
- Atkins, P. and Jones, L., *Chemicals Principles*, 5th ed., W. H. Freeman & Company, (2010).
- Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Interscience, (1999).
- Svehla, G., *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*, 5th ed., Longman Group Limited, (1979).
- Huheey, J. E., Keiter, E. A. and Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Prentice Hall, (1997).
- Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods*, 2nd ed., Chapman and Hall (1974).
- Mala Nath, *Inorganic Chemistry-A laboratory Manual*, 2016.

## BS 3<sup>rd</sup> Year

### Semester-V

Course Title: **ORGANIC CHEMISTRY-III**

Code: **CHEM-361**

Credit Hours: **3+1**

Marks **100**

### Course Objectives:

The primary objective of this course is to provide undergraduate students with a comprehensive understanding of aliphatic and aromatic substitution reactions. Students will develop a deep conceptual framework to analyze the mechanisms, factors affecting reactivity, stereochemical outcomes, and practical applications of these reactions in organic chemistry.

### Course Content:

**Aliphatic Substitution Reaction at Saturated Carbon:** SN1, SN2, SNi, SN1', SN2', SNi'-Mechanism, Factors affecting aliphatic nucleophilic substitution and structural variation of substrate, Nucleophile, Nucleophile and Solvent, Stereochemistry and substitution, Conjugate Substitution reactions, Neighboring group participation.. Aliphatic Electrophilic substitution reactions at saturated Carbon: SE1, SE2 (front) SE2(back), SEi mechanisms. Factors affecting substitution reactions, effect of substrate structures, effect of leaving group, effect of attacking group and effect of medium.

**Aromatic Substitution Reactions:** Aromaticity: Aromatic, non-aromatic, anti-aromatic and heterocyclic aromatic system, Mechanisms of electrophilic substitution; orientation and reactivity; electrophilic substitution reactions i.e. nitration, halogenation, sulphonation, Friedel-Craft's reaction, diazocoupling, formylation and carboxylation; Nucleophilic substitution reactions i.e. SNAR, SN1 and benzyne mechanism, factors affecting substitution reactions, effect of substrate structures, leaving group, attacking group and solvent.

### CHEM-361 Lab.

Quantitative & Qualitative analysis of organic compounds with different mono and difunctional, functional groups like carboxylic Acids, Phenols, Amines, Anilines, Carbohydrates, Carbonyl Compounds, Hydrocarbons, Amides, Esters.

Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility

### Recommended Books:

- *Eliel, E. L., Wilen, S. H. and Doyle, M. P., "Basic Organic Stereochemistry", Wiley-Interscience, New York.*
- *Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.*
- *March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.*
- *Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.*
- *Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham. McMurry J. Organic Chemistry*
- *Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.*
- *L.G. Wade JR. Organic Chemistry*
- *IL. Finar Vol. I Organic Chemistry*
- *IL. Finar Vol. II Organic Chemis*

## BS 3<sup>rd</sup> Year

### Semester-V

Course Title: **PHYSICAL CHEMISTRY-III**

Code: **CHEM-371**

Credit Hours: **3+1**

Marks **100**

### Course Objectives:

This course aims to equip undergraduate students with foundational concepts and tools in quantum chemistry and the chemical applications of symmetry and group theory. The focus is on understanding the principles underlying atomic and molecular behavior, applying quantum mechanical models, and leveraging symmetry to explain molecular properties and interactions.

### Course Content:

**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 eigenvalues, Hamiltonian operator, Schrödinger wave equation, wavefunctions for hydrogen-like atomic orbitals, radial distribution functions, shielding and penetration, effective nuclear charge, orbital energies, periodic trends in the properties of the elements in the periodic table.

**Chemical Application of Symmetry and Group Theory:** Symmetry elements and operations, Classification of molecules in point groups, Introduction to group theory, Symmetry of atomic orbitals, Character table, Reduction of reducible representations, Applications

### CHEM-371 Lab.

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

### Recommended Books:

- *Silbey, R. J., Alberty, R. A., and Bawendi, M. G., Physical Chemistry, 4 th ed., John-Wiley & Sons, (2005).*
- *McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1st ed., University Science Books, (1997).*
- *Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).*
- *Moore. W. J., Physical Chemistry, 4 th ed., Longman Publisher (1972).*
- *Coulson C. A., Vanlence, Oxford University Press (1980).*
- *Keeler. J. and Wothers, P., Chemical Structure and Reactivity: An Integrated Approach, 1 st ed., Oxford University Press, (2008).*
- *Helpern, A. M., Experimental Physical Chemistry: A Laboratory Textbook 2 nd ed., Prentice Hall, (1997).*
- *Garland, C. W., Nibler, J. W. and Shoemaker, D., P., Experiments in Physical Chemistry, 8 th ed., McGraw-Hill, (2003).*
- *Born, Max., Atomic Physics, 8 th ed., Blackie & Son Ltd., (1969).* 10. *Atkins, P., Jones,*

L., *Chemical Principles: The Quest for Insight*, 5th ed., W. H. Freeman, New York, (2010). 27 11. James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3rd ed., Longman Group Limited, New York, (1974).

- Cotton F. A. "Chemical Application of Group Theory" Interscience Publishers (1963)
- Lowell Hall H. "Group Theory and Symmetry in Chemistry" McGraw-Hill Book Company London (1969)

### BS 3<sup>rd</sup> Year

#### Semester-VI

**Course Title: FUNDAMENTALS OF APPLIED CHEMISTRY**

**Code: CHEM-321**

**Credit Hours: 3+1**

**Marks**

**100**

#### **Course Objectives:**

The objectives of the course are to educate the students about production of various heavy chemicals in industry. They will also become able to understand Water Treatment, Steam Production and Scale Removal.

#### **Course Content:**

Chemical Industries

Introduction, Physical and Chemical properties, Cost evaluations, Commercial production and Applications of heavy chemicals such as sulfuric acid, nitric acid, hydrochloric acid, caustic soda, washing soda and milk of lime.

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

#### **CHEM-321 Lab.**

1. Determination of hardness in water
2. Determination of acidity in water
3. Determination of alkalinity in water
4. Determination of total dissolved solids in water
5. Determination of Ca and Mg in water
6. Determination of chlorides in water
7. Determination of fluorides in water
8. Determination of nitrates in water
9. Determination of sulphate in water
10. Determination of oils and fats in given sample of contaminated water
11. Determination of nitrates in water
12. Determination of sulphate in water
13. Determination of chemical oxygen demand (COD) in water
14. Determination of biological oxygen demand (BOD) in water

#### **Recommended Books**

- Kent, J. A., *Riegel's Handbook of Industrial Chemistry*, 10<sup>th</sup> ed., Kluwer Academic/ Plenum Publishers, (2003).
- George T. Auston., *Shreve's Chemical Process Industries*, 5<sup>th</sup> Edition., McGraw Hill Book Company Inc. New York (1984).
- P.C. Jain., *A Textbook of Applied Chemistry* (1987).
- Furnas, C. C., *Industrial Chemistry, Vol-II 6th Ed.*, D. VanNostrand Company, Inc. Princeton New Jersey, New York (1957).
- Hede, P. D., Bier. S.P., *Inorganic and Applied Chemistry*, Ventus publishing app.,

- (2007).
- Sharma, J., Ndi., *Applied Industrial Chemistry*, Arise publishers & Distributors, (2012).
  - Erwin D. L., *Industrial Chemical Process Design*, McGraw-Hill, (2002).
  - Manahan, S. E., *Fundamentals of Environmental Chemistry*, 2<sup>nd</sup> ed., CRC Press, (2001).
  - Prakash, N. B., *Applied Chemistry Lab Manual*, LAP Lambert Academic Publishing, (2013).
  - Vermani, O. P., *Applied Chemistry : Theory And Practice*, 2<sup>nd</sup> ed., New Age International, (2006).
  - Goostray. S and Schwenck. R. J., *Experiments in Applied Chemistry*, Collier-Macmillan, (1966).

### BS 3<sup>rd</sup> Year

#### Semester-VI

**Course Title:** INORGANIC CHEMISTRY-III

**Code:** CHEM-352

**Credit Hours:** 3+1

**Marks**

**100**

#### Course Objectives:

Students will acquire knowledge about various types of inorganic materials, their structure, synthesis, characterization and non-aqueous solvents.

#### Course Content:

##### 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.

##### Non-Aqueous Solvents:

Classification of solvents, types of reaction in solvents, effect of physical and chemical properties of solvent, detail study of liquid NH<sub>3</sub>, liquid HF, liquid SO<sub>2</sub>.

#### CHEM-352 Lab

Qualitative and quantitative analysis metal ions

Preparations of metal (lanthanides-available) complexes

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

#### Recommended Books:

**Note: Updated version of following reference books may be consulted from library or available online.**

- A.K. Holliday and A.G Massey, "Inorganic Chemistry in Non Aqueous Solvents" pergamon press, New York, 1990.
- Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3<sup>rd</sup> ed., John-Wiley & Sons, New York, (1994).
- Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4<sup>th</sup> ed., Prentice Hall, (1997).
- Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2<sup>nd</sup> ed., Oxford University Press, (1994).
- Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., *Advanced Inorganic Chemistry*, 6<sup>th</sup> ed., Wiley-Interscience, (1999).

- *Atkins, P. and Jones, L., Chemicals Principles: The Quest for Insight, 5 th ed., W. H. Freeman, (2010).*
- *Crabtree, R. H., The Organometallic Chemistry of the Transition Metals, 5th ed., John-Wiley and Sons, New Jersey, (2011).*
- *Yamamoto, A., Organotransition Metal Chemistry, Prentice Hall, (1992).*

### BS 3<sup>rd</sup> Year

#### Semester-VI

**Course Title: ORGANIC CHEMISTRY-IV**

**Code: CHEM-362**

**Credit Hours: 3+1**

**Marks**

**100**

#### Course Objectives:

Students will acquire knowledge and understanding about Elimination reaction, their types, reactivity with special emphasizing on stereochemistry. Students will acquire knowledge regarding Addition reactions and Chemistry of Enols and Enolates including some name reactions.

#### Course Content:

**Addition Reactions:** Introduction, mechanisms, orientation and stereochemistry of addition of halogens and hydrogen halides to C=C; electrophilic addition to conjugated dienes; nucleophilic addition to C=C and C=C-C=O linkage; Structure and reactivity of C=O group; simple nucleophilic addition reactions to C=O i.e. addition of water, alcohol, hydrogen cyanide, bisulphate, addition of derivatives of ammonia; stereoselectivity in carbonyl addition reactions. Enolization of carbonyl compounds; addition of enolate ions and Grignard reagents; aldol condensation; Mixed aldol condensation; stereo- and diastereoselectivity in aldol condensations; other aldol type condensations, condensation reactions of esters, active methylenes and their synthetic application; Acid catalyzed condensation: Mechanism, limitation, scope of acid catalyzed condensation, Mannich reaction and its applications.

**Elimination Reactions:** Study of E1, E1cB and E2 mechanisms; orientation: Saytzeff and Hofmann rules; structure and reactivity: the effects of substrate structure, attacking base, leaving group and the reaction medium on the rates and mechanisms of elimination reactions; elimination vs substitution.

#### CHEM-362 Lab.

Qualitative analysis of mixtures of organic compounds with mono and difunctional groups like carboxylic Acids, Phenols, Amines, Anilines, Carbohydrates, Carbonyl Compounds, Hydrocarbons, Amides, Esters

Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility

#### Recommended Books:

- *Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.*
- *Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University Press, New York.*
- *Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.*
- *March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.*
- *Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.*
- *Carey, F. A., "Organic Chemistry", McGraw-Hill, New York.*
- *Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi*

## BS 3<sup>rd</sup> Year

### Semester-VI

Course Title: PHYSICAL CHEMISTRY-IV

Code: CHEM-372

Credit Hours: 3+1

Marks

100

### 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.

### Course Content:

#### Electrochemistry

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

#### Surface Chemistry

Interfaces, Gibbs surface excess, curved surfaces, capillary action, adsorption and adsorption isotherms, Freundlich, BET, D-R, Temkin and Langmuir adsorption isotherms and their applications, Adsorption kinetics and thermodynamics, 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, beta decay systematic.

### CHEM-372 Lab.

1. Conductometric titrations
2. Adsorption Isotherms, Adsorption kinetic and thermodynamics
3. Spectroscopic determination of Cu percentage in the given sample.
4. Conductometric determination of Cu (II)- EDTA mole ratio in the complex.
5. To determine the effectiveness of an extraction of I<sub>2</sub> solution by using Solvent Extraction method.
6. Determination of molecular weight of a polymer by viscosity method.
7. Determination of percentage composition of KMnO<sub>4</sub>/ K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in a given solution by spectrophotometry.
8. Conductometric determination of hydrolysis constant (K<sub>h</sub>) of conjugate base of a weak acid.

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

### Recommended Books:

- *Silbey, R. J., Alberty, R. A., and Bawendi, M. G., Physical Chemistry, 4 th ed., John-Wiley & Sons, (2005).*
- *McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1st*

- ed., *University Science Books*, (1997).
- Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry*, 9th ed., Oxford University Press, (2010).
  - Moore. W. J., *Physical Chemistry*, 4 th ed., Longman Publisher (1972).
  - Coulson C. A., Vanlence, Oxford University Press (1980).
  - Keeler. J. and Wothers, P., *Chemical Structure and Reactivity: An Integrated Approach*, 1 st ed., Oxford University Press, (2008).
  - Helpert, A. M., *Experimental Physical Chemistry: A Laboratory Textbook* 2 nd ed., Prentice Hall, (1997).
  - Garland, C. W., Nibler, J. W. and Shoemaker, D., P., *Experiments in Physical Chemistry*, 8 th ed., McGraw-Hill, (2003).
  - Born, Max., *Atomic Physics*, 8 th ed., Blackie & Son Ltd., (1969). 10. Atkins, P., Jones, L., *Chemical Principles: The Quest for Insight*, 5th ed., W. H. Freeman, New York, (2010). 27 11. James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3 rd ed., Longman Group Limited, New York, (1974).
  - Cotton F. A. "Chemical Application of Group Theory" Interscience Publishers (1963)
  - Lowell Hall H. "Group Theory and Symmetry in Chemistry" McGraw-Hill Book Company London (1969)

## ANALYTICAL CHEMISTRY

**Semester-VII**

**Course Title: Atomic Spectroscopic Techniques**

**Code: CHEM-411-I**

**Credit Hours: 03**

**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 Content:**

### **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 (radiation sources, atomic reservoirs, monochromators, detectors), applications of atomic fluorescence spectrometry, Interferences, merits, and limitations.

Atomic Absorption Spectroscopy (AAS)

**Fundamentals:** Basic principle (absorption of free atoms, atomic line widths, resonance line), concentration dependence of absorption, quantitative methodology

**Instrumentation:** Radiation sources (hollow cathode lamp (HCL), electrodeless discharge lamp (EDL)), spectral interferences, background correction with a continuum source, background correction by the Zeeman effect and Smith-Hieftje method; Atomizers (i) flames (burners, nebulizers, micro-sampling boat, Delves cup system, STAT, FIA, atomization in flames, nebulization, vaporization, chemical reactions, gas phase and spatial distribution interferences, their elimination and control), (ii) electrothermal atomizers (electrographite, pyrolytic graphite, tungsten) graphite furnaces (WETA, platform technique, graphite probe), electrothermal atomization, mechanisms and interferences, (iii) cold vapor mercury system, monochromators, detectors (Photomultiplier Tubes, Charge-Coupled Devices (CCDs), sample handling in AAS (preparation of the sample, use of organic solvents, microwave, digestion, effect of organic solvents, matrix modifiers, generation of volatile hydrides.

Atomic Emission Spectroscopy (AES)

Introduction to emission spectrum, flame atomic emission spectroscopy (FAES) ; flame as an excitation source, instrumentation: burner assembly, wavelength selection devices (monochromators, filters), interferences, AES 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 (hyphenation, interface, requirements, variation from ICP-AES).

**Atomic Spectroscopy Techniques in Practice:** Elemental analysis in environmental samples, air quality monitoring, and quality control in industrial manufacturing processes, geological and geochemical analysis, speciation analysis.

**Emerging Trends:** Introduction to Laser-Induced Breakdown Spectroscopy (LIBS), miniaturization and portable instruments, Field-deployable atomic spectroscopy devices, Point-of-Care applications in healthcare, advances in detection limits and sensitivity, nanotechnology and surface-enhanced techniques in AES/AAS.

**Recommended Books:**

- *Atomic and Molecular Spectroscopy Basic Concepts and Applications, Cambridge University, Publisher: 2015, <https://doi.org/10.1017/CBO9781107479999.013>*
- *R. García Atomic and Molecular Spectroscopy, Excelic Press, 9781642242751, 2020*

- S. Svanberg, *Atomic and Molecular Spectroscopy, Basic Aspects and Practical Applications*, Springer Cham, 2023. <https://doi.org/10.1007/978-3-031-04776-3>
- B. Welz, *Atomic Absorption Spectrometry*, WILEY-VCH Verlag GmbH, 1999, 10.1002/9783527611690
- J. W. Robinson, *Atomic Emission Spectroscopy, Instrumental Analytical Chemistry, 1st Edition*, CRC Press 2021

## Semester-VII

**Course Title: ELECTROANALYTICAL TECHNIQUES**

**Code: CHEM-411-II**

**Credit Hours: 03**

### Course Objectives:

Students will acquire sound knowledge regarding the theoretical, instrumental as well as application related aspects of different electroanalytical techniques. The course aims to provide in-depth theoretical and practical insights into modern electroanalytic techniques. The course also aims to develop the students' ability to independently select and optimize appropriate electroanalytical methods and to provide a coherent overview of the subject.

### Course Content:

**Potentiometry:** Potentiometric techniques, redox potentials, Nernst equation, junction potential, reference electrodes (SHE, calomel, Ag/AgCl electrode), metallic indicator electrodes, ion selective electrodes (ISE) (membrane potentials, selectivity of membrane, glass ion selective electrode, solid state ISE, liquid-based ISE, gas sensing electrode, potentiometric biosensors, quantitative applications (activity and concentration determination, pH measurement)

**Electrodeposition/Electrogravimetry:** Introduction, over potential processes of deposition, electro-gravimetric methods, instrumentation for constant current methods, spontaneous electrolysis, applications

**Coulometry:** Principle, coulometric titrations, instrumentations, applications and limitations

**Voltammetry:** Voltammetric measurement (voltammetric cell, mercury electrodes; DME, HDME, SDME, solid electrodes), influence of mass transport on the faradaic current, voltammograms, voltammetric techniques; polarography (half wave potential, polarographic analysis, Ilkovic equation, pulse methods (differential pulse, normal pulse, square wave, stair case), hydrodynamic voltammetry, stripping voltammetry (anode/cathode) cyclic voltammetry, single and multicomponent analysis.

**Amperometry:** Introduction, mercury thin-film electrode (MTFE), amperometric sensors (Clark sensors for dissolved O<sub>2</sub> in blood, glucose sensors)

**Electrochemical Sensors:** Sensors, types of electrochemical sensors, conductometric sensors, component of electrochemical sensors, working, advantages and limitations, biosensors, working of electrochemical biosensors, electrocatalysis, photocatalysis, Lab-on-a-chip

### Recommended Books:

- F. Scholz, *Electroanalytical Methods: Guide to Experiments and Applications*, Springer, 2009
- V. S. Bagotsky, *Fundamentals of Electrochemistry*, John Wiley & Sons, Inc. 2006, ISBN:9780471700586
- A. J. Bard *Electrochemical Methods: Fundamentals and Applications, 3rd Edition*, John Wiley & Sons, Inc. 2022, ISBN: 1119334063

## Semester-VII

**Course Title:** ANALYTICAL CHEMISTRY

**Code:** CHEM-411-III

**Credit Hours:** 03

### Course Objectives:

Students will acquire knowledge about different spectroscopic techniques with special emphasis on the theoretical, instrumental and applications.

### Course Content:

**UV-Visible Spectroscopy: Fundamentals:** Electronic transitions and theory, chromophores, auxochrome and conjugation, Beer-Lambert Law and deviation; photometric errors, **Instrumentation:** Light sources, monochromator and their efficiency, single beam and double beam instrument, diode array detector, sample cuvette **Quantitative/Qualitative Methodology:** Solution preparation and choice of solvent, quantitation wavelength, derivative spectrometry, quantitative measurements in multi-component systems.

Micro-volume, Nano-volume, and handheld UV/VIS Spectrometers

**Infrared Spectroscopy: Fundamentals:** Molecular vibrations, dipole moments, vibration of diatomic, polyatomic molecules, criteria for IR absorption, selection rules, forbidden transitions.

**Instrumentation:** Light sources, IR laser sources, optical systems (monochromators, interferometer components), detectors (bolometer, thermocouple, thermistor, pyroelectric, photon detectors), dispersive IR, Fourier-Transform (FT) spectrometers, ATR-FTIR, FTIR microscopy. **IR Spectra and Interpretation:** Sample preparation techniques for different IR instruments, functional group analysis, spectral features, factors affecting IR spectrum.

**NIR Spectroscopy Instrumentation:** NIR vibrational Bands, spectral interpretation, sampling techniques (liquids and solutions, solids, gases) **Raman Spectroscopy:** Principles, Instrumentation (Light Sources, FT-Raman Spectrometers, Fiber-Optic-Based Modular and handheld systems, Surface-Enhanced Raman Spectroscopy (SERS))

**Nuclear Magnetic Resonance Spectroscopy: Fundamentals:** Basic Principles, quantization of  $^1\text{H}$  nuclei in a magnetic field, nuclei shielding, chemical shifts, spin-spin coupling, signal splitting, **NMR Spectrometers:** Sample holder, sample probe, magnet, RF generation, detection, signal integrator, sample preparation, Spectra and Interpretations **Hyphenation:** NMR imaging and MRI, Time domain NMR

**Mass Spectrometry: Fundamentals:** Principles, resolving power and resolution of a MS, **Instrumentation:** Sample input systems (Gas expansion, direct insertion, direct exposure probes, chromatographic and electrophoretic setup); ionization sources (Electron Ionization (EI), Chemical Ionization (CI), Atmospheric Pressure Ionization Sources (API), Desorption Ionization); mass analyzers (Magnetic and Electric Sector, Time-of-Flight (TOF), Quadrupole Mass Analyzer, Quadrupole Ion Trap, Fourier Transform Ion-Cyclotron Resonance (FT-ICR), Orbitrap; detectors (Electron Multiplier, Faraday Cup Array Detectors), Ion Mobility Spectrometry

### Recommended Books:

- R. SanMartin, M. T. Herrero, "Structure Determination By Spectroscopic Methods A Practical Approach" 1st Edition, 2020, CRC Press, <https://doi.org/10.1201/9781351032506>
- Jürgen H Gross, "Mass Spectrometry, A Textbook" #rd Edition, 2018, Springer Cham, <https://doi.org/10.1007/978-3-319-54398-7>
- Yadav, L.D.S. (2005). Ultraviolet (UV) and Visible Spectroscopy. In: Organic Spectroscopy. Springer, Dordrecht. [https://doi.org/10.1007/978-1-4020-2575-4\\_2](https://doi.org/10.1007/978-1-4020-2575-4_2)
- Workman Jr., Concise Handbook of Analytical Spectroscopy, The: Theory, Applications And Reference Materials, Illustrated Edition, 2016, World Scientific Publishing

Company

## Semester-VII

**Course Title:** ADVANCE ANALYTICAL LAB-I

**Code:** CHEM-411-IV

**Credit Hours:** 03

### Course Objectives:

An introduction to the fundamentals of instrumental chemical analysis is presented in a laboratory environment, with emphasis on selection of appropriate analytical techniques, sample treatment, data handling, and communication of experimental results. Instrumental techniques include

Classical analytical techniques, chromatography, spectrophotometry, and electrochemistry with applications in different biological, environmental and clinical samples

### Course Content:

A study of characteristics infrared absorption frequencies

Experimental design and multiplexed modeling using titrimetry and spreadsheets

Charge density quantification of polyelectrolyte polysaccharides by conductometric titration

Investigation of Cu(II) binding to bovine serum albumin by potentiometry with an ion selective electrode

Microscale determination of vitamin C by weight titrimetry

Determination of free lime in clinker and cement by iodometry

Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry

Develop colorimetric assay of tabletop sweeteners using a modified Biuret reagent

Determination of phosphorus in Cola drinks

Spectrophotometric determination of Fe in water sample using standard addition method

Determination of nicotine in tobacco (non-aqueous titration).

Determine unsaturation in different brands of cooking oil by observing C  $\Rightarrow$  C stretching frequency using IR absorption spectrum.

Simultaneous determination of l-phenylephrine (PEH) and chlorpheniramine maleate (PAM) in nasal spray by UV spectroscopy.

Caffeine serial dilution and analysis using (UV-vis) spectroscopy

To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample calorimetrically

Determination of acetyl salicylic acid in aspirin tablets.

Infrared Determination of a Mixture of Xylene.

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

### Recommended Books: (Font 15, Arial, Bold, Justify Align Left)

- E. H. Evans., M. E. Foulkes, "Analytical Chemistry: A Practical Approach", 2019, Oxford University Press.
- G. D. Christian, "Analytical Chemistry," 7th Edition, John Wiley and Sons Inc, Hoboken
- N. Singla, N. Kaur, "Practical Manual of Analytical Chemistry" 2<sup>nd</sup> Edition, 2023, PharmaMed Press

## APPLIED CHEMISTRY

**Semester-VII**

**Course Title: AGRO BASED INDUSTRIES AND POLLUTION CONTROL**

**Code: CHEM-421-I**

**Credit Hours: 3**

**Course Objectives:**

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

**Course Content:**

### **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. Applications of nanofertilizers

### **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:**

- 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).
- Lister, J. and Ennis, B., *The Science and Engineering of Granulation Processes*, Kluwer Academic Publishers, (2004).
- Park, M., *The Fertilizer Industry*, Woodhead Publishing Limited, (2001).
- Anastas, P. T. and Warner, J. C., *Green Chemistry: Theory and Practice*, Oxford University Press, (2000).
- Kumar, A., *Industrial Pollution: Problems and Solution*, Daya Publishing House, India, (2006).
- Kent, J. A., *Riegel's Handbook of Industrial Chemistry*, 10th ed., Kluwer Academic/Plenum Publishers, (2003).

**Semester-VII**

**Course Title: APPLIED FLUID MECHANICS**

**Code: CHEM-421-II**

**Credit Hours: 3**

**Marks**

**100**

**Course Objectives:**

The successful completion of this course will help in understanding the nature of fluid statics, hydrostatic forces, and elementary fluid dynamics especially for incompressible

flows using Bernoulli equation in particular. Models for Inviscid and viscous fluid flow. To apprehend the applications/solutions of models developed in the advanced course in industrial applications using analytical as well as numerical methods.

**Course Content:**

**Chapter 1.** Introductory Concepts – Dimensions, units, fluid mass and weight, Compressibility, vapor pressure, viscosity, surface tension Fluid Statics –Pressure, hydrostatic force on plane and curved surface, Manometers, Plane and inclined manometers, Buoyancy and Archimedes Principle Elementary Fluid Dynamics – Stream lines, Bernoulli's Equation along the streamline and across the streamline, Application of Bernoulli's Equation, Static, stagnation and total Pressure and pitot tube, Hydraulic grade line and energy grade line, Assumption of Bernoulli's equation

**Chapter No 2.** Fluid Kinematics –Velocity field, acceleration field, control volume, Material Derivative, Reynolds's transport theorem, Finite Control Volume Analysis – Conservation of Mass for a Control Volume, Derivation and application of linear momentum equation, Derivation and application of momentum of momentum equation, Derivation and application of energy equation, Comparison of equations, Differential Analysis of Fluid Flow – Overview of types of motion and deformation a fluid element, Differential form of continuity equation, The stream functions, Deriving the equations of motion

**Chapter 3.** Dimensional Analysis, Similitude, and Modeling-Dimensional Analysis, Buckingham Pi Theorem, Compressors and Pumps

**Recommended Books:**

- *Holland FA, Bragg R 1995, Fluid Flow for Chemical Engineers, 2nd Edition, Edward Arnold.*
- *Darby R 2001, Chemical Engineering Fluid Mechanics, Marcel Dekker.*
- *Gerhart PM, Gross RJ, Hochstein JI 1992, Fundamentals of Fluid Mechanics, 2nd Edition, Addison-Wesley.*
- *Hydraulics and Fluid Mechanics Including Hydraulic Machines P.N. Modi.*
- *Vectors, Tensors and the Basic Equations of Fluid Mechanics Rutherford Aris.*
- *An Introduction to Fluid Dynamics G.K. Batchelor.*
- *Viscous Flow (MCGRAW HILL SERIES IN MECHANICAL ENGINEERING) by Frederick S. Sherman*

**Semester-VII**

**Course Title: MOLECULAR SPECTROSCOPY AND PHARMACEUTICAL INDUSTRY**

**Code: CHEM-421-III**

**Credit Hours: 3**

**Marks**

**100**

**Course Objectives:**

In this course, students will acquire knowledge about Pharmaceutical manufacturing process along with natural products as dietary supplements. They will also be able to understand industrial applications of molecular spectroscopy.

**Course Content:**

**Pharmaceutical Industry**

Pharmaceutical manufacturing process. Unit operations involved in pharmaceutical industry blending, granulation, milling, coating, tablet pressing, filling and others. Pharmaceutical Excipients. Current issues in pharmaceutical Excipients. Natural

products as drugs. Microorganism as a source of drugs. Plants products as source of new drugs. Natural products as safety dietary supplement

### **Molecular Spectroscopy and applications**

Instrumentation of UV-Visible Spectrophotometer. Principle of UV-Visible spectroscopy. Beers Lambert Law. Application of UV-Visible spectroscopy. FTIR spectroscopy Basic theory and Instrumentation. Functional groups characterization in FTIR. Raman Spectroscopy principles and applications. Mass spectrometer principles. Mass spectrometry applications. <sup>1</sup>H NMR spectroscopy basic principles. Chemical Shifts. Factors affecting the chemical Shifts. Applications of <sup>1</sup>H NMR spectroscopy

### **Recommended Books:**

- *Chemistry for Engineers. HK. Chopra, Anupama Parmer. Narooosa Publishing 2016*
- *University, UK and Department of Chemistry, King Abdulaziz University, Saudi Arabia. 2015*
- *Srivastava A, Mallela KMG, Deorkar N, Brophy G (2021) Manufacturing Challenges and Rational Formulation Development for AAV Viral Vectors. J Pharm Sci 110(7): 2609-2624.*
- *Ganesh S, Su Q, Dan Vo LB, Pepka N, Rentz B, et al. (2020) Design of condition-based maintenance framework for process operations management in pharmaceutical continuous manufacturing. Int J Pharm 587: 119621.*
- *Korasa K, Vre?er F (2018) Overview of PAT process analysers applicable in monitoring of film coating unit operations for manufacturing of solid oral dosage forms. Eur J Pharm Sci 111: 278-292.*
- *Mittal B (2017) Pharmaceutical Unit Operations. Academic Press: 69-95.*
- *Chemistry of Drugs. David E. NEWTON. 2007*
- *Wilsons and Gisvold. Text book of Organic medicinal Pharamaceutical Chemistry. 12th Edition. 2011*
- *Organic spectroscopy. Principles and applications. Second Edition. . Narooosa Publishing 2000.*
- *Introduction to Spectroscopy. Donald L. Pavia, Department of Chemistry, Western Washington University.*

### **Semester-VII**

**Course Title: ADVANCE LAB OF APPLIED CHEMISTRY-I**

**Code: CHEM-421-IV**

**Credit Hours: 2**

**Marks**

**100**

### **Course Objectives:**

The practical design for this course code will polish the psychomotor skills of students and enable them to acquire knowledge about analysis, estimations, preparation, and extraction of various commercial and industrial products.

### **Course Content:**

1. Analysis of caustic soda and soda ash in mixtures.
2. Analysis of effluents from tanneries.
3. Extraction of capsicum oil (soxhlet extraction).
4. Preparation of liquid detergents.
5. Study of the kinetics of dissolution of Magnesium metal in dilute HCl.
6. Estimation of Manganese in Steel.
7. Extraction of nicotine from tobacco leaves.

8. Extraction of plant pigment and separation by TLC.
9. Separation of benzoic acid from sodium benzoate by solvent extraction.
10. Preparation of phenol formaldehyde resins (Bakelite).
11. Synthesis of Biodiesel (Trans-esterification).
12. Preparation of Urea Formaldehyde resins.
13. Synthesis of Shaving Cream.
14. Preparation of toothpaste.
15. Preparation of shampoo.
16. Preparation of picric Acid.
17. Determine the Insoluble Residue in Portland Cement.
18. Determination of melting point of a given sample.
19. Determination of viscosity of a given sample by using Ostwald viscometer.
20. Determination of boiling point of a given sample.

**Recommended Books:**

- *Roger's Industrial Chemistry. Von Norstand Co. N. Y.*
- *Reigel's Handbook of industrial chemistry. Von NorstandReeinhold Co. N. Y.*
- *Chemical Process Industries by Shreve and Dum. McGraw Hill.*
- *An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.*
- *Practical chemistry by O.P. Pandey , D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.*
- *Concise Engineering Chemistry, NeetuGoel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, Delhi.).*

## INORGANIC CHEMISTRY

Semester-VII

Course Title: **ADVANCED INORGANIC CHEMISTRY-I**

Code: **CHEM-451-I**

Credit Hours: **3**

Marks

**100**

**Course Objectives:**

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

**Course Content:**

**INORGANIC REACTION MECHANISM:** Classification of reaction mechanisms; rate laws; steady state approximation; inert and labile complexes; substitution reactions in octahedral complexes and square planar complexes, acid hydrolysis, base hydrolysis, steric effects of inert ligands, nucleophilic reactivity, trans-effect, cis-effect, racemization reactions.

**ELECTRON TRANSFER REACTION:** Electron transfer reaction in coordination compounds, mechanism of electron transfer reactions, outer sphere or tunneling mechanism, inner sphere or ligand bridge mechanism, factors effecting the rate of electron transfer reactions, two electron transfer reactions, complementary or non-complementary electron transfer reaction, oxidation reduction reactions of metal ions

**OXIDATIVE ADDITION AND REDUCTIVE ELIMINATION:** Oxidative Addition: one electron oxidative addition, addition of oxygen, addition of bimetallic species, hydrogen addition, HX addition, organic halides, reductive elimination reactions.

**Recommended Books:**

**Note:** Updated version of following reference books may be consulted from library or available online.

- *R.B Jordan, Reaction Mechanism of Inorganic and organometallic systems. Oxford university press, New York, 1991*
- *Wilkins R.G. "Kinetics and Mechanism of reactions of Transition Metal Complex" VCH Publishers 1991.*
- *Huheey, J. E., Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).*
- *Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).*
- *Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).*
- *Atkins, P. and Jones, L., Chemicals Principles: The Quest for Insight, 5th ed., W. H. Freeman, (2010).*

Semester-VII

Course Title: **ADVANCED INORGANIC CHEMISTRY-II**

Code: **CHEM-451-II**

Credit Hours: **3**

Marks

**100**

**Course Objectives:**

Students will acquire knowledge about  $\pi$ -acceptor ligands and different types of inorganic polymers.

### Course Content:

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

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

### Recommended Books:

**Note: Updated version of following reference books may be consulted from library or available online.**

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

### Semester-VII

**Course Title:           ADVANCED INORGANIC CHEMISTRY-III**

**Code:                   CHEM-451-III**

**Credit Hours:       3**

**Marks**

**100**

### Course Objectives:

Students will acquire knowledge about inorganic spectroscopic methods that provides introduction to common spectroscopic techniques for interpretation of spectra and application to inorganic based system.

### Course Content:

#### Spectroscopic Methods

UV-Visible Spectroscopy: Understanding and interpretation of electronic absorption spectra

by UV-Visible spectroscopy. The nature of electronic excitations, origin of UV Band structure, principle of absorption, interpretation of electronic absorption spectra of common metal complexes.

**Infra-Red Spectroscopy:** The infrared absorption process, The modes of stretching and bending, bond properties and absorption trend, how to examine FT-IR spectrum, How to approach the analysis of a FT-IR spectrum including organic functional groups and metal-carbon, oxygen, nitrogen, sulphur bond containing compounds.

**Nuclear Magnetic Resonance Spectroscopy:** Understanding and interpretation of organometallic compounds/metal complexes using NMR spectroscopy, Nuclear spin states and nuclear magnetic moments, absorption process and mechanism, population densities, chemical shift and shielding, chemical equivalence, spin-spin splitting, coupling constant, interpretation of  $^1\text{H}$  NMR spectra of common compounds.

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- *Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 4th ed., Prentice-Hall International, New Jersey, USA, (2010).*
- *Douglas, B., McDaniel, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd ed., John-Wiley & Sons, New York, (1994).*
- *Huheey, J. E., Keiter, E. A., Keiter, R. L., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Prentice Hall, (1997).*
- *Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).*
- *Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., Advanced Inorganic Chemistry, 6th ed., Wiley-Interscience, (1999).*
- *Atkins, P. and Jones, L., Chemicals Principles: The Quest for Insight, 5<sup>th</sup> ed., W. H. Freeman, (2010).*
- *Mandelkern, L., An Introduction to Macromolecules, 2nd ed., SpringerVerlag, New York, (1983).*
- *Ravve, A., Principles of Polymer Chemistry, 2nd ed., Plenum Publishers, (2000).*

**Semester-VII**

**Course Title: ADVANCED INORGANIC CHEMISTRY LABORATORY**

**Code: CHEM-451-IV**

**Credit Hours: 2**

**Marks**

**100**

**Course Content:**

Preparations of metal complexes using coordinating ligands

- I. Preparation of aluminiumacetylacetonate
- II. Preparation of Cobalt acetylacetonate
- III. Preparation of iron acetylacetonate
- IV. Preparation of Manganese acetylacetonate
- V. Preparation of Zinc anthranillate
- VI. Preparation of Cadmium anthranillate
- VII. Preparation of Nickleanthranillate
- VIII. Preparation of Cobalt anthranillate
- IX. Synthesis of Cis-bis(glycinato)copper(II)
- X. Synthesis of Bis(salicylaldiminato)copper(II)
- XI. Synthesis of Bis(acetylacetonato)copper(II)

### **Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- *Bassett, J., Denny, P. C., Jeffery, G. H., Mendham, J., Vogel's textbook of Quantitative Inorganic Analysis, 4th ed., English Language Book Society, (1978).*42
- *Pass, G., Sutcliffe, H., Practical Inorganic Chemistry: Preparation Reactions and Instrumental Methods, 2nd ed., Chapman and Hall, (1974)*

## ORGANIC CHEMISTRY

### Semester-VII

**Course Title:** ADVANCED ORGANIC CHEMISTRY-I

**Code:** CHEM-461-I

**Credit Hours:** 03

**Marks**

**100**

### Course Objectives:

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

### Course Content:

Oxidation: Introduction; Common oxidizing agents, reactions involving elimination of hydrogen, cleavage of C-C bond, replacement of hydrogen by oxygen and addition of oxygen to the substrate; oxidative coupling.

Reduction: Introduction; Common Reducing agents, reactions involving replacement of oxygen by hydrogen, removal of oxygen from the substrate and reduction with cleavage; reductive coupling.

Pericyclic Reactions: Principles; cycloadditions; electrocyclic reactions; cheletropic reactions; sigmatropic rearrangements; the ene-reaction and related reactions.

### Recommended Books:

- Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.
- Rinehart Jr., K. L., "Oxidation and Reduction of Organic Compounds", Prentice-Hall, London.
- Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.
- Smith, M. B., "Organic Synthesis", McGraw-Hill, New York.
- March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
- Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
- Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University Press, New York.
- Carey, F. A. and Sundberg, R. J. "Advanced Organic Chemistry Part B: Reactions and Synthesis", Plenum Press, New York.
- Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.

### BS 4<sup>th</sup> Year

### Semester-VII

**Course Title:** ADVANCED ORGANIC CHEMISTRY-II

**Code:** CHEM-461-II

**Credit Hours:** 03

**Marks**

**100**

### 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 Content:

Mechanisms and Methods of Determining Them:

Review of kinds and mechanism of organic reactions; thermodynamic and kinetic requirements for reactions: kinetic and thermodynamic control; The Hammond postulate; microscopic reversibility; methods of determining mechanisms; identification of products; determination of the presence of an intermediate; the study of catalysis; crossover experiments; isotopic labeling; stereo-chemical and kinetic studies; solvent effect.

**Reactive Intermediates:** Free Radical, Carbenes, nitrenes, and arynes: Their generation, stability, reactions and synthetic applications.

**Molecular Rearrangements:** Types of rearrangements; general mechanisms of nucleophilic, free radical and electrophilic rearrangements; reactions: 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:**

- March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York
- Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.
- Bruckner, R., "Advanced Organic Chemistry-Reaction Mechanisms", Harcourt Science & Technology Company, New York.
- Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.
- Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry Part A: Structure and Mechanisms", Kluwer Academic /Plenum Publishers, New York.
- Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
- Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University Press, New York.

**Semester-VII**

**Course Title: ADVANCED ORGANIC CHEMISTRY-III**

**Code: CHEM-461-III**

**Credit Hours: 03**

**Marks**

**100**

**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 Content:**

**Spectroscopy:** A brief review of introductory spectroscopy; Introduction to UV, and IR, and their usage for structure elucidation of some simple organic compounds.

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

**IR spectroscopy:** Basic concepts, absorption mechanisms, functional group determination and factors affecting the absorption frequencies.

**$^1\text{H-NMR}$  and  $^{13}\text{C-NMR}$ :** Introduction to  $^1\text{H-NMR}$ ; Principal of  $^1\text{H-NMR}$ ; Chemical shift; factors affecting chemical shift; spin relaxation; spin-spin coupling; coupling constants; factors affecting coupling constants;  $^{13}\text{C-NMR}$  and 2-D NMR.

**Mass Spectrometry:** Introduction; mass spectrometers; ionization and ion sources: electron impact and chemical ionization; field ionization; fragmentation pattern of common functional groups. Combined usage of IR, UV, NMR and Mass spectrometric methods for structure elucidation of organic compounds having medium complexity.



## PHYSICAL CHEMISTRY

**Semester-VII**

**Course Title:** ADVANCED PHYSICAL CHEMISTRY-I

**Code:** CHEM-471-I

**Credit Hours:** 03

**Marks**

**100**

**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 Content:**

**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, GouyChapmann model, Stern model of electrical double layer, and BDM (BockrisDevanathan-Muller) model, charge density, differential capacitance, shape of capacitance-charge curve, the Capacitance hump. Electrochemical devices, charge transfer processes in the absence and presence of electrical field, the over potential, Butler-Volmer's equation, the idea of equilibrium exchange current density, the symmetry factor, high field and low field approximation, Tafel's equation, cyclic voltammetry and its applications, Fuel cell, corrosion and its prevention, electrochemical impedance spectroscopy.

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

**Recommended Books:**

- Gasser, R. P. H., *Entropy and Energy Level*, Rev. ed., Oxford University Press, New York, (1986).
- Wayatt, P. A. H., *The Molecular Basis of Entropy and Chemical Equilibrium*, Royal Institute of Chemistry London, UK, (1971).
- Bockris J. O. M., and Reddy, A. K. N., *Modern Electrochemistry: Ionics*, Vol. I, 2nd ed., Plenum Press, London, (1998).
- Seddon, J. M. and Gale, J. D., *Thermodynamics and Statistical Mechanics*, Royal Society of Chemistry, (2001).
- Engel, T., Reid, P., *Thermodynamics, Statistical Thermodynamics, and Kinetics*, 3rd ed., Prentice Hall, (2012).
- Bard, A. J. and Faulkner, L. R., *Electrochemical Method: Fundamentals and Applications* 2nd ed., John-Wiley & Sons, New York, (2001).

- Kondepudi D., *Introduction to Modern Thermodynamics*, John-Wiley & Sons, (2008).
- Hamann, C. H., Hamnett, A. and Veilstich, W., *Electrochemistry*, 2 nd ed., Wiley-VCH Verla Gnb H and Co. KGaA, (2007).
- Braun R. D. and Walters F., *Application of Chemical Analysis*, McGrawHill, (1982).
- McQuarrie, D. A., *Statistical Mechanics*, Viva Books Private Ltd. (2008).

### BS 4<sup>th</sup> Year

#### Semester-VII

**Course Title:** ADVANCED PHYSICAL CHEMISTRY-II

**Code:** CHEM-471-II

**Credit Hours:** 03 **Marks** 100

#### Course Objectives:

Students will acquire sound knowledge regarding the theoretical, instrumental as well as application related aspects of different electroanalytical techniques. The course aims to provide in-depth theoretical and practical insights into modern electroanalytic techniques. The course also aims to develop the students' ability to independently select and optimize appropriate electroanalytical methods and to provide a coherent overview of the subject.

#### Course Content:

**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:

- Sperling, L. H. *Introduction to Physical Polymer Science*, 4th ed., WileyInterscience, New York, USA, (2006).
- Boyd, R. H. and Phillips, P. J., *The Science of Polymer Molecules*, Cambridge, UK, (1993).
- Odian, G., *Principles of Polymerization*, 4 th ed., Wiley Interscience, (2004).
- Carraher Jr, C. E., *Carraher's, Polymer Chemistry*, 8 th ed., CRC Press, Inc., (2010).
- Ravve, A., *Principles of Polymer Chemistry*, 3 rd ed., Springer, (2012).
- Stevens, M. P., *Polymer Chemistry: An Introduction*, 3 rd ed., Oxford University Press, (1998).
- Allcock, H., Lampe, F. and Mark, J., *Contemporary Polymer Chemistry*, 3 rd ed., Prentice Hall, (2003).
- Flory, J., *Principles of Polymer Chemistry*, Cornell University Pres (1953)

### BS 4<sup>th</sup> Year

#### Semester-VII

**Course Title:** ADVANCED PHYSICAL CHEMISTRY-III

**Code:** CHEM-471-III

**Credit Hours:** 03 **Marks** 100

**Course Objectives:**

Students will acquire knowledge about different spectroscopic techniques with special emphasis on the theoretical, instrumental and applications.

**Course Content:**

**Quantum Chemistry:** Operators and their properties, Schrödinger wave equation, particle in a box and a ring, quantum mechanical tunneling, angular momentum, postulates of quantum mechanics, central field problem, approximate methods, perturbation methods and variation principle, many electron systems, treatment of simple harmonic oscillator, diatomic rigid rotor, valence bond and molecular orbital theories, Hückel 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:**

- Fayer, M. D., *Elements of Quantum Mechanics*, Oxford University Press, London, UK, (2001).
- Becker, E. D., *High Resolution NMR; Theory & Chemical Application*, 3rd ed., Academic Press, New York, USA, (2000).
- Graybeal, J. D., *Molecular Spectroscopy*, 1st ed., McGraw-Hill, New York, (1988).
- Hayward, D. O., *Quantum Mechanics for Chemists*, Royal Society Of Chemistry, (2002).
- House, J. E., *Fundamentals of Quantum Mechanics 2 nd ed.*, Elsevier Academic Press, New York, USA, (2004).
- Kirsten, H. J. W. M., *Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral 1 st ed.*, World Scientific Publishing Co. Pvt. Ltd., (2006).
- Barrow, G. M., *Physical Chemistry*, 6 th ed., McGraw-Hill Book Company, (1996).
- Straughan, B. P., and Walker, S., *Spectroscopy, Vol. 1 and 2.*, Chapman and Hall Ltd., (1976).
- Coulson C. A., *Vanlence*, Oxford University Press (1980).
- Sathyanarayana, D. N., *Vibrational Spectroscopy, Theory and Applications*, New Age International Publishers (2004).

**Semester-VII**

**Course Title:** ADVANCED PHYSICAL CHEMISTRY LABORATORY-I

**Code:** CHEM-471-IV

**Credit Hours:** 03 **Marks** 100

**Course Objectives:**

The course will provide the practical grounds for the verification of fundamental principles of physical chemistry and applications of these principles. In addition, it will enable the students to apply these practical methods in other branches of chemistry. Students will also learn the advance techniques like XRD and cyclic voltammetry for characterization of materials.

**Course Content:**

1. Determination of partial molar properties.
2. Determination of free energy changes, standard free energies.
3. Study of temperature dependence of electrode potentials.

4. Precipitation value of electrolytes.
5. Measurement of IR spectra of simple compound and their interpretation.
6. Measurement of cyclic voltammogram of an organic compound and its interpretation.
7. Determination of dipole moment of an organic liquid.
8. Synthesis of metal oxide nanoparticles and their characterization using IR and XRD techniques

#### **Recommended Books:**

- *Garland, C. W., Shoemaker, D. P., and Nibler, J. W., Experiments in Physical Chemistry, 8th ed., McGraw-Hills, New York, (2003).*
- *James, A. M., Prichard, F. E., Practical Physical Chemistry, 3 rd ed., Prentice Hall Press, (1974).*
- *Halpern, A., McBane, G., Experimental Physical Chemistry: A Laboratory Textbook, 3rd ed., W. H. Freeman, (2006).*
- *Athawale, V. D., and Mathur. P., Experimental Physical Chemistry, New Age International (2001).*
- *Farrington, D., Experimental Physical Chemistry, BiblioBazaar, (2011).*
- *Palmer, W. G., Experimental Physical Chemistry, 2 nd ed., Cambridge University Press (2009)*

## ANALYTICAL CHEMISTRY

### Semester-VIII

**Course Title:** LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS

**Code:** CHEM-412-I

**Credit Hours:** 03 **Marks** 100

#### 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 Content:

**Luminescence Spectroscopy:** 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:

**Thermogravimetry (TGA):** Instrumentation, analytical aspects of TGA, Derivative Thermogravimetry (DTG), sources of error in TGA

**Differential Thermal Analysis (DTA):** Instrumentation, analytical aspects of DTA.

**Differential Scanning Calorimetry (DSC):** Instrumentation, analytical aspects of DSC (pressure and modulated DSC) Microcalorimetry, Micro-DSC Instrumentation and applications (Isothermal Titration Calorimetry, Microliter Flow Calorimetry)

Thermomechanical Analysis and Dynamic Mechanical Analysis: Instrumentation (TMA and DMA equipment) and applications, **Optical Thermal Analysis:** Heating microscope, optical dilatometers, optical thermal analyzers with Differential Thermal Analysis.

#### Recommended Books:

- Creaser, C.S., Sodeau, J.R. (1990). *Luminescence Spectroscopy*. In: Andrews, D.L. (eds) *Perspectives in Modern Chemical Spectroscopy*. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-642-75456-2\\_5](https://doi.org/10.1007/978-3-642-75456-2_5)
- M. E. Brown, "Introduction to Thermal Analysis. Techniques and Applications" 2<sup>nd</sup> Edition, 2001, Springer Dordrecht, <https://doi.org/10.1007/0-306-48404-8>
- F. Miomandre, P. Audebert, "Luminescence in electrochemistry : applications in analytical chemistry, physics and biology", Springer, Cham, Switzerland, 2017

### Semester-VIII

**Course Title:** HYPHENATED TECHNIQUES

**Code:** CHEM-412-II

**Credit Hours:** 03 **Marks** 100

#### Course Objectives:

Students will be able to appreciate the use of a variety of hyphenations for better method

developments, separations, and the analysis. The students will learn about detailed chemical analysis through hyphenations/coupling. The course focuses on understanding the principles and methodologies of coupling processes, techniques, and their interdependence.

**Course Content:**

Analytical aspects of hyphenation, interfaces and significance, Advantages and limitations compared to individual techniques.

Hyphenated Chromatography-Mass Spectrometry

**LC hyphenation:** LC-MS/MS-MS; LC-FTIR; LC-NMR

**Gas Chromatography:** GC-MS/MS, GC-IR, GC-NMR, TG-GC-MS

**Mass Spectrometric hyphenation:** CE-MS, SFC-MS, MS<sup>n</sup> Instruments

Instrumentation and operation principles

Hyphenated Techniques in Sample Preparation: SPE/SPME-LC-MS, online sample cleanup techniques

**Applications of hyphenated techniques:** Drug discovery and development, environmental analysis (e.g., water quality monitoring, pesticide residues), food safety and authentication, forensic analysis, clinical diagnostics, metabolomics, proteomics

**Recommended Books:**

- R. A. Shalliker, "Hyphenated and Alternative Methods of Detection in Chromatography" 1<sup>st</sup> Edition, 2019, CRC Press
- J. Rosenfeld, "Sample Preparation for Hyphenated Analytical Techniques", 2009, Wiley-Blackwell
- N. Kandasamy., R. B. Bodla., L.K. Ghosh, "Trends in Hyphenated Analytical Techniques: Baiscs, Concepts, Different Methods" 2011, LAP LAMBERT

**Semester-VIII**

**Course Title:** ADVANCED SEPARATION TECHNIQUES

**Code:** CHEM-412-III

**Credit Hours:** 03 **Marks** 100

**Course Objectives:**

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

**Course Content:**

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

**Gas Chromatography (GC):** General principle, sample preparation/derivatization, separation process, instrumentation: injectors (syringes, autosamplers, split and splitless injections), column (stationary phases, selection of stationary phases, carrier gas and flow parameters), GC operation parameters (column temperature/pressure and elution values), detectors (TCS, FID, ECD, ELCD, SP-FPD, NPD, HID), GC-GC, 2D GC, sample derivatization for GC, applications.

**High Performance Liquid Chromatography (HPLC):** General principle, sample preparation, separation process (normal phase and reverse phase (C8, C18) separation), HPLC-phase combinations for assays of very polar bio-molecules (IEC, HILIC, selective affinity), HPTLC, Size exclusion chromatography (SEC), Supercritical Fluid Chromatography (SFC), instrumentation and method development, Ultra Performance Convergence Chromatography.

**Electrophoresis:** Theory and principle of CE, mobility, electro-osmotic flow separation Paper and Gel Electrophoresis; Two-Dimensional Electrophoresis; Capillary Zone Electrophoresis (CZE); Capillary iso-electric focusing, Capillary electrochromatography CEC (Micellar Electrokinetic Capillary Chromatography), Fractionation and Purification of Macromolecules

**Solid Phase Extraction (SPE):** Principles and Fundamentals; Importance of Sample Preparation; SPE as Sample Preparation Tool; Load and Elute Conditions; Sorbent Chemistries; Sorbent Packaging; Packed Particle Beds and Disks; Sorbent Capacity and Recovery; Offline and Online Approaches; Method Developments and Protocols; Silica, Polymer and other Sorbents; Applications and Automation. Application to real sample, i.e. Microchips; Nanochips; Lab-on-a-Chip; Microfluidics; Micro- and Nano-LC Systems; Applications.

**Recommended Books:**

- M. Holčapek., W. C. Byrdwell, "Handbook of Advanced Chromatography/Mass Spectrometry Techniques" 2017, Academic Press and AOCs Press, <https://doi.org/10.1016/C2016-0-01418-3>
- Yee-Shan Ku, "Electrophoresis - Recent Advances, New Perspectives and Applications", 2024, Intech Open, <https://doi.org/10.5772/intechopen.108843>
- C. F. Poole, "Solid-Phase Extraction", 1st Edition, 2019, eBook ISBN: 9780128169070
- G-H, Agustina., J. M. Fernández-Romero., "Microfluidic Systems in Analytical Chemistry" 2017, <https://doi.org/10.1002/9780470027318.a959>

**Semester-VIII**

**Course Title: ADVANCED SEPARATION TECHNIQUES**

**Code: CHEM-412-III**

**Credit Hours: 03**

**Marks**

**100**

**Course Objectives:**

Specific goals for the course include the student learning as proper interpretation of data (including statistics and theoretical comparisons), the characteristics and working mechanisms of common and advanced analytical tools, the application of analytical methods to current scientific challenges and to prepare and present data in an accurate and meaningful way

**Course Content:**

Determination of free fat content in oil/ milk.

Determination of free fatty acids and acid values of biodiesel.

Determination of saponification value.

Determination of iodine value.

Determination of phosphate contents in commercial fertilizer samples by spectrophotometry.

Determination of iron in food items.

Determination of citric acid/ ascorbic acid in juices/tablets.

Determination of carbon dioxide in soft drinks.

Iron in pharmaceutical samples.

Quantification of Proteins.

Spectroscopic determination of lead in leaves using solvent extraction.

Determination of heavy metals in biological samples.

Liquid-Liquid extraction of insecticides from juice

Spectrophotometric determination of Fe in water sample using standard addition method

Determination of pesticides (Organophosphate) in soil sample using column

chromatography

Determination of anions in aqueous samples using ion chromatography

Estimation of ammonia in water using Kjeldahl method

Analysis of BOD and DO in waste water sample

Determination of Chemical Oxygen Demand (COD)

Analysis of standard human blood serum

Analysis of analgesic mixture by TLC and detection by UV / VIS spectrophotometry

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

**Recommended Books:**

- *N. Li., J. J. Hefferren., K. Li., "Quantitative Chemical Analysis" 2013, World Scientific, <https://doi.org/10.1142/8727>*
- *D. C. Harris., C.A. Lucy., "Quantitative Chemical Analysis" Tenth Edition, 2020*

## APPLIED CHEMISTRY

**Semester-VIII**

**Course Title: COMMON INDUSTRIES-I**

**Code: CHEM-422-I**

**Credit Hours: 3**

**Marks**

**100**

**Course Objectives:**

The objectives of the course are to educate the students about the fundamentals and manufacturing of clinker and cement industry, soap and detergents, and industrial polymerization.

**Course Content:**

**Chemistry and Production of Clinker and Cement** Raw materials of cement; Chemistry involved in cement production; Manufacture of cement by wet and dry processes; Types of cement and composition of clinker. Chemical phenomena and theories of the setting of cement. Role of gypsum in cement setting and hardening.

**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.

**Industrial Polymerization:**General classification and characterization of polymers; Mechanism and Chemistry of polymerization; Thermoplastic and thermosetting polymerization; Production of polymers i.e. Nylon-6 and Nylon-66; polyethylene, polystyrene, polyurethanes; polyesters and urea phenol formaldehyde resins.

**Recommended Books:**

- G. C. Bye., *Portland Cement*, (1983).
- F. Moore *Rheology of Ceramic Systems* (1965).
- George T. Auston., *Shreve's Chemical Process Industries, 5th Edition.*, McGraw Hill Book Company Inc. New York, (1984).
- Riegel, E. R., *Industrial Chemistry, 5th Ed.*, Reinhold Publishing Corporation New York, (1959).
- Vermani, O. P, Narula, A.K, *Applied Chemistry, Theory and Practice, 2nd ed.*, New Age International. Publisher, India, (1995).
- Balasaraf, V. M, *Applied Chemistry, I. K. International House Pvt. Ltd, India, (2009).*
- P. K. Chattopadhyay, *Modern Technology of Soaps, Detergents and Toiletries:with formulae and project profile, 2nd ed.*, National Institute of Industrial Research, India, (2003).
- Erwin D. L., *Industrial Chemical Process Design, McGraw-Hill, (2002).*
- Tchobanoglous, G., Burton, F. L. and Stensel, H. D., *Wastewater Engineering: Treatment and Reuse, 4th ed.*, McGraw-Hill, (2003).
- Prakash, N. B., *Applied Chemistry Lab Manual, LAP Lambert Academic Publishing, (2013).*
- Vermani, O. P., *Applied Chemistry: Theory and Practice, 2nd ed.*, New Age International, (2006).
- George Odin, *Principles of Polymerization, 3rd Edition, John Wiley Publishers (1991).*
- Billmeyer, F. W. Jr., *Text Book of Polymer Science, 3rd Ed.*, John Wiley and Sons Inc. Singapore, (1994).



**Extraction of Metals and Reaction Kinetics Modelling** :Classification of mineral ores; Dissolution and leaching kinetics modelling of mineral ores; Production and extraction of various metals from their ores such as magnesite, bauxite, flour apatite etc. Modern Techniques of metal extraction. Role of metallurgy in national economy.

**Iron and Steel:** Iron ores; Constituents and their classification; Extraction of iron from their ores; Production of iron and steel; Types of iron and steel; Blast furnace and its control; Chemistry involved in the blast furnace process. Modern applications of iron and steel.

Corrosion and its Prevention Chemistry of Corrosion; Theories and Causes of corrosion; Types of Corrosion; Corrosion prevention and inhibitors; Surface coating and Electroplating.

**Recommended Books:**

- George T. Auston., *Shreve's Chemical Process Industries, 5th Edition.*, McGraw Hill Book Company Inc. New York (1984).
- Riegel, E.R., *Industrial Chemistry, 5th Ed.*, Reinhold Publishing Corporation New York (1997).
- Gyngell, E. S., *Applied Chemistry for Engineers, 3rd Ed.* Edward Arnold, Ltd London (1960) Reprinted (1989).
- Riegel, E.R., *Industrial Chemistry, 5th Ed.*, Reinhold Publishing Corporation, New York (1949) Fifth Printing (1959).
- P.C. Jain., *A Textbook of Applied Chemistry* (1987).
- Shukla., *A Textbook of Chemical Technology* (1977).
- B.N.Chakrabarty, *Industrial Chemistry* (1991).
- Howard L.White, *Introduction to Industrial Chemistry* (1986).
- James, *Handbook of Industrial Chemistry* (1974).
- Coulson & Richardson, *Chemical Engineering, 2nd Ed.*, (1985)
- Furnas, C. C., *Industrial Chemistry, Vol-II 6th Ed.*, D.Van Nostrand Company, Inc. Princeton New Jersey, New York (1957).

**Semester-VIII**

**Course Title: ADVANCE LAB OF APPLIED CHEMISTRY-II**

**Code: CHEM-422-IV**

**Credit Hours: 2** **Marks 100**

**Course Objectives:**

The practical design for this course code will polish the psychomotor skills of students and enable them to acquire knowledge about Separation of various ions by paper chromatography. They will also be enabling to do analysis, estimations, preparation, and extraction of various commercial and industrial products.

**Course Content:**

1. Paper chromatographic separation of Ag(I), Hg(II) and Pb(II) ions.
2. Paper chromatographic separation of As(III), Sb(III) and Sn(II) ions.
3. Paper chromatographic separation of Fe(III), Al(III) and Cr(III) ions
4. Paper chromatographic separation of Ni(II), Co(II), Zn(II) and Mn(II) ions.
5. Paper chromatographic separation of Ca(II), Sr(II) and Ba(II) ions.
6. Paper chromatographic separation of Mg(II), NH<sub>4</sub><sup>+</sup>, Na(I) and K(I) Ions.
7. Preparation of Calcium gluconate

8. Preparation of detergents
9. Preparation of cosmetics
10. Preparation of vanishing creams.
11. Determination of acid value.
12. Saponification value and Iodine value.
13. Extraction and characterization of essential oils from fragment plants.
14. Determine the percentage of available chlorine in the supplied sample of bleaching powder.
15. To determine the iron contents in the given iron ore solution by using external indicator.
16. A review report on research paper on a given topic

**Recommended Books:**

- *Roger's Industrial Chemistry. Von Norstand Co. N. Y.*
- *Reigel's Handbook of industrial chemistry. Von NorstandReeinhold Co. N. Y.*
- *Chemical Process Industries by Shreve and Dum. McGraw Hill.*
- *An introduction to industrial organic chemistry by Wiseman. App. Sci. Publ.*
- *Practical chemistry by O.P. Pandey, D.N. Bajpai, S. and S. Giri (S. Chand & Company limited, Ramnagar, New Delhi-110055.*
- *Concise Engineering Chemistry, NeetuGoel and Sanjay Kumar, AITBS Publisher and distributor (Krishan Nagar, Delhi.).*
- *Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBN0-07-112 721-6 Vogel's Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.*
- *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.*

## INORGANIC CHEMISTRY

### Semester-VIII

**Course Title: ADVANCED INORGANIC CHEMISTRY-I**

**Code: CHEM-452-I**

**Credit Hours: 3**

**Marks**

**100**

#### **Course Objectives:**

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

#### **Course Content:**

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

#### **Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Powell, P., *Principles of Organometallics Chemistry*, 2nd ed., Springer, (1998).
- Yamamoto A., *Organotransition Metal Chemistry: Fundamental Concepts and Applications*, 1st ed., John-Wiley & Sons, Inc., (1986).
- Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Interscience, New York, (1999).
- Miessler, G. L., Fisher, P. J. and Tar, D. A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).
- Douglas, B., McDaniel, D. and Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons, Inc., (1994).
- Haiduc, I. and Zuckerman, J. J., *Basic Organometallic Chemistry*, Walter De Gruyter Inc., (1985).
- Jolly, W. L., *Modern Inorganic Chemistry*, 2nd ed., McGraw-Hill Company, (1991).
- Porterfield, W. W., *Inorganic Chemistry: A Unified Approach*, 2nd ed., Academic Press, (1993).
- Vincet, A., *Molecular Symmetry and Group Theory: 2nd ed.*, John-Wiley & Sons, Ltd., (2001).
- Malik, W. U., Tuli, G. D., Madan, R. D., *Selected Topics in Inorganic Chemistry*, S. Chand and Co. Ltd., (2010).

### Semester-VIII

**Course Title: ADVANCED INORGANIC CHEMISTRY-II**

**Code: CHEM-452-II**

**Credit Hours: 3**

**Marks**

**100**

#### **Course Objectives:**

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

**Course Content:**

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

**Nuclear Chemistry:** 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:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons Inc., (1997).
- Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Prentice Hall, (1997).
- Mackay, K. M., Mackay, R. A. and Henderson, W., *Introduction to Modern Inorganic Chemistry*, 6th ed., CRC Press, (2002).
- Miessler, G. L., Fisher, P. J. and Tar, D. A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).
- Friedlander, G., Kennedy, J. W., Miller, J. M. and Maciugas, E. S., *Nuclear and Radiochemistry*, 3rd ed., John-Wiley & Sons, Inc., (1981).
- Choppin, G. R., Rydberg, J., Liljenzin, J., *Radiochemistry and Nuclear Chemistry*, 3rd ed., Butterworth-Heinemann Ltd., (2002).
- Arnikar, H. J., *Essentials of Nuclear Chemistry*, 4th ed., New Age International Pvt. Ltd. Publishers, (1996).
- Naqvi, I. I. and Farrukh, M. A., *Radiotracers in Chemical Applications* VDM Verlag Dr. Müller, Germany, (2010).
- Loveland, W., Morrissey, D. J. and Seaborg, J. T., *Modern Nuclear Chemistry*, John Wiley and Sons, Inc., (2006)

**Semester-VIII**

**Course Title: ADVANCED INORGANIC CHEMISTRY-III**

**Code: CHEM-452-III**

**Credit Hours: 3**

**Marks**

**100**

**Course Objectives:**

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

**Course Content:**

**Symmetry and Group Theory:**Symmetry and group theory, point groups, multiplication tables, group representation and development of character tables, Application of group theory, interpretation of spectra and structure elucidation.

**Inorganic Electronic Spectroscopy:**Electronic States of transition metal complexes, Russel-Sander's coupling scheme, derivation of term symbols for  $d^1$ - $d^{10}$

systems, d-d transitions, connecting atomic states and molecular states, correlation diagram, Tanabe-Sugano diagrams.

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons Inc., (1997).
- Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Prentice Hall, (1997).
- Mackay, K. M., Mackay, R. A. and Henderson, W., *Introduction to Modern Inorganic Chemistry*, 6th ed., CRC Press, (2002).
- Miessler, G. L., Fisher, P. J. and Tar, D. A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).67
- Purcell, K. F., Kotz, J. C., *An Introduction to Inorganic Chemistry*, W. B. Saunders, Company Holt-Saunders, International ed., (1980).
- Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Interscience, New York, (1999).
- Jolly, W. L., *Modern Inorganic Chemistry*, 2nd ed., McGraw-Hill Company, (1991).
- Carter, R. L., *Molecular Symmetry and Group Theory*, 1st ed., John-Wiley & Sons, Inc., New York, (1997).
- Orchin, M., Jaffe, H. H., *Symmetry, Orbitals, and Spectra*, John-Wiley & Sons, Inc., New York, (1971).
- McWeeny, R., *Symmetry: An Introduction to Group Theory and its Applications*, Dover Publications, Inc., (2002).
- Vincet, A., *Molecular Symmetry and Group Theory*, 2nd ed., John Wiley & sons Ltd, (2001).

**Semester-VIII**

**Course Title: ADVANCED INORGANIC CHEMISTRY LABORATORY**

**Code: CHEM-452-IV**

**Credit Hours: 2**

**Marks**

**100**

**Course Content:**

1. Synthesis of Schiff bases using various available aldehydes/ketones and amines
2. Synthesis of Schiff bases metal complexes
3. Synthesis of coordinated metal complexes
4. Metals (Al(III) and Fe(III)) complexes using 8-hydroxyquinoline.
5. Hexaaminenickel(II) iodide  $[\text{Ni}(\text{NH}_3)_6]\text{I}_2$
6. Hexaaminenickel(II)  $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Takashiro Akitsu, *Introductory Chapter: A study on Schiff base metal complexes, Basic Concepts viewed from frontier in inorganic coordination chemistry*, 2018.
- Angelici, R. J. (1977). *Synthesis and technique in inorganic chemistry*, pp.157-168 Philadelphia: W. B. Saunders Company.
- Spessard, G. O., & Miessler, G. L. (1996). *Organometallic chemistry*. Upper Saddle

- River, New Jersey: Prentice Hall.*
- *J. Bassett, R. C. Denny, G. H. Jeffery and J. Mendham, Vogel's TextBook of qualitative Inorganic Analysis, the English Language Book Society and Longman, New York, (2008)*

## ORGANIC CHEMISTRY

### Semester-VIII

<b>Course Title:</b>	<b>Advanced Organic Chemistry-I</b>		
<b>Code:</b>	<b>CHEM-462-I</b>		
<b>Credit Hours:</b>	<b>03</b>	<b>Marks</b>	<b>100</b>

#### 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 Content:

**Organometallics:** Introduction; principles; structure, reactivity, methods of preparation and synthetic applications of organomagnesium, organosodium, organolithium, organocopper, organocadmium, organomercury and organozinc compounds.

**Chemistry of Biomolecules:** Chemistry of lipids, proteins, carbohydrates, nucleic acids and their importance in living systems.

**Drugs-Pharmaceutical Compounds:** Introduction; classification of drugs, drug discovery, sources of therapeutic agents, structure activity relationship (SAR), drug-receptor interaction, drug administration and its methods, different types of drugs; chemistry and modes of action of some common drugs.

### BS 4<sup>th</sup> Year

### Semester-VIII

<b>Course Title:</b>	<b>Advanced Organic Chemistry-II</b>		
<b>Code:</b>	<b>CHEM-462-II</b>		
<b>Credit Hours:</b>	<b>03</b>	<b>Marks</b>	<b>100</b>

#### 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 Content:

**Protective Groups:** Use of hydroxyl-, amino-, carboxyl-, carbonyl- sulfanyl- and C=C protecting groups in organic synthesis, solid phase synthesis, phase-transfer catalysis

**Retrosynthesis:** Introduction to retrosynthesis and disconnection approach; synthesis of aromatic compounds with one and two group carbon C-X disconnections; donor and acceptor synthons; C-C disconnections of difunctionalized compounds; and 1,2-, 1,3-, 1,4-, 1,5- and 1,6- difunctionalized compounds, synthesis of cyclic compounds (3-6 membered), chemo-, regio- and stereoselectivity. use of hydroxyl-, amino-, carboxyl- and carbonyl- protecting groups in organic synthesis, use of transition metal in coupling reactions. donor and acceptor synthons, C-C disconnections

#### Recommended Books:

**Semester-VIII**

**Course Title:** Advanced Organic Chemistry-III  
**Code:** CHEM-462-III  
**Credit Hours:** 03 **Marks** 100

**Course Objectives:**

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

**Course Content:**

**Alkaloids** : Introduction; classification; isolation; general methods for structure elucidation; discussion with particular reference to structure and synthesis of ephedrine, nicotine atropine, quinine and morphine.

**Terpenoids** :Introduction; classification; isolation; general methods for structure elucidation; discussion with particular reference to structure and synthesis of citral,  $\alpha$ -terpineol,  $\alpha$ -pinene and camphor

**Steroids:** Introduction; nomenclature and stereochemistry of steroids; structure determination of cholesterol and bile acids; introduction to steroidal hormones with particular reference to adrenal cortical hormones.

**Flavonoids:** Introduction and classification of flavonoids, general biosynthetic pathway, synthesis of flavone, flavonol and cyanidin

**Recommended Books:**

- Dewick, P. M., *Medicinal Natural Products: A Biosynthetic Approach*, 3<sup>rd</sup> ed., *Medicinal Natural Products*, John-Wiley & Sons, Ltd., (2009).
- 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).
- Shahidi, F. and Naczki M., *Phenolics in Food and Nutraceuticals*, CRC Press, (2004).
- Oyvind, M. A., and Kenneth, R. M., *Flavonoids: Chemistry, Biochemistry and Applications*, CRC, Taylor & Francis, New York, (2010).
- Finar, I. L., *Organic Chemistry, Vol. 2, Stereochemistry and the Chemistry of Natural Products*, 5<sup>th</sup> ed., Pearson Education Ltd., Delhi, (2008).
- Hesse, M., *Alkaloid Chemistry*, John-Wiley & Sons, New York, (1981).
- Bhat, S. V., Nagasampagi, B. A. and Sivakumar, M., *Chemistry of Natural Products*, Narosa Publishing House, (2005).
- Shoppee, C. W., "Chemistry of the Steroids", Butterworths, London.
- Fieser, L. F. and Fieser, M., "Steroids", Asia Publishing House, London

**BS 4<sup>th</sup> Year****Semester-VIII**

**Course Title:** Advanced Organic Chemistry IAB-III  
**Code:** CHEM-462-IV  
**Credit Hours:** 02 **Marks** 100

**Course Objectives:**

Students will acquire knowledge about the principles and instrumentation of chromatographic techniques; overview of paper, thin layer and column chromatography.

**Course Content:**

Experiments based on separation of reaction mixtures using different chromatographic techniques; to separate multi-component organic mixture.

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

**Recommended Books:**

- *Naser-ud-Din, "Introduction to Chromatography", University of Peshawar, Peshawar.*
- *Gunter Zweig, John R. Whitaker, "Paper Chromatography and Electrophoresis", Academic Press, New York.*

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

## PHYSICAL CHEMISTRY

### Semester-VIII

**Course Title:** ADVANCED PHYSICAL CHEMISTRY –I

**Code:** CHEM-472-I

**Credit Hours:** 03

**Marks** 100

### 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 Content:

#### Reaction Dynamics:

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

#### Reactions in solutions:

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

#### Recommended Books:

- Espenson, J. H., *Chemical Kinetics and Reaction Mechanism 2 nd ed.*, McGraw-Hill, London (2002).
- Connors, K. A., *Chemical Kinetics: The Study of Reaction Rates in Solution*, VCH Publishers, Inc., (1990).
- Silbey, R. J., Alberty, R. A. and Bawendi, M. G., *Physical Chemistry, 4 th ed.*, John-Wiley & Sons, (2005).
- Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry, 9 th ed.*, Oxford University Press, (2010).
- Houston, P. L., *Chemical Kinetics and Reaction Dynamics*, Dover Publications, (2006).
- Levine, R., *Molecular Reaction Dynamics*, Cambridge University Press, (2005).
- Laidler, K. J., *Chemical Kinetics, 3rd Edition*, Prentice Hall, (1987).
- Frost, A. A., and Pearson, R. G., *Reaction Mechanism, 2 nd Edition* John Wiley and sons, Inc; (1961).
- Benson, S. W., *Foundation of Chemical Kinetics*, Krieger Publication Co. (1980).

### BS 4<sup>th</sup> Year

### Semester-VIII

**Course Title:** ADVANCED PHYSICAL CHEMISTRY -II

**Code:** CHEM-472-II

**Credit Hours:** 03

**Marks**

### Course Objectives:

Students will be able to appreciate the use of a variety of hyphenations for better method



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:**

- Hunter, R. J., *Introduction to Modern Colloid Science*, Oxford University Press, Oxford, (1994).
- Poole, C. P. and Owens, F. J., *Introduction to Nanotechnology*, 1 st ed., Wiley-Interscience, (2003).
- Klabunde, K. J., *Nanoscale Materials in Chemistry*, John-Wiley & Sons, Inc., (2003).
- Kolunsi, K. W., *Surface Science: Foundations of Catalysis and Nanoscience*, 3rd ed., John-Wiley & Sons, Ltd., (2012).
- Adamson, A. W. and Gast, A. P., *Physical chemistry of Surfaces*, 6 th ed., Wiley-Interscience, (1997).
- Atkins, P. and Paula, J. D., *Atkin's Physical Chemistry*, 8 th ed., Oxford University Press, (2006).
- Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, (2004).

#### **Semester-VIII**

**Course Title: ADVANCED PHYSICAL CHEMISTRY LABORATORY-II**

**Code: CHEM-472-III**

**Credit Hours: 03**

**Marks 100**

#### **Course Objectives:**

The course will provide basic as well as the advance understandings of experimental methods of energy storage devices. The course will also enable the students to understand about the photocatalysis, its mechanism, synthesis of photocatalysts and other materials other than oxides.

#### **Course Content:**

1. Study of isotherms and experiments of surface chemistry.
2. Experiments related to photocatalysis
3. Studies related to electrochemistry
4. Studies related to energy storage devices
5. Synthesis of solid materials other than oxides, their characterization and applications

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

#### **Recommended Books:**

- Halpern, A., McBane, G., *Experimental Physical Chemistry: A Laboratory Textbook*, 3 rd ed., W. H. Freeman, (2006).
- Palmer, W. G., *Experimental Physical Chemistry*, 2 nd ed., Cambridge University Press, (2009).
- Athawale, V. D., and Mathur. P., *Experimental Physical Chemistry*, New Age International (2001).
- Farrington, D., *Experimental Physical Chemistry*, BiblioBazaar, (2011).
- James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3rd ed., Prentice Hall Press, (1974).

**Contents According to HEC Undergraduate Education Policy 2023 and onwards**  
**General Education Courses & Interdisciplinary Courses**  
**For**  
**BS 4 YEAR Program**  
**Institute of Chemical Sciences**  
**Bahauddin Zakaryia University Multan**  
***Scheme of Studies (Course Outline) for BS Chemistry 2023 for Institute and Affiliated***  
***Colleges***

**BS 1<sup>st</sup> Year**

**Semester-I**

**Course Title:** Quantitative Reasoning-I

**Code:** QANR-100

**Credit Hours:** 03

**Marks**

**100**

**Course Objectives:**

Course Description: This course provides BS Chemistry students with a solid foundation in Quantitative Reasoning-I concepts and techniques essential for success in chemistry-related coursework. It focuses on algebra, functions, calculus, geometry, trigonometry, and introductory statistics, with an emphasis on their applications in chemistry.

**Course Contents:**

Unit 1: Algebra, Real numbers and algebraic expressions, Equations and inequalities,, Polynomials and factoring, Rational expressions

Chemistry Application: Balancing chemical equations involves solving systems of linear equations, which are fundamental in chemistry. Balancing chemical equations using algebraic methods is crucial in designing and optimizing organic synthesis routes. Identifying limiting reactants through algebra helps determine the maximum yield of a chemical reaction.

Chemistry Fields: Organic and Inorganic Chemistry (Stoichiometry)

Unit 2: Functions and Graphs, Basics of functions, Linear and quadratic functions

Exponential and logarithmic functions, Trigonometric functions (if relevant to chemistry)

Chemistry Application: Graphing chemical reactions and plotting concentration-time curves. Plotting concentration-time curves and fitting data to exponential functions aids in determining reaction kinetics and rate constants. Understanding logarithmic functions is essential for calculating pH values in acid-base chemistry.

Chemistry Fields: Physical Chemistry (Kinetics, Thermodynamics).

Unit 3: Geometry and Trigonometry Geometry basics (angles, lines, triangles, etc.)

Trigonometric ratios and identities, Applications of trigonometry in chemistry (e.g., molecular geometry) Chemistry Application: Understanding molecular geometry and bond angles in organic and inorganic compounds. Trigonometry helps determine bond angles and molecular shapes, crucial for predicting chemical properties and reactivity. Geometry is used to analyze crystal structures, particularly in inorganic chemistry and materials science Chemistry Fields: Organic and Inorganic Chemistry.

Unit 4: Differential Calculus

Limits and continuity

Differentiation and its applications in chemistry (e.g., rate of reactions)

Maxima and minima, Chemistry Application: Calculating reaction rates and determining reaction mechanisms. Calculating reaction rates using differentiation aids in elucidating reaction mechanisms in physical and organic chemistry. Differential equations are used to model enzyme-substrate interactions and enzyme kinetics in biochemistry.

Chemistry Fields: Physical Chemistry (Reaction Kinetics).

Unit 5: Integral Calculus, Integration and its applications in chemistry (e.g., finding volumes)

Techniques of integration, Chemistry Application: Finding reaction volumes and integrating rate equations. Integrating heat capacity curves provides information about energy changes in chemical processes, vital for physical chemistry research. Integration is used to determine areas under spectral peaks, aiding in identifying chemical compounds.

**Recommended Books:**

As available in the main library, and departmental library.

**BS 1<sup>st</sup> Year**

**Semester-I**

**Course Title:** **Functional English**  
(Science Faculty Dean's Office Course Contents)

**Code:** **ENGL-100**

**Credit Hours:** **03** **Marks** **100**

**Course Introduction:**

This is first course in English to the Bachelor of Science students and covers all the fundamental concept of English composition and comprehension. The course is designed in such a way that students can use this knowledge to further enhance their language skills in English. The course aims at enhancing students' skill and competence in communicating their ideas in writing and speaking in English language. It will primarily focus on four areas of language to help the students achieve proficiency in language use, develop skills in listening comprehension, improve reading efficiency, use the conventions of standard written English with skill and assertion, build-up vocabulary, and clearly and accurately reproduce specific data. It will illustrate the force and effectiveness of simple and direct English.

**CLO No. Course Learning Outcomes**

**Bloom Taxonomy**

**Course Outline:**

Paragraph and Essay Writing, Descriptive Essays; Sentence Errors, Persuasive Writing; How to give presentations, Sentence Errors; Oral Presentations, Comparison and Contrast Essays, Dialogue Writing, Short Story Writing, Review Writing, Narrative Essays, Letter Writing

**Reference Materials: (or use any other standard and latest books)**

1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
2. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

## BS 1<sup>st</sup> Year

Semester-I

Course Title: **Application of Information and Communication Technology**  
(Science Faculty Dean's Office Course Contents)

Code: **AICT-100**

Credit Hours: **3** Marks **100**

### Course Introduction:

This is an introductory course in Computer Science designed for beginners. Apart from leading the participants through a whirlwind history of computing, the course also develops a feel for web programming through a series of lectures that help the students develop their own web page. Main objective of the course is to build an appreciation for the fundamental concepts in computing and to become familiar with popular PC productivity software.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basics of computing technology	C1 (Knowledge)
CLO-2	Do number systems conversions and arithmetic	C2(Understand)
CLO-3	Have knowledge of types of software	C2(Understand)
CLO-4	Have knowledge of computing related technologies	C3 (Apply)

### Course Outline:

Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computer (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Class2. Organizing Computer Facility, Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex, Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Some Common Services available on Internet.

### Reference Materials:

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

## BS 1<sup>st</sup> Year

Semester-I

Course Title: **Islamic Studies**  
(Science Faculty Dean's Office Course Contents)

Code: **ISLS-100**

Credit Hours: **2** Marks **100**

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**Course Name:** *Islamic Studies*  
**Credit Hours:** 2 (2-0)  
**Contact Hours:** 2-0  
**Pre-requisites:** None

### Course Introduction:

To provide Basic information about Islamic Studies. To enhance understanding of the students regarding Islamic Civilization. History of Islam, understanding of the worship and its usefulness. The basic concept of Quran Pak: wisdom, patience, loyalty. The comparative analysis of Islam with other religions. The Concept and Value of *Haqooq ul Ibad* (Bandon Kay Haqooq) in Islam. What is The rights of people in Islamic Point of View. Islamic point of view about other religions.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
1	• To further enhance the knowledge of Islam.	
2	• To understand the basic concept of Islam and Quran Pak.	
3	• To understand the concept of Haqooq ul ibad in the light of Quran.	
4	• To know the importance of Islamic concept about other religions.	

### Course Outline:

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam. Definition of Akhlaq. The Most Important Characters mentioned in the Holy Qur'an and Sunnah, SIDQ (Truthfulness) Generosity Tawakkaul (trust on Allah) Patience Taqwa (piety). Haqooq ul ibad in the light of Quran & Hadith - the important characteristic of Islamic Society.

### Reference Materials: (or use any other standard and latest books)

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

## BS 1<sup>st</sup> Year

### Semester-II

**Course Title:** Quantitative Reasoning II

**Code:** QANR-101

**Credit Hours:** 3

**Marks**

**100**

### Course Objectives:

This course builds upon the mathematical foundation established in Quantitative Reasoning-II and delves into advanced topics in mathematics and statistics relevant to chemistry research. It covers matrices, sequences, multivariable calculus, differential equations, advanced statistics, and data analysis, with an emphasis on their applications in various chemistry subfields. By the end of this course, students will be able to:

Apply matrix operations and determinants to solve systems of linear equations in chemical equilibrium calculations.

Utilize sequences and series to approximate complex functions in quantum chemistry and spectroscopy.

Analyze functions of several variables, including thermodynamic surfaces, using multivariable calculus.

Model chemical kinetics, rate laws, and chemical reactions using differential equations.

Perform advanced statistical analyses of experimental data and hypothesis testing relevant to chemistry research.

Process and analyze complex experimental data using advanced data analysis techniques and visualization tools.

### Course Content:

**Descriptive statistics** (mean, median, mode, variance, standard deviation).

Graphs and their significance in chemistry (histograms, scatter plots, box plots). Concept of maxima and minima

Statistical Inference: Concepts of population and sample. Estimation and confidence intervals.

Hypothesis testing (null and alternative hypotheses, p-values). Mean, Comparing means (t-tests, F-Test, ANOVA).

**Regression Analysis:** Simple linear regression (interpretation of slope and intercept). Curve fitting. Solutions of linear equations, Correlation,

Multiple linear regressions (model building, diagnostics, and multicollinearity).

Applications of regression in chemistry research (calibration curves, sensitivity, Limit of detection, Limit of quantification).

**Experimental Design:** Principles of experimental design (randomization, replication, blocking). Factorial designs and interaction effects. Applications of experimental design in chemistry (e.g., optimization studies).

Numerical Methods and Modeling: Numerical methods for solving equations (e.g., root finding, numerical integration).

Modeling chemical processes (e.g., reaction kinetics, thermodynamics, Logarithmic functions, Exponential functions, Differentiation, Partial differentiation, Differential equations and their use in chemical problems Integration, Determinants, real number lines, functions and their graphs, solutions of equations, limits and continuity)

Functions of Several Variables ,Multiple Integrals (Volume and Surface area Calculations)

### Recommended Books:

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

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

**BS 1<sup>st</sup> Year**

**Semester-II**

**Course Title:**

**Expository Writing**

*(Science Faculty Dean's Office Course Contents)*

**Code:**

**ENGL-101**

**Credit Hours:**

**3**

**Marks**

**100**

**Course Introduction:**

The course introduces students to the communications so they can effectively communicate their message. The course also covers how to make an effective presentation both written and verbal. Various modern techniques of communication and presentation skills are covered in this course. Further the course aims to enhance students' linguistic command, so they could communicate effectively in diversified socio-cultural situations; create larger stretches of interactive text in speech and writing; and identify and repair any instances of potential communication break-up.

**CLO No. Course Learning Outcomes**

**Bloom Taxonomy**

**Course Outline:**

Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation. Process of writing, observing, audience collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams; Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.

**Reference Materials: (or use any other standard and latest books)**

1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748
3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
4. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

BS 1<sup>st</sup> Year

Semester-II

Course Title: **Ideology and Constitution of Pakistan**  
(Science Faculty Dean's Office Course Contents)

Code: **IDCP-100**

Credit Hours: **2** Marks **100**

**Course Introduction:**

Pakistan studies is an important course at this university in which students study about their motherland. The following are the specific objective of the course

- to develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

**CLO No. Course Learning Outcomes**

**Bloom Taxonomy**

- |   |  |
|---|--|
| 1 | • To educate students about the history of Pakistan        |
| 2 | • To educate student about the various pillar of the state |
| 3 | • To educate student Government and politics               |

**Course Outline:**

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

**Reference Materials: (or use any other standard and latest books)**

1. The Emergence of Pakistan, Chaudary M., 1967
  2. The making of Pakistan, Aziz. 1976
  3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
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BS 1<sup>st</sup> Year

Semester-II

Course Title: FINE ARTS

Code: 100

Credit Hours: 2

Marks

100

**Course Objectives:**

Students will learn how to explore the diverse branches and forms of art, to appreciate the interdisciplinary nature of artistic practices and their cultural significance throughout history and in modern society. This course will also help to evaluate the importance and impact of art on human expression, cultural identity, and societal discourse, encouraging critical thinking about art's role in shaping historical narratives and contemporary perspectives across global contexts.

**Course Content:**

Introduction to Art: Define art, Elements and Principles of Art: Explore the fundamental elements of art such as line, shape, form, color, texture, and space, as well as principles of design such as balance, contrast, emphasis, movement, pattern, and unity.

Various branches, forms, and types, including painting, sculpture, drawing, printmaking, Architecture, photography, Craft and graphic design, Film making, Camera and computer art, multimedia and other digital art forms.

Discuss the importance of visual art in human history and contemporary society.

**Recommended Books:**

- *Art Fundamentals: Theory and Practice* by Otto G. Ocvirk, Robert E. Stinson, Philip R. Wigg, and Robert O. Bone N7430.A697 2012. 701'.8—dc23. 2011045559 (2012)
- *Understanding Art* by Lois Fichner-Rathus, 11th Edition; 978-1285859293 (2016)
- *The Visual Experience* Hobbs, Jack A.; Salome, Richard; Vieth, Ken; Publisher Davis Pubns, 2004 ISBN 10: 087192627X / ISBN 13: 9780871926272 (2004)

## BS 1<sup>st</sup> Year

Semester-II

Course Title: PRINCIPLES OF ECONOMICS

Code: ECON-100

Credit Hours: 2

Marks

100

### Course Objectives:

Economics is the study of how a society decides how to use its limited resources. This course will introduce you the ways economists study the decisions people and firms make and the implications of those decisions. Students will learn how to think analytically about the economic forces at work in a modern society by developing a set of analytical tools and practicing applying them to selected policy issues.

### Course Content:

**SECTION A: MICROECONOMIS:** Definitions of Economics, Adam Smith, Alfred Marshall, Lionel Robbins, ,Types of Economics , Theoretical & Practical Importance of Economics , Economic Way of Thinking Concept of Demand ,Law of Demand ,Statement, Assumptions, Exceptions, Determinants of Demand Elasticity ,Factors of Price Elasticity of Demand , Importance of Price Elasticity of Demand, Elasticity vs Slope ,Elasticity of Demand , Price Elasticity, Income Elasticity, Cross Price Concept of Supply and Stock ,Law of Supply ,Statement, Assumptions, Exceptions ,Determinants of Supply ,Price Elasticity of Supply ,Factors of Price Elasticity of Supply Market ,Definition, Kinds ,Market Equilibrium ,Effects on Market Equilibrium Utility: Concept and Kinds Law of Diminishing Marginal Utility Statement, Assumptions, Exceptions Law of Equi-Marginal Utility Statement, Assumptions, Exceptions

Production Concept and Kinds Factors of Production Factor Pricing Rent, Wage, Interest, Profit Laws of Returns Law of Variable Proportions Cost Concept, Kinds Revenue Concept, Kinds Concept & Characteristics of Market Structures Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly

**SECTION B: MACROECONOMICS:** National Income: Concept Aggregates of National Income Consumption Concept, Kinds Savings Concept, Kinds Investment Concept, Kinds Determinants of Consumption and Investment

Unemployment Concept, Kinds, Causes and Solution Inflation Concept, Kinds, Causes and Solution Trade Cycle Concept, Causes and Solution Budget Deficit Concept, Causes and Solution Taxes Concept, Kinds, Canons Pitfalls of Barter System Money Concept and Functions, Evolution, Kinds Banks Concept and Kinds of Bank Functions of Commercial Bank Functions of Central Bank Balance of Payments Concept of BOP and BOT Causes of Deficit and Solution Exchange Rate Concept, Kinds

### Recommended Books:

- *John Sloman, Alison Wride (Latest Issue). Economics, Pearson Education Limited.*
- *Michael Parkins (Latest Issue) Economics, New York Addison Wesley.*
- *Deviga Vengedadasalam, Karunagaran Madhavan. Principles of Economics,(Third Edition). Oxford University Press.*

### Further Suggested Readings

- *Colander C. David (2006). Economics. 6th edition Mc Graw. Hill international edition*
- *Hailstone J. Thomas and Matrianna V. Frank (2004). Basic Economics. 13th edition,*

Thomson

- Colin Bamford (2002) *Economics*, Cambridge.
- Robert H. Frank, Ben S. Bernanke, Kate Antonovics, and Ori Heffetz (2016). *Principles of Economics 6th Edition*.
- Hall, R. E. and M. Lieberman (2005), *Introduction to Economics*, 2nd edition (USA: Thomson South-Western).
- Dr. Muhammad Ramzan & Dr Muhammad Zahir Faridi *Principles of Economics Latest Issue* by Target Publications

### BS 1<sup>st</sup> Year

#### Semester-II

**Course Title: PHILOSPHY**

**Code: PHIL-100**

**Credit Hours: 2**

**Marks 100**

#### Course Objectives:

This course is designed to acquaint students with the subject matter of philosophy, its terms, methods, and theories of several different areas within philosophy. There are many different ways in which philosophy can be and has been defined by many different thinkers. In a scholarly sense, philosophy is the study of the history of human thought. And this course also aims at the familiarity with great ideas understood through the various major thinkers in world history of ideas or great conversation. This course introduces these general areas of philosophy: Logic, epistemology (theory of knowledge), metaphysics, ethics, Aesthetics and political values and Philosophy of Science. It will explore such concepts as the nature of the world and how we have access to knowledge of the world; moral behavior and the nature of good and evil; the relationship between minds and bodies; the relationship between our thoughts and the external world; arguments for and against the existence of God; and how we should employ logical analysis and empirical observations to evaluate arguments, history of science, logical positivism and social and feminist critique of science. The objective of this course is to provide a clear, systematic, and comprehensive introduction to the core areas of Philosophy and philosophy of science which is sub branch of Philosophy.

#### Course Content:

Introduction; Four Knowledge Forms, Time-line of Knowledge revolutions, Definition and Branches of Philosophy, Core branches, Sub- branches, Approaches to Philosophy, Philosophy Religion and Science, Introduction to Metaphysics and Epistemology, Plato's Allegory of the Caves, Definition and sources of knowledge, Concept of God, Problem of evil, Personal Identity, Axiology (Ethical, Political and Aesthetic Values), Introduction to Ethics, Basic concepts and historical development of ethical theories, Natural Law Ethics, Deontology, Utilitarianism

The meaning of life, The influence of Philosophy on Life, Introduction to Logic, Basic concepts, Types of arguments and fallacies, Categorical propositions and Syllogism, Inductive Logic (Analogical Reasoning, Casual Reasoning, Science and Hypothesis, Probability), History of Philosophy, Ancient Philosophy, Medieval Philosophy, Modern Philosophy, Post-modern Philosophy, Philosophy of Science, History of Science, Logical Positivism, Philosophy of Chemistry, Social and Feminist Critique of Science

#### Recommended Books:

**Note: Updated version of following reference books may be consulted from library or available online.**

- *Philosophy A Beginner's Guide* by Jenny Teichman & Kathrine C. Avenas



**Social Institutions;** Definition, Structure and function of social institutions, Inter-relationships among various social institutions

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Anderson, Margaret and Howard F. Taylor. 2001. *Sociology the Essentials*. Australia: Wadsworth.
- Brown, Ken 2004. *Sociology*. UK: Polity Press
- Giddens, Anthony 2002. *Introduction to Sociology*. UK: Polity Press.
- Macionis, John J. 2006. *10<sup>th</sup> Edition Sociology* New Jersey: Prentice-Hall
- Tischler, Henry L. 2002. *Introduction to Sociology 7th ed*. New York: The Harcourt Press.
- Frank N Magill. 2003. *International Encyclopedia of Sociology*. U.S.A: Fitzroy Dearborn Publishers
- Macionis, John J. 2005. *Sociology 10<sup>th</sup> ed*. South Asia: Pearson Education
- Kerbo, Harold R. 1989. *Sociology: Social Structure and Social Conflict*. New York: Macmillan Publishing Company.
- Koenig Samuel. 1957. *Sociology: An Introduction to the Science of Society*. New York: Barnes and Nobel.
- Lee, Alfred McLung and Lee, Elizabeth Briant 1961. *Marriage and The family*. New York: Barnes and Noble, Inc.
- Leslie, Gerald et al. 1973. *Order and Change: Introductory Sociology* Toronto: Oxford University Press.
- Lenski, Gevbard and Lenski, Jeam. 1982. *Human Societies*. 4<sup>th</sup> edition New York: McGraw-Hill Book Company.
- James M. Henslin. 2004. *Sociology: A Down to Earth Approach*. Toronto: Allen and Bacon.

**BS 1<sup>st</sup> Year**

**Semester-II**

**Course Title: BIOCHEMISTRY**

**Code: BCHM-101**

**Credit Hours: 2** **Marks 100**

**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 carbohydrates, lipids, amino acids, proteins and nucleic acids.

**Course Content:**

**Biochemistry:** Brief introduction to Biochemistry, the scope and history of Biochemistry.

**Cell:** A general introduction about molecular logic of the living organism, cell structures and their functions, origin and nature of biomolecules, forms, functions and brief classification of prokaryotes; cellular architecture and diversity of eukaryotes.

**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 homeostasis, variation of Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup> in acid-base disturbances.

**Carbohydrates:** 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.

**Lipids:** Definition and classification of lipids, chemistry and biological importance of fatty

acids, waxes, glycerides, phospholipids, sphingolipids, glycolipids, sterols prostaglandins. Significance of lipids in biological membranes and transport mechanism.

**Amino acids and proteins:** 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.

**Recommended Books:**

- *Fundamentals of Biochemistry. (2008) 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.*
- *Text Book of Biochemistry (1970) by E. West & W. Todd Macmillan*
- *Biochemistry. (1999) 3rd Ed. by C. K. Mathews, K. E. Van Holde, & K.G. Ahern. Prentice Hall.*
- *Harper's Illustrated Biochemistry, 27th Ed. by R.K. Murray, D.K. Grannar, V. W. Rodwell. McGraw-Hill.*
- *Lehninger Principles of Biochemistry (2008) 5th Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers*

**BS 1<sup>st</sup> Year**

**Semester-II**

**Course Title: BIOANALYTICAL TECHNIQUES**

**Code: BATS-111**

**Credit Hours: 2+1**

**Marks**

**100**

**Course Objectives:**

At the end of the course, students will know the basics of conventional bioanalytical techniques, as well as general bioanalytical methods. They will learn and develop understanding about the bio-samples and their bio-based studies. Students will be able to select appropriate (bio) analytical methods to solve given analytical questions, to apply an analytical protocol and to analyze biological samples.

**Course Content:**

**Introduction:** Introduction to bioanalytical nomenclature, Biomacromolecules, Biopolymers, Bioanalytical samples (blood, cerebrospinal fluids, lymph, saliva etc.), Assays, Immobilization, etc.

**Bio-based Materials and Biosensing:** Sensors (chemical, physical, optical, electrical); Enzyme-based biosensors, Immune-sensors, DNA biosensors  
Environmental monitoring techniques, Biomarker analysis, Toxicological analysis

**Bioanalytical Methods:** Introduction to fundamental concepts of identification and quantification of analytes in biological samples

**Immunological techniques:** Enzyme Linked Immunosorbent Assay (ELISA), Radioimmunoassay (RIA), Fluorescence immunoassay (FIA)

**Centrifugation techniques:** Principles of sedimentation, Preparative (differential, density gradient) and analytical centrifugation

**Electrophysiological methods:** Electrocardiogram (ECG), Positron emission tomography (PET), Magnetic Resonance Imaging (MRI), Computed tomography (CT), Flow cytometry, Introduction to polymerase chain reaction

**BATS-111 Lab.**

1. Cleaning, washing, and calibration of volumetric glassware, electronic and analytical equipment available in laboratory
2. Statistical evaluation of analytical data including Linear Regression Analysis
3. Chemicals and solvents toxicity, safety and handling
4. Solution preparation: Molarity, Normality, Molality, Formality with the concept of conversion of units and stoichiometric calculations.
5. Preparation of buffer solutions
6. Acid Base Titration (Strong acid vs. weak base, strong acid vs. strong base, strong base vs. strong acid, strong base vs. weak base) with concept of indicators
7. Kjeldahl analysis: protein determination
8. Titration of amino acids
9. Spreadsheet Calculation: Amino Acid pH Distribution
10. Estimation of reducing sugars (Benedict's method)

**Note: Experiment can be designed/ modified by Instructors/Teacher keeping in view of semester courses contents according to lab facility**

**Recommended Books:**

- Mikkelsen, S. R., Corton, E. *Bioanalytical Chemistry, 2nd Edition*, John Wiley & Sons Inc. 2016, ISBN: 978-1-118-30254-5.
- Ugo, P., Marafini, P., Meneghello, M. *Bioanalytical Chemistry, From Biomolecular Recognition to Nanobiosensing*, De Gruyter, 2021, ISBN: 9783110589160. <https://doi.org/10.1515/9783110589160>
- Labuda, Jan et al., "Terminology of bioanalytical methods (IUPAC Recommendations 2018)" *Pure and Applied Chemistry*, 2018, <https://doi.org/10.1515/pac-2016-1120>
- Kubota, L. T., *Tools and Trends in Bioanalytical Chemistry*, Springer Cham, 2021, 978-3-030-82381-8. <https://doi.org/10.1007/978-3-030-82381-8>
- Victor, G., *Understanding Bioanalytical Chemistry, Principles and Applications*, John Wiley & Sons, 2009, ISBN: 978-0-470-02906-0.
- Andreas Manz, A., *Bioanalytical Chemistry*, Imperial College, Press, 2015, ISBN: 9781860943706.

## BS 2<sup>nd</sup> Year

### Semester-III

Course Title: NATURAL SCIENCE

Code: NASC-221

Credit Hours: 2 +1

Marks

100

### Course Objectives:

The objectives of the course are to educate the students about the fundamentals of chemical industry, raw materials, manufacturing and industrial processes. They will also become able to understand alternate energy sources.

### Course Content:

#### Fundamentals of Chemical Industry

Applied chemistry and its role in the commercial sector; Factors for installation of the chemical industry and registration process; Unit Operations and Unit Processes; Raw materials and chemicals; Flow sheet diagrams. Future trends of chemical industry

#### Alternate Energy Resources

Biomass Resources: Biomass conversion processes, bio gas technology. Alcohols and its uses as alternative fuel. Hydrogen: Hydrogen production, storage, handling and its uses as alternative fuel. Solar Energy: Photovoltaic power conversion & solar energy collectors. Hydel Energy: introduction to Hydel energy. Prospecting of hydel powers in Pakistan.

#### CHEM-221 Lab.

1. Safety and Record Keeping
2. Application of various units of concentration Molarity, Molality, Normality, PPM, PPB, PPT, and % age composition of a solution
3. Solution preparation
4. Standardization of prepared solution
5. Preparation of standard oxalic acid solution
6. Find strength in g/L of given sodium hydroxide solution with the help of standard oxalic acid solution
7. Find strength in g/L of given sodium hydroxide solution with the help of standard sodium carbonate solution and intermediate solution of an acid.
8. Production of biogas
9. Application of solar energy to produce Hydrogen from water,
10. Preparation of green house

#### Recommended Books:

- Kent, J. A., *Riegel's Handbook of Industrial Chemistry, 10th ed., Kluwer Academic/ Plenum Publishers, (2003).*
- George T. Auston., *Shreve's Chemical Process Industries, 5th Edition., McGraw Hill Book Company Inc. New York (1984).*
- P.C. Jain., *A Textbook of Applied Chemistry (1987).*
- Furnas, C. C., *Industrial Chemistry, Vol-II 6th Ed., D. VanNostrand Company, Inc. Princeton New Jersey, New York (1957).*
- Hede, P. D., Bier. S.P., *Inorganic and Applied Chemistry, Ventus publishing app., (2007).*
- Sharma, J., Ndi., *Applied Industrial Chemistry, Arise publishers & Distributors, (2012).*
- Erwin D. L., *Industrial Chemical Process Design, McGraw-Hill, (2002).*
- Prakash, N. B., *Applied Chemistry Lab Manual, LAP Lambert Academic Publishing, (2013).*



Strategic planning, for development (community linkages and mobilization) Human rights, constitutionalism and citizens' responsibilities Introduction to Human Rights Human rights in constitution of Pakistan Public duties and responsibilities Constitutionalism and democratic process Social Institutions, Social Groups, Formal Organizations and Bureaucracy Types of Groups, Group identities, Organizations Bureaucracy, Weber's model of Bureaucracy Role of political parties, interest groups, and non-governmental organizations Civic Engagement Strategies • Grassroots organizing and community mobilization • Advocacy and lobbying for policy change • Volunteerism and service-learning opportunities Social issues/Problems of Pakistan Overview of major social issues of Pakistani society Social Action Project

**Recommended Books:**

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

**Reference Books:**

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

**BS 2<sup>nd</sup> Year**

**Semester-III**

**Course Title: MATERIAL SCIENCE**

**Code: MTSC-251**

**Credit Hours: 2** **Marks 100**

**Course Objectives:**

Students will acquire knowledge about the key introductory concepts of materials, fundamental properties of materials, basic knowledge of metals, polymers and ceramics

**Course Content:**

Introduction to materials science, Classification of materials, structure of crystalline solids, Unit cell, types of unit cell like simple/primitive, face centered, body centered, end centered unit cells, Structure of some simple ionic compounds like CsCl, ZnS, CaF<sub>2</sub>, Radius ratio and co-ordination number, Number of atoms per unit cell in primitive, FCC, BCC unit cells, Calculation

of density of a crystal, Imperfections in solids

**Metals and alloys:** steel, iron, Aluminium, Titanium, Zinc, Copper, Nickel, Cobalt of their alloys, properties, application, everyday life examples and future trends. **Ceramics:** Introduction, natural ceramics, refractories, ceramics composites, cement and concrete, high performance ceramics, glasses.

**Polymers:** introduction and classifications advance polymer, liquid crystal polymer, films, foams, coatings, fiber, Adhesives, elastic polymers, thermoplastic polymers, thermosetting polymer.

**Composites:** History of composites, natural composite, polymer matrix composites, metal matrix composites, ceramic matrix composite, carbon carbon composites.

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity*, 3rd ed., Harper International SI Edition, (2006).
- House, J. E., *Inorganic Chemistry*, Academic Press. USA, (2008).
- Lee, J. D., *Concise Inorganic Chemistry*, 5th ed., Chapman and Hall, (1996).
- Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3rd ed., Pearson Education, India, (2008).
- Huheey, J. E., Keiter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Benjamin-Cummings Pub Co., (1993).
- Sharpe, A. G., *Inorganic chemistry*, 3rd ed., Pearson Education India, (1981).
- G.S. Sodhi, "Principle of Inorganic Chemistry" 1st edition 2013. R.L.Madan, *Inorganic Chemistry*, 2010
- Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Lahore, (2013).
- Catherine E. House crdft, Alan G. Sharpe, *Inorganic Chemistry*, 3rd ed., Prentice Hall, (2008).

**BS 2<sup>nd</sup> Year**

**Semester-IV**

**Course Title: Environmental Science**

**Code: ENSC-241**

**Credit Hours: 2**

**Marks**

**100**

**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 Content:**

**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.

**Recommended Books:**

- Baird, C. and Cann, M., *Environmental Chemistry*, 5th ed., W. H. Freeman & Company, (2012).
- Dara, S. S. and Mihsra, D. D., *A Text Book of Environmental Chemistry and Pollution Control*, 9th ed., S. Chand & Co. Ltd., (2004).
- Singhi, R. and Singh, V., *Green Chemistry for Environmental Remediation*, John-Willey & Sons, Inc., (2011).
- Holloway, A. M. and Wayne, R. P., *Atmospheric Chemistry*, 1st ed., Royal Society of Chemistry, (2010).
- Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. *Water Treatment Technologies for Removal of High Toxicity Pollutants*, Springerlink, UK, (2010).
- Manahan, S. E., *Environmental Chemistry*, 9th ed., CRC press, Taylor & Francis group, USA, (2009).
- Girard, J. E., *Principles of Environmental Chemistry*, 2nd ed., Jones and Bartlett publishers, (2010).
- Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. and Hulsal, C., *Principles of Environmental Chemistry*, 1st ed., Royal Society of Chemistry, (2007).
- Matalack, A., *Introduction to Green Chemistry*, 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
- Wright, J., *Environmental Chemistry*, Routledge, (2003).
- O'Neill, P., *Environmental Chemistry*, 3rd ed., Blackie Academic & Professional, (1998)

**BS 2<sup>nd</sup> Year**

**Semester-IV**

**Course Title: FUNDAMENTAL OF PHYSICS**

**Code: PHYS-200/BIOL-200**

**Credit 3**

**Marks 100**

**Hours:**

**Course Objectives:**

The main objective of this course is to understand the Physics of Electromagnetism and to develop simple mathematical formalisms to analyze the electromagnetic fields and interactions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

**Course Content:**

Electrostatics: Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to a Charge Distribution, Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry.

Electric Potential: Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation

between Electric Field and Electric Potential Energy.

**Capacitors and Capacitance:** Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in an Electric Field, Dielectrics and Gauss' Law (1 week).

DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, Semiconductors and Superconductors, Work, Energy, and EMF, Resistances in Series and Parallel, Single and Multi-loop Circuits, Kirchhoff's Rules, RC Circuits, Charging and Discharging of a Capacitor.

**Magnetic Field and Magnetic Force:** Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot- Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole, Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self-Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.

#### **Alternating Fields and**

**Currents:** LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents, Forced Oscillations, Resistive, Capacitive, and Inductive Loads, RLC series Circuit, Power in AC Circuits, Transformers, Gauss' Law for Magnetism, Induced Magnetic Fields, Displacement Current, Spin & Orbital Magnetic Dipole Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis.

#### **Recommended Books:**

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

### **BS 2<sup>nd</sup> Year**

#### **Semester-IV**

**Course Title: FUNDAMENTAL OF BIOLOGY**

**Code: BIOL-200**

**Credit Hours: 3**

**Marks 100**

#### **Course Objectives:**

Students will gain basic knowledge about the biology including various subdivisions and applications. They will learn how biology is necessary for human beings and how it is linked with the development and evaluation of human beings.

#### **Course Content:**

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

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

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

**BS 2<sup>nd</sup> Year**

**Semester-IV**

**Course Title:**

**LAW AND LEGISLATURE**

**Code:**

**LALA-200**

**Credit Hours:**

**2**

**Marks 100**

**Course Objectives:**

This course introduces fundamental principles of law and legislature with a focus on topics relevant to chemistry students. It explores the legal framework surrounding scientific research, intellectual property rights, environmental regulations, and ethical considerations in scientific practice. Through case studies and discussions, students will gain an understanding of how law and legislation intersect with chemistry and scientific innovation.

**Course Content:**

**Introduction to Law and Legal Systems:** Overview of legal systems and branches of law, Basic legal concepts: statutes, regulations, precedent, Sources of law relevant to chemistry

**Legal Framework for Scientific Research:** Ethical principles in scientific research, Institutional review boards and research ethics, Legal requirements for conducting experiments and trials

**Intellectual Property Rights in Chemistry:** Patents, trademarks, and copyrights, Protection of inventions and innovations, Case studies on landmark patent disputes in chemistry

**Environmental Regulations and Chemistry** Overview of environmental laws and regulations, Chemical substances and their regulation, Case studies on environmental litigation involving chemical pollution

**Ethical Considerations in Chemistry:** Ethical responsibilities of chemists, Professional codes of conduct, Ethical dilemmas in research and industry

**Legal Issues in Chemical Industry:** Product liability and safety regulations, Compliance with health and safety standards, Legal challenges in chemical manufacturing and distribution.

**Recommended Books:**

- *"Chemistry and the Law" by Margaret E. McLaughlin*
- *"Intellectual Property Law for Chemists" by John R. Thomas*
- *"Environmental Law and Policy for Chemists" by William H. Rodgers Jr.*

**BS 2<sup>nd</sup> Year**

**Semester-IV**

**Course Title:**

**JOURNALISM**

**Code:** JOUR-200  
**Credit Hours:** 2  
**Marks** 100

### **Course Objectives:**

This introductory course in journalism is specifically designed for chemistry students to develop essential communication and media literacy skills within the context of scientific reporting and communication. The course will cover basic journalism principles, news writing techniques, ethical considerations in science journalism, and the role of media in shaping public perception of scientific advancements and challenges. Students will learn to critically analyze and report scientific information accurately, engaging with various media platforms relevant to the field of chemistry.

### **Course Content:**

#### **Fundamentals of Journalism:**

Definition of journalism and its role in society, History of journalism, Key principles of ethical journalism

#### **News Writing and Reporting:**

Basics of news writing: inverted pyramid structure, headline writing, Conducting interviews and gathering information, Writing news articles related to chemistry topics

#### **Media Literacy in Science Communication**

Understanding different media formats: print, digital, broadcast, Analyzing and critiquing science news coverage in mainstream media, Identifying bias and evaluating sources in science reporting

#### **Science Communication Techniques**

Communicating complex scientific concepts to non-expert audiences, Using visuals, graphics, and multimedia tools for effective science storytelling, Writing press releases, blogs, and social media posts related to chemistry news

#### **Ethical Issues in Science Journalism Specifically in Chemistry**

Accuracy, objectivity, and fairness in science reporting, Avoiding sensationalism and misinformation in science news, Ethical considerations in reporting on controversial scientific topics

#### **Role of Media in Science Education and Public Engagement**

Importance of science journalism in fostering public understanding of chemistry and scientific research, Impact of media coverage on public perception of scientific issues, Engaging with the public through science outreach initiatives and media campaigns

Writing and editing news articles on current chemistry developments, Creating multimedia presentations or podcasts on chemistry topics and Industry Insights

Compiling a portfolio of Chemistry news articles, multimedia projects, and reflections on chemical science journalism experiences throughout the course, Presenting and discussing the portfolio in a culminating showcase.

### **Recommended Books:**

- *Christians, C.G., Fackler, M., Kreshel, P.J., & Richardson, K.B. (2020). Media Ethics: Cases and Moral Reasoning (11th ed.). Routledge. <https://doi.org/10.4324/9780429282249>*
- *Mark Poepsel, (2018).Media, Society, Culture and You Publisher Rebus Community*
- *American Chemical Society (ACS): Specifically geared towards chemists. Provides a source of information for every step in the publishing process. It is printed by Oxford University Press.*
- *Scientific Style and Format, The CSE Manual for Authors, Editors, and Publishers, Eighth Edition*
- *Andrew Abbott (2014) Digital Paper-A Manual for Research and Writing with Library and*

	<b>BS 2<sup>nd</sup> Year</b>		
<b>Semester-IV</b>			
<b>Course Title:</b>	<b>INTRODUCTION TO MASS COMMUNICATION</b>		
<b>Code:</b>	<b>IMCO-200</b>		
<b>Credit Hours:</b>	<b>2</b>	<b>Marks</b>	<b>100</b>

**Course Objectives:**

The students will understand the fundamental concepts of Communication, Mass Communication, and Journalism, including their definitions and distinguishing characteristics. Teaching Chemistry students about Mass Communication will help them understand how to effectively communicate scientific information to diverse audiences. Moreover they will be able to analyze the significance of Mass Communication in society, recognizing its role in shaping public opinion, agenda setting, and dissemination of information across diverse media platforms.

**Course Content:**

Types Of Communication, The Significance of Mass Communication, The Process And Models of Communication, Essentials for Effective Communication, Barriers in Communication, Four Theories of Press, The Role of Mass Media in Agenda Setting, Various Types Of Media Including Print Media and Electronic Media, The Importance of Social Media in Society, Functions of Mass Communication, and Aspects Related to News Such as its Importance, Types, and Elements.

Public Relations and Marketing in Science: Strategies for promoting scientific work and research findings. Crisis communication and handling controversies in science. Building and maintaining relationships with the media.

**Recommended Books:**

- *Dominick, J. R. (2006) Dynamics of Mass Communication (8<sup>th</sup> ed.), New York: McGraw-Hill*
- *Staubhaar, LaRose. (2002) Media Now: Communication Media in the Information Age (3<sup>rd</sup> ed.). USA: Wadsworth.*
- *Understanding Mass Communication, Defleur Dennis, Houghton, 2000*
- *Introduction to Mass Communication, Edward J. Whetmore Publishing, (1995)*
- *Media of Mass Communication, John Vivian and Bacon, 2000*
- *Introducing Mass Communication, Michael W. Gambol, 1996.*

**BS 2<sup>nd</sup> Year**

**Semester-IV**  
**Course Title:**  
**Code:**  
**Credit Hours:**

**Public Administration**  
**PADM-200**

**Marks 100**

**Course Objectives:**

The course gives an overview of public administration concepts, offer a definition of public administration, identify ways that public and private organizations are similar and different, explain the consequences of those differences for what government does and does not do. The students will be able to learn about the tools that modern public administrators use to pursue public goals, along with the pros and cons of those tools, explain the major values that public administration has and illustrate how those affect the work of government.

**Course Content:**

Introduction, definition, Nature and Scope of Public Administration, Approaches of public administration Public vs private sector and public vs private administration- similarities and differences, Evolution of public administration as a specialized academic discipline

Public Administration and Development: Administrative Structure of Pakistan: Nature, Organization and Management Processes in the Central and the Provinces. Role of Public administration in Modern Welfare States, Constitutional framework of Public Administration in Pakistan

Personal and Financial Administration, its Techniques and Functions.

Corruption, its Types, causes and Effects.

Decision Making, Role of Bureaucracy, Good Governance

**Recommended Books:**

- *Khan, Haroon A, An Introduction to Public administration (Maryland; University Press of America 2008).*
- *Sharma, Urmila, Public administration (New Delhi: Atlantic Publishers,2002).*
- *Khan, Sultan, Dr, Public Administration (Famous Books 40- Urdu Bazar, Lahore).*

## BS 2<sup>nd</sup> Year

**Semester-IV**  
**Course Title:**

**EDUCATION**

**Code:**

**EDU-200**

**Credit Hours:**

**2**

**Marks**

**100**

### **Course Objectives:**

The purpose of this course is to give an introduction to BS students to understand the basic concepts of education. Education is in fact a key subject to get insight of teaching and learning process. It is not only helpful for students but it will also be useful for prospective teachers. This course will provide learners with grounding in view of philosophy, teaching, learning, curriculum and assessment and evaluation. The major goal is to give an overview about the whole process of education which evolves around the above mentioned key areas. The numerous topics under these key areas will develop a thorough insight of learners to enhance their teaching and learning skills.

### **Course Content:**

**Chapter 1:** Basics of Education Introduction (Why this course?), Concept and meaning of education, Islamic concept of education, Modes of Education, formal, informal, and non-formal education, Philosophical foundations of education

**Chapter 2:** Teaching : Role of teacher in classroom: teaching philosophy and classroom management, Principles of effective teaching, Qualities of a good teacher, Teaching strategies and methods

**Chapter 3:** Curriculum ; Introduction of curriculum and curriculum development, Curriculum Models Curriculum development in Pakistan

**Chapter 4:** Education and Psychology ; Relationship between psychology and education, Laws of learning, Factors affecting students' learning, Theories of Motivation (Intrinsic Motivation and Extrinsic Motivation)

**Chapter 5:** Assessment and Evaluation; Concept of assessment and evaluation, Types of assessment and evaluation, Internal and external assessment, Essay type test and Objective type test, Course Wrap up

**Assessment and Evaluation:** Course Grading Policy, Grading policy will be based on Mid-term and Final-term exams. Additionally, class participation, class assignments, surprise tests, quizzes and attendance will be marked for sessional marks as per university rules. The assessment policy will be shared with the students at the beginning of the course.

### **Recommended Books:**

- Downey, M., & Kelly, A. V. (1986). *Theory and practice of education*. Sage.
- Lowery, C. L., & Jenlink, P. M. (Eds.). (2019). *The Handbook of Dewey's Educational Theory and Practice*. BRILL.
- Hattie, J., & Yates, G. C. (2013). *Visible learning and the science of how we learn*. Routledge.
- Moore, A. (2012). *Teaching and learning: Pedagogy, curriculum and culture*. Routledge.
- Jarvis, P. (Ed.). (2006). *The theory and practice of teaching*. Routledge.
- Daniels, H., Lauder, H., & Porter, J. (Eds.). (2012). *Educational theories, cultures and learning: A critical perspective*. Routledge.
- Boyle, B., & Charles, M. (2016). *Curriculum development: A guide for educators*. Sage.
- Secolsky, C., & Denison, D. B. (Eds.). (2012). *Handbook on measurement*,

- *assessment, and evaluation in higher education. Routledge.*
- *ul Amin, S. N., & Jan, M. H. Educational Measurement and Evaluation. Evincepub Publishing.*
- *Mangal, S. K., & Mangal, S. (2019). ASSESSMENT FOR LEARNING. PHI Learning Pvt. Ltd..*

### BS 2<sup>nd</sup> Year

**Semester-IV**  
**Course Title:**

**History**

**Code:**

**HIST-200**

**Credit Hours:**

**3**

**Marks**

**100**

#### **Course Objectives:**

The objective of the undergraduate history course is to develop students' understanding of historical events, processes, and contexts across different periods and regions. It aims to cultivate critical thinking, research skills, and the ability to analyze historical sources and evidence. Students will also explore the impact of historical developments on contemporary society and global perspectives.

#### **Course Content:**

**Introduction:** What is History? Literal, terminological and conceptual meaning of history  
History as Fact History as Process History as Narrative

#### **Memory, Record and History**

**Nature of History:** Being and Becoming; Continuity and Change; Evolution, Progress and Development  
Macrocosm & Microcosm: Time, Space, Causation, Facts and opinion/objectivity & Subjectivity

**Utility, Benefits & importance of History:** History as a corrective/cohesive force; History as a repetitive force  
Continuity of History from Past to Future Lessons from Past Historical determinism, etc. History as Mother of All Sciences/Knowledge

**Epistemological nature of History:** Relationship of History with other forms of knowledge:  
Natural Sciences Social Sciences Literature and Arts

#### **Forms and Classification of History**

#### **Recommended Books:**

- *Burke, Varieties of Cultural History, Cornell University Press, 1977 Carlo, Ginzburg. Clues.*
- *Myths, and the Historical Method, John Hopkins: University Press, 1992*
- *Carr, E. H., What is History? Harmondsworth: Penguin, 1961*
- *Cohn, Bernard. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988*
- *Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.*
- *Daniels, Studying History: How and Why, New Jersey, 1981.*
- *Gertrude Himmelfarb. The New History and the Old, Cambridge: Harvard University Press, 1987*
- *Govranski. History Meaning and Methods, USA, 1969*
- *Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991*
- *Qadir, Khurram, Tarikh Nigari Nazriyat-o-Irtiqa, Lahore: Palgrave, 1994.*
- *Qureshi, Muhammad Aslam. A Study of Historiography. Lahore: Pakistan Book Centre, Latest Edition.*
- *Steedman. Caroline, Dust: The Archive and Cultural History, Manchester University Press, 2002*

- Stern Fritz, *Varieties of History: from Voltaire to the Present*, Vintage, 2nd Edition 1975
- Tahir Kamran, *The Idea of History Through Ages*, Lahore: Progressive Publisher, 1993
- Lemon, M. C., *Philosophy of History*, London: Routledge, 2003
- Marwick, Arthur, *The New Nature of History*, London, 1989, pp.31-35.
- Roberts, Geoffrey, ed., *History and Narrative Reader*, London: Routledge, 2001.
- Shafique, Muhammad, *British Historiography of South Asia: Aspects of Early Imperial Patterns and Perceptions*, Islamabad, NIHCR, Quaid-iAzam University, 2016

### BS 2<sup>nd</sup> Year

#### Semester-IV

#### Course Title:

**International Relations**

#### Code:

**INTR-200**

#### Credit Hours:

**2**

**Marks 100**

#### Course Objectives:

The purpose of this course is to understand the key concepts of academic International Relations. Moreover, students will be able to get understanding about pattern and dynamics of International Politics. And, they will be taught key concepts such as International Politics, State-System, National Interest, Nationalism, Cold War, Détente, Foreign Policy, International Political Economy, Deterrence, Globalization etcetera. Moreover, focus of this course also will be on Pakistan's participation in international arena especially on Pakistan's engagement with major powers such as USA, China, Russia, China and Pakistan's relations with its neighbors particularly India. Pakistan's response to contemporary regional and international issues will also be discussed during this course.

#### Course Content:

The class will be conducted in lecture cum discussion format. However, two-third portion of class session will be reserved for lecture while remaining one-third time of the class session will be allocated for discussion. All students are requested to read from the prescribed texts before coming to class. Class participation, presentation, assignments, mid-term and final examinations are the elements in the determination of final grade. All assignments must be submitted by the due date. Eighty percent attendance, as per the University rules, is mandatory.

**Definition and Scope of International Relations:** Definition of International Relations, World Politics and International ,Politics, IR in everyday life, State and State System, Evolution of global state system, Historical Context of International Relations 1900-1939, First World War (1914-1919), Causes and Consequences of WWI, Inter war Period 1919-1939, The Treaty of Versailles, The Great Depression, World War Second (1939-1945), Causes and Consequences of World War II, International Relations 1945-1990, The Post World War II Developments, Cold War, Nuclearization of world politics, Cold War: Definition, Origin and Causes, Policy of Containment, The Marshall Plan, Politics of Alliances (NATO & WARSAW PACT), SEATO & CENTO, Détente: Rise and Fall, SALT I & SALT II, End of Cold War, The Concept of Power, Balance of Power, Theoretical Approaches in IR Liberalism, Realism, Marxism, International Political Economy, Definition of IPE, Approaches of Political Economy, Mercantilism, Economic Liberalism, Marxism, The concept of Foreign Policy in IR, The concept of Nationalism, Globalization, Pakistan and International Community

#### Recommended Books:

- Robert Jackson and George Sorensen, *Introduction to International Relations*, (New York: Oxford University Press, 1999)

- John Baylis & Steve Smith, *The Globalization of World Politics: An Introduction to International Relations*, 2nd ed., (New York: Oxford University Press Inc., 2001)
- Charles W. Kegley, Jr. & Eugene R. Wittkopf, *World Politics: Trend and Transformation*, 6th ed., (New York: St. Martin's Press, 1997)
- Theodore A. Columbus, *Introduction to International Relations: Power and Justice*, 4th ed. (New Jersey: Prentice-Hall, Inc. 1978)
- Joshua S. Goldstein, *International Relations*, 5th ed. (New Delhi: Pearson Education Inc., 2004)
- Abdul Sattar, *Pakistan Foreign Policy: 1947-2001 A Concise History*, (Karachi: Oxford University Press, 3rd ed., 2013)

## BS 2<sup>nd</sup> Year

### Semester-IV

**Course Title: ENTREPRENEURSHIP**

**Code: MNGT-200**

**Credit Hours:**

**2**

**Marks**

### Course Objectives:

- To provide students with an understanding of the nature of business formation, growth & execution with particular reference to:
- To develop in students an understanding of the theoretical and practical aspects of Entrepreneurships literature.
- To develop in students the skills of analysis, synthesis and evaluation in context of Pakistani business environment.

### Course Content:

**Introduction To Entrepreneurship:** The Nature and Importance of Entrepreneurship: Nature and Development of Entrepreneurship; Entrepreneurial Decision Process; Role of Entrepreneurs in Economic development; Ethics and Social Responsibility of Entrepreneurship; The Future of Entrepreneurship, The Entrepreneur and Entrepreneurial Mind: The Entrepreneurship process; Myths of Entrepreneurs, Managerial VS Entrepreneurial Decision Making; Entrepreneurial Leadership Characteristics

**Idea Generation:** The Individual Entrepreneur, and Techniques for Idea Generation Process; Entrepreneur VS Intrapreneur. Inside the Entrepreneurial Mind: From Ideas to reality: Creativity, Innovation and Entrepreneurship; Creativity A necessity for survival; Creative Thinking; Barriers to creativity; How to enhance creativity; The creative Process; Techniques for improving the creative process; Protecting your ideas.

**Planning:** The Customer and Product Plan/Feasibility: Understanding of Customer through Demand and Desire, and of Product (Good and/or Service) The Industry and Marketing Plan/Feasibility: Understanding of Marketing Plan, Characteristics of Marketing Plan; and Environment Analysis and Steps in preparing the Marketing Plan The Financial Plan/Feasibility: Operating and Capital Budgets, Break Even Analysis; Cash Flows and Balance Sheets, The Organizational Plan/Feasibility: Developing the management team; Building the successful Organization, The Role of BODs

**Business Plans And Business Model Business Plan:** Components, and Classification of Business Plans Financing Options: e.g. Leveraged Buyouts;

**Product Life Cycle:** Preparing for the new Launch; Execution & Growth; Managing early growth of the New Venture

**Environmental Issues / Trends And Their Impact Pestel :**Analysis, and Competitive

Environment Analysis

**Strategic Options For Growth:** Growth Options: Joint Venture; Franchising; Acquisitions; Synergy; Mergers; Hostile Takeovers; Licencing etc.

Sustainability Analysis and Maintenance

**International Entrepreneurship Opportunities:** The Nature of International Entrepreneurship; Importance of International Entrepreneurship; Entrepreneurial Entry into International Business

**Contemporary Issues:** Management of SMEs in today's world , Promotion and Development of SMEs in Pakistan, SMEs' contribution towards Income, Employment and other Macroeconomic Variables , Management succession and continuity: A family Business Perspective, Woman and Minority Entrepreneurship , Social Entrepreneurship (Social Responsibility) , Latest Theories/Research Work on SMEs and Entrepreneurship ,Any other ancillary topic/issue/research/article

**Recommended Books:**

**Note: Updated version of following reference books may be consulted from library or available online.**

- *Entrepreneurship: Successfully Launching New Ventures* by Bruce R. Barringer, Duane Ireland, Latest Edition .
- *Entrepreneurship new venture creation* by David H. Holt - Latest Edition
- *Pitts R.A. and Snow C.C., Strategies for Competitive Success, Johan Willy - Latest Edition*
- *Barlett, Christopher A., and Sumantra Goshal. Strategy & Leadership - Latest Edition*
- *Hisrich and Peters, Entrepreneurship, McGraw-Hill – Latest Edition*
- *Carrier, Camille., Entrepreneurship in Large Firms and SMEs. A Comparative Study – Latest Edition*

**Reference Books:**

- *Kagan, Daniel. (Latest Edition), Why Entrepreneurs ignore good advice: A study in non-linearity and Ego. Human System Management Vol14, no 4, pp327-33.*
- *Thomas W. Zimmer, Norman M, Essentials of entrepreneurship and small business management, Prentice Hall - Latest Edition*
- *Donald F. Kuratko, Richard M. Hodegetts, Entrepreneurship, Theory, Process and Practise - Latest Edition*
- *Essentials of Entrepreneurship and Small Business Management, Norman M. Scarborough, Latest Edition*