# CURRICULUM

# OF

# CHEMISTRY

## BS & MS/MPhil

(Revised 2013)


**HIGHER EDUCATION COMMISSION**
**ISLAMABAD**

# CURRICULUM DIVISION, HEC

| | |
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Composed by: Mr. Zulfiqar Ali, HEC, Islamabad

# Table of Content

# PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled "Supervision of Curricula and Textbooks and Maintenance of Standard of Education". With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

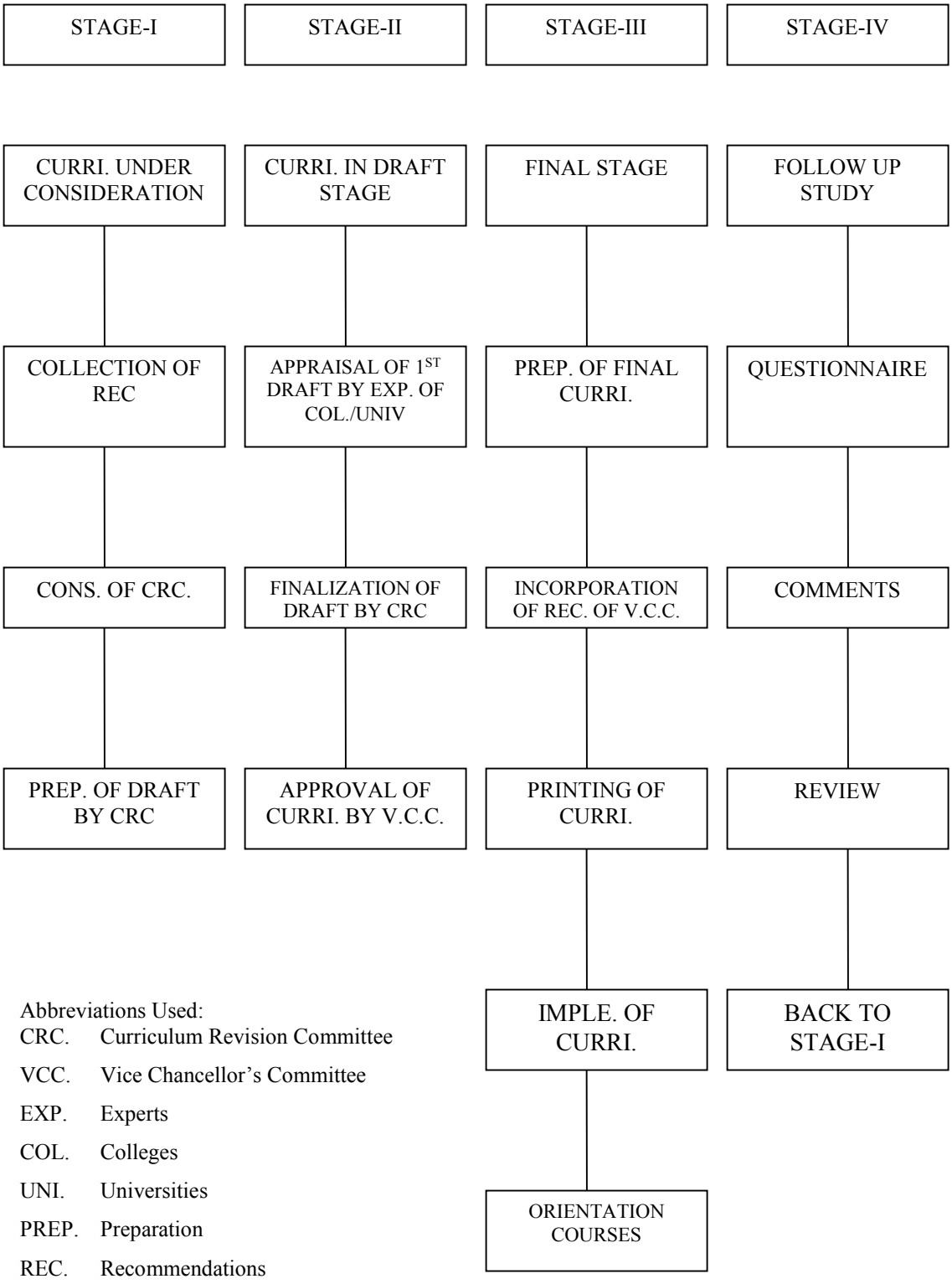
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC's, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC (www.hec.gov.pk).

**(Fida Hussain)**
**Director General (Academics)**

# CURRICULUM DEVELOPMENT PROCESS




Abbreviations Used:

| | |
|---|---|
| CRC. | Curriculum Revision Committee |
| VCC. | Vice Chancellor's Committee |
| EXP. | Experts |
| COL. | Colleges |
| UNI. | Universities |
| PREP. | Preparation |
| REC. | Recommendations |

## Introduction:

The final meeting of National Curriculum Revision Committee in the discipline of Chemistry was held at HECR Regional Centre, Peshawar from March 06-08, 2013, to review and finalized the draft curriculum of B.S.(4 year) and M.S Program in Chemistry prepared in Preliminary meeting held in September, 2012, in Karachi and to make recommendations for the promotion and development of the discipline. The following members attended the meeting:-

Prof. Dr. Munawar Ali Munawar, Convener
Institute of Chemistry,
University of the Punjab, Lahore.

Prof. Dr. Islam Ullah Khan, Secretary
Dean, Faculty of Science and Technology
Chairperson, Department of Chemistry,
Government College University, Lahore.

Prof. Dr. Fahim Uddin, Member
Registrar, Federal Urdu University of Arts, Sciences &
Technology, Karachi.

Prof. Dr. Fida Mohammad, Member
Dean, Faculty of Material Science and Engineering,
GIK Institute of Engineering & Technology,
Topi, Swabi, KPK.

Prof. Dr. Shaikh Sirajuddin Nizami, Member
Chairman, Department of Chemistry,
University of Karachi, Karachi.

Prof. Dr. Imdad Ullah, Member
Director, Institute of Chemical Sciences,
University of Peshawar, Peshawar.

Prof. Dr. Iftikhar Hussain Bukhari, Member
Chairman, Department of Chemistry,
Government College University, Faisalabad

Prof. Dr. Vinod Kumar Dewani, Member
Department of Chemistry,
Shah Abdul Latif University, Khairpur.

Prof. Dr. Rashid Ahmad, Member
Chairman, Department of Chemistry,
University of Malakand, Chakdara Dir (Lower).

Dr. Dildar Ahmed Alvi, Member
Department of Chemistry,
Forman Christian College, Lahore.

Prof. Dr. Mohammad Saeed Iqbal Member
Department of Chemistry,
Forman Christian College, Lahore.

Dr. Muhammad Danish, Member
Associate Professor,
Chairman, Department of Chemistry,
University of Gujrat, Gujrat.

Dr. Falak Sher, Member
Assistant Professor,
Department of Chemistry,
Lahore University of Management Sciences (LUMS), Lahore.

Dr. Muhammad Nasimullah Qureshi, Member
Assistant Professor,
Department of Chemistry,
Abdul Wali Khan University, Mardan.

Dr. Iqbal Shah Member
Assistant Professor,
Department of Science Education,
Allama Iqbal Open University,
Islamabad.

Dr. Farooq Anwar Member
Chairman
Department of Chemistry,
University of Sargodha, Sargodha.

Prof. Dr. Mohammad Saeed Iqbal Member
Department of Chemistry,
Forman Christian College, Lahore.

The following members could not attend the meeting due to their official/personal engagements.

Dr. Tahira Sultana,

Assistant Professor,
Department of Environmental Science,
International Islamic University,
H-10, Islamabad.

Dr. Muhammad Aziz Ch.,
Professor,
Department of Chemistry,
Mirpur University of Science & Technology,
Campus, Bhimber, AJK.

Dr. Mohammad Yaqoob
Associate Professor,
Department of Chemistry,
University of Balochistan, Quetta.

Dr. Nikhat Ahmed Siddiqui,
Professor & Chair,
Department of Biochemistry,
University of Karachi, Karachi.

Dr. Mehdi Hassan Kazmi,
Department of Applied Chemistry,
Chemical Technology,
University of Karachi, Karachi

The meeting started with the recitation of Verses from the Holy Quran by Dr. Iftikhar Hussain Bukhari. Mr. Zaheer Ahmad Awan , Director Regional Centre, Peshawar, HEC on behalf of the Chairman and the Executive Director, HEC welcomed the participants and thanked all the members of the Committee for sparing precious time for this national cause. He further added that their efforts will go along way in developing workable, useful and comprehensive degree programmes in Chemistry. He briefed the participants on the aims and objectives of the meeting with a particular focus on revising the course outlines of BS (4-Years) and also developing the course outlines of MS Programme in Chemistry so as to make it compatible with international standards and demands as well as ensuring the uniformity of academic standard within the country.

The Convener started proceedings of the meeting in accordance with the agenda. After exhaustive discussion, the Committee finalized the layout of courses in the light of guidelines provided by the HEC. The Committee reviewed the course contents prepared by the pre-constituted sub-committees of the experts along with draft Curriculum of Chemistry compiled in preliminary meeting.

Mr. Nasir Shah, Deputy Director, Regional Centre, Peshawar requested the Convener of the meeting to keep the curriculum at par with quality standards set by the HEC in order to meet the accreditation criteria. The Director, RC Peshawar then requested the Convener of the Committee to conduct proceedings of technical sessions for three days. The Convener started proceedings of the meeting in accordance with the agenda.

The Committee reviewed the course contents prepared by the pre-constituted sub-committees of specialists along with draft Curriculum of Chemistry compiled in the preliminary meeting.

The Committee, considered the recommendations given by the sub-committees as well as the feedback from the meetings held at Lahore, Peshawar and Karachi. After thorough deliberations for three days, the Committee unanimously approved the final draft curriculum for BS (4-year).

The Committee discussed the agenda item regarding development of scheme of studies for MS/MPhil Chemistry degree programme .After detailed discussion, the Committee concluded that as per HEC policy and international standards credit hours for MS/MPhil will be 30 (24 credit hours for course work and 6 credit hours for research work). The suggested course titles for the MS/MPhil programme were included in the scheme. It was recommended that the institutions may offer any suitable courses as per their needs or resources. The Committee also proposed the allocation of MS/MPhil course codes.

In conclusion, the Committee, in the light of HEC guidelines, achieved the following goals:-

*Finalized the draft Curriculum of Chemistry for BS and MS /MPhil Programs, so as to bring it at par with international standards.*

*Incorporated latest reading materials for each course.*

*Made recommendations for promotion and development of the discipline of Chemistry.*

*Approved the Final Curriculum of Chemistry for BS and MS/MPhil Programs.*

The Convener of the NCRC thanked the members for their active participation in finalizing the draft curriculum keeping in view the requirements of the country and to make it more practical, competitive and effective, according to country needs. The Committee acknowledged the services of Dr. Farooq Anwar, and Prof. Dr. Iftikhar Bukhari for the preparation of final draft.

Mr. Riaz-ul-Haque, Assistant Director, Curriculum HEC thanked the Convener, the Secretary and all the members of the Committee for sparing their precious time and for their valuable contribution towards preparation of the final draft.

The Committee highly appreciated the efforts made by officials of HEC Regional Centre, Peshawar for hospitality and making arrangements to facilitate the meetings of the Committee and their accommodation at Peshawar.

The meeting ended with the vote of thanks from and to the Chair.

**THE FOLLOWING SCHEME OF STUDIES WAS APPROVED BY THE COMMITTEE**

## BS (4-YEAR) PROGRAMME IN CHEMISTRY
## SCHEME OF STUDIES

| **Course Title** | **Credit hours** | |
|---|---|---|
| **Semester-I** | **Theory** | **Lab.** |
| ENG-100: English-I (Functional) | 3 | 0 |
| GEN-100: General-I | 3 | 0 |
| GEN-101: General-II | 3 | 0 |
| MATH-100: Mathematics-I/Functional Biology | 3 | 0 |
| COMP-100: Computer Applications | 3 | 0 |
| CHEM-151: Inorganic Chemistry | 3 | 1 |
| **Total** | 18 | 1 |
| **Semester-II** | **Theory** | **Lab.** |
| ENG-200: English-II (Functional) | 3 | 0 |
| GEN-200: Islamic Studies / Ethics | 2 | 0 |
| GEN-201: General-III | 3 | 0 |
| MATH-200: Mathematics-II/Functional Biology/University Optional | 3 | 0 |
| STAT-100: Statistics | 3 | 0 |
| CHEM-161: Organic Chemistry | 3 | 1 |
| **Total** | **17** | **1** |
| **Semester -III** | **Theory** | **Lab.** |
| ENG-300: English-III (Report Writing) | 3 | 0 |
| GEN-300: Pakistan Studies | 2 | 0 |
| GEN-301: General-IV | 3 | 0 |
| GEN-302: General-V | 3 | 0 |
| CHEM-141: Environmental Chemistry | 3 | 0 |
| CHEM-171: Physical Chemistry | 3 | 1 |

| | | |
|---|---|---|
| **Total** | **17** | **1** |

| **Semester -IV** | **Theory** | **Lab.** |
|---|---|---|
| ENG-400: English-IV / University Optional | 3 | 0 |
| GEN-401: General-VI | 3 | 0 |
| GEN-401: General-VII | 3 | 0 |
| CHEM-111: Analytical Chemistry | 2 | 1 |
| CHEM-121: Applied Chemistry | 2 | 0 |
| CHEM-131: Biochemistry | 2 | 1 |
| **Total** | **15** | **2** |

| **Course Title** | **Credit hours** | |
|---|---|---|
| **Semester-V** | **Theory** | **Lab.** |
| CHEM-251: Inorganic Chemistry | 3 | 1 |
| CHEM-261: Organic Chemistry | 3 | 1 |
| CHEM-271: Physical Chemistry | 3 | 1 |
| CHEM-211: Analytical Chemistry | 3 | 1 |
| **Total** | **12** | **4** |
| **Semester-VI** | **Theory** | **Lab.** |
| CHEM-351: Inorganic Chemistry | 3 | 1 |
| CHEM-361: Organic Chemistry | 3 | 1 |
| CHEM-371: Physical Chemistry | 3 | 1 |
| CHEM-*: Biochemistry/Applied Chemistry/Fuel Chemistry etc. | 3 | 1 |
| **Total** | **12** | **4** |
| **Semester-VII:** Specialization (Inorganic/Organic/Physical/ Analytical/Biochemistry/Applied Chemistry/ Fuel Chemistry etc.) | Theory | Lab. |
| Paper-I | 3 | 0 |
| Paper-II | 3 | 0 |
| Paper-III | 3 | 0 |
| Lab-I | 0 | 1 |
| Elective Course-I (other than the field of specialization) | 3 | 0 |
| Research Thesis / Research Project / Advanced Lab. / Position Paper (literature survey) | 0 | 3 |
| **Total** | **12** | **4** |
| **Semester - VIII:** Specialization (Inorganic/ Organic/Physical/ Applied/Analytical-/Biochemistry/ Fuel Chemistry etc.) | Theory | Lab |
| Paper-IV | 3 | 0 |
| Paper-V | 3 | 0 |
| Paper-VI | 3 | 0 |
| Lab-II | 0 | 1 |
| Elective Course - II (other than the field of specialization) | 3 | 0 |
| Research Thesis / Research Project / Advanced Lab / Position Paper (write-up) | 0 | 3 |
| Total | 12 | 4 |

**Total Credit Hours: 136**

**Notes:**

i) This revised curriculum provides baseline information for designing a befitting BS program; the institutions may include any appropriate topic at an appropriate place or reschedule any course as per institutional convenience.

ii) * The course codes may also be allocated as per institutional policy and may be coded as appropriate.

# DETAIL OF COURSES

## BS 1st Year
## Semester-I

**Course Title:** **INORGANIC CHEMISTRY**
**Code:** **CHEM-151**
**Credit Hours:** **3+1**

### Course Objectives:

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

### Course Content:

**Chemical Bonding:**

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

**Acids and Bases:**

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

**p-Block Elements:**

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

**CHEM-151 Lab.**

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

## Recommended Books:


1. Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity,* 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., *Inorganic Chemistry,* Academic Press. USA, (2008).
5. Lee, J. D., *Concise Inorganic Chemistry,* 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3rd ed., Pearson Education, India, (2008).
7. Huheey, J. E., Kieter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity,* 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., *Inorganic chemistry,* 3rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry,* Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, *Inorganic Chemistry,* 3rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., *Descriptive Inorganic Chemistry,* 2nd ed., Brooks Cole, (2010).
12. Wulfsberg G., *Principles of Descriptive Inorganic Chemistry,* 1st ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., *Laboratory Safety for Chemistry Students,* John-Wiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., *Vogel's Textbook of Quantitative Chemical Analysis,* 6th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., *Vogel's Qualitative Inorganic Analysis,* 7th ed., (7th imp.), Pearson Education, Ltd., (2009).

# BS 1st Year
# Semester-II

**Course Title:** **ORGANIC CHEMISTRY**
**Code:** **CHEM-161**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Content:

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

**Chemistry of Hydrocarbons:**
Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and electrophilic substitution reactions.

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

**CHEM-161 Lab.**
Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

## Recommended Books:

1. Brown, W. and Poon, T., *Introduction to Organic Chemistry,* 3rd ed., John-Wiley & Sons, Inc., (2005).

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

# BS 2nd Year
# Semester-III

**Course Title:** **ENVIRONMENTAL CHEMISTRY**
**Code:** **CHEM-141**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

### Atmospheric Pollution:

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

ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

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

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

**Green Chemistry:**
Atom economy, integrated pests management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water based paints.

## Recommended Books:


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

12. Elsom, D. M., *Atmospheric Pollution: A Global Problem,* 2nd ed., Wiley-Blackwell, (1992).

# BS 2nd Year
# Semester-III

**Course Title:** **PHYSICAL CHEMISTRY**
**Code:** **CHEM-171**
**Credit Hours:** **3+1**

## Course Objectives:

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

**Chemical Thermodynamics:**

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

**Chemical Equilibrium:**

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

**Solution Chemistry:**

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

**Chemical Kinetics:**

The rates of reactions, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, experimental

techniques for rate determination and methods for determination of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

**CHEM-171 Lab.**

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

## Recommended Books:


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

# BS 2nd Year
# Semester-IV

**Course Title:** **ANALYTICAL CHEMISTRY**
**Code:** **CHEM-111**
**Credit Hours:** **2+1**

## Course Objectives:

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

## Course Contents:

**Chemometrics:**
Sampling, significant figures, stoichiometric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard deviation/relative standard deviation, confidence limits, Gaussian distribution, least square method, tests for significance, outliers

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

**Classical Analytical Methods:**
Acid-base, complexometric and redox titrations, gravimetric analysis.

**CHEM-111 Lab.**
Calibration of volumetric glassware, electronic and analytical equipment, statistical evaluation of analytical data including linear regression analysis, constructing a calibration curve from a given analytical data using spread sheet software, determination of hardness of water using EDTA, determination of chloride in tap water sample, estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry, gravimetric analysis, determination of barium in barium nitrate, determination of nickel in a given steel sample, determination of bicarbonates in a clinical sample using back-titration, determination of cation in a mixture by complexometric titration, studying the effect of common ions on solubility of sparingly soluble salts (e. g. AgCl / $PbSO_4$).

## Recommended Books:

1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9th ed., Brooks Cole Publishing Company, (2013).

2. Christian, G. D., *Analytical Chemistry.* 6th ed., John-Wiley & Sons, New York, (2006).
3. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York,USA, (2011).
4. Kealey, D. and Haines, P. J,Instant Notes., *Analytical Chemistry*, Bios Scientific Publishers Limited, Oxford, UK, (2002).
5. Matthios, Otto, *CHEMOMETRICS-Statistics and Computed applications in Analytical Chemistry,* 2nd ed., Wiley-VCH, Germany, (2007).
6. Mitra A., *Fundamentals of Quality Control and Improvement,* 3rd ed., John-Wiley & Sons, (2008).
7. Miller, J. and Miller, J., *Statistics and Chemometrics for Analytical Chemistry,* 5th ed., Prentice Hall, (2005).

# BS 2nd Year
# Semester-IV

**Course Title:** **APPLIED CHEMISTRY**
**Code:** **CHEM-121**
**Credit Hours:** **2**

## Course Objectives:

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

**Fundamentals of Chemical Industry:**

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

**Chemical Industries:**

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

## Recommended Books:

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

# BS 2nd Year
# Semester-IV

**Course Title:** **BIOCHEMISTRY**
**Code:** **CHEM-131**
**Credit Hours:** **2+1**

## Course Objectives:

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

**Introduction to Biochemistry:**

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

**Acid–Base and Electrolyte Chemistry:**

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

**Carbohydrates, Lipids and Proteins:**

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

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

Significance of lipids in biological membranes and transport mechanism.

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

**CHEM-131 Lab.**
Qualitative and quantitative analysis of carbohydrates, lipids and proteins.
Laboratory work illustrating topics covered in the lecture of Chem.131, Determination of pH, Preparation of buffers.
Enzyme catalysis, Progress curve for enzyme catalyzed reactions, Determination of $K_m$ values. To study the effect of different factors on the rate of enzyme catalyzed reactions.

## Recommended Books:


1. R. C. Alkire, D. M. Kolb, J. Lipkowski, *Biselectro chemistry, volume 13,* 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
2. Nelson,D.L., *Lehninger's Principles of Biochemistry,* 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
3. Voet, D. and Voet, J.D., *Biochemistry,* 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
4. Murray, R.M. and Harper, H.A., *Harper's Biochemistry,* 25th ed., Publisher:Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
5. Zubay, G. L., *Biochemistry,* 4th ed., illustrated, Publisher W. M. C. Brown Publishers, (1998), Digitized (2008). ISBN: 0697219003, 9780697219008.
6. Guyton, A. C. & Hall, J. E., *Guyton & Hall Textbook of Medical Physiology,* 12th ed., Publishers: Saunders Elsevier, (2011). ISBN: 978-1-4160-4574-8.
7. Harvey, R. A., Ferrier, DR, Karandish S., *Lippincott's illustrated Reviews: Biochemistry,* 5th ed., *and Biochemistry Map (Med maps)* Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.


# BS 3rd Year
# Semester-V

**Course Title:** **INORGANIC CHEMISTRY**
**Code:** **CHEM-251**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

**Chemistry of d-block elements and coordination complexes:**
Back ground of coordination chemistry, nomenclature and structure of coordination complexes with coordination number 2-6, chelates and chelate effect, theories of coordination complexes, Werner's theory, valence bond

theory (VBT), crystal field theory (CFT) and molecular orbital theory (MOT), Jahn-Teller theorem, magnetic properties, spectral properties, isomerism, stereochemistry, and stability constants of coordination complexes.

**Chemistry of f-block elements:**

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

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

**CHEM-251 Lab.**

Preparations of following Inorganic Complexes;
Tetraamminecopper (II) sulphate.
Potassiumtrioxalatochromate (III).
Potassiumtrioxalatoaluminate (III).
cis-Potassium dioxalatodiaquachromate (III).
Determination of zinc and cadmium by complexometric titration
Chromatographic separations of transition metals;
Separation of $Ni^{2+}$ & $Co^{2+}$ ions in a mixture by paper chromatography.
Separation of $Ni^{2+}$ & $Cu^{2+}$ ions in a mixture by paper chromatography.
Separation of $Cu^{2+}$ & $Fe^{2+}$ ions in a mixture by paper chromatography.
Spectrophotometric determination of iron, manganese and nickel.

## Recommended Books:


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

11. Müller, U., *Inorganic Structural Chemistry,* 2nd ed., John-Wiley & Sons, Ltd., (2006).
12. Marusak R. A., Doan K., Cummings S. D., *Integrated Approach to Coordination Chemistry,* 1st ed., John-Wiley & Sons, (2007).
13. Chaudhary, S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2013).

# BS 3rd Year
# Semester-V

**Course Title:** **ORGANIC CHEMISTRY**
**Code:** **CHEM-261**
**Credit Hours:** **3+1**

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

## Course Contents:
**Stereochemistry:**
Types of stereoisomers, RS and EZ notation, optical activity, stereoselectivity and stereospecificity, conformational analysis.

**Organic Reactions and Mechanism:**
Detailed mechanism of aliphatic reactions including addition, substitution, and elimination reactions, concept of energy profile, transition state and intermediate.

**CHEM-261 Lab.**
Experiments using polarimeter such as to determine optical activity of a sugar solution and to determine sugar concentration by polarimeter, isomerization of maleic acid.

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

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

## Recommended Books:
1. Robert, T. M., and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall, New Jersey, (1992).
2. John, E. M., *Organic Chemistry*, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Younas, M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, (2006).

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

# BS 3rd Year
# Semester-V

**Course Title:** **PHYSICAL CHEMISTRY**
**Code:** **CHEM-271**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

### Quantum Chemistry:

Black body radiation, photoelectric effect, line spectra of elements, Bohr atomic model, wave and particle nature of matter, de Broglie's equation, Young's double slit experiment, Heisenberg's uncertainty principle, wavefunctions and Born interpretation of wavefunctions, probability density,

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

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

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

**CHEM-271 Lab.**
Equilibrium constant of the $KI + I_2 = KI_3$ reaction.
Kinetics of saponification of ethyl acetate.
Acid catalyzed hydrolysis of sucrose.
Study of the adsorption isotherms of acetic acid-charcoal system.
Study of the charge transfer complex formation between iodine and benzene.
Determination of activation energy for the acid catalyzed hydrolysis of ethyl acetate.
Determination of partial molar volumes.
Characterization of the given compound by UV-Vis spectroscopy.

## Recommended Books:


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

11. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed., Longman Group Limited, New York, (1974).

# BS 3rd Year
# Semester-V

**Course Title:** **ANALYTICAL CHEMISTRY**
**Code:** **CHEM-211**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

**Separation Methods:**

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

**Analytical Spectrophotometry:**

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

**CHEM-211 Lab.**

Separation of phenol from given organic mixture using solvent extraction.
Separation of given mixture of cations using Paper Chromatography.
Analysis of the composition of a mixture of nitro anilines by TLC.
Separation of sugars using paper chromatography.
Separation of amino acids using paper/thin layer chromatography.
Deionization and softening of water using ion exchange chromatography.
Determination of $\lambda_{max}$ of $KMnO_4$ and $K_2Cr_2O_7$ solutions and verification of Beer-Lambert's law.
Determination of stoichiometry of a metal complex by visible spectrometry.
Determination of aspirin and caffeine in a proprietary analgesic by double beam UV-Vis. spectrometer.
Quantification of iron in a given sample by using single beam spectrophotometer.
A study of characteristics infrared absorption frequencies.

## Recommended Books:


1. Skoog, D. A., West, P. M., Holler, F. J., Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9th ed., Brooks Cole Publishing Company, (2013).
2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, USA, (2011).
3. Christian, G. D., *Analytical Chemistry*, 6th ed., John Wiley and Sons, New York, (2006).
4. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry,* 1st ed.,Bios Saence Publisher Ltd. Oxford UK. (2002)
5. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. A., *Introduction to spectroscopy,* 4th ed., Cengage Learning, (2008).
6. Wall, P. E., *Thin Layer Chromatography: A Modern Approach (RSC Chromatography Monographs),* 1st ed., Royal Society of Chemistry, (2005).
7. Deinstrop, E. H., *Applied Thin Layer Chromatography,* 2nd ed., Wiley-VCH, (2006).
8. Kellener. R, Mermet. J. M., Otto, M., Valcarcel, M., Widmer, H.M., *Analytical Chemistry: A Modern Approach to Analytical Science*, Wiley. VCH, (2004)
9. Hollas, J. M., *Modern Spectroscopy,* 4th ed., John-Wiley & Sons, Ltd., England (2004).


# BS 3rd Year
# Semester-VI

**Course Title:** **INORGANIC CHEMISTRY**
**Code:** **CHEM-351**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

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

### CHEM-351 Lab

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

3. Gravimetric estimation of oxalate.
4. Precipitation Titrations.
   a) Determination of strength of NaCl given solution by $AgNO_3$ using Fluorescein as indicator.
   b) Determination of % age purity of KBr using Fluoresceine as indicator.
   c) Determination of % composition of mixture of KI & $KNO_3$ using Eoscein as indicator.
5. Spectrophotometric determination of cerium.
6. Separation of heavy metals using solvent extraction technique.

## Recommended Books:


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


# BS 3rd Year
# Semester-VI

**Course Title:** **ORGANIC CHEMISTRY**
**Code:** **CHEM-361**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

**Aromatic Substitution Reactions:**
Mechanisms of aromatic reactions including electrophilic and nucleophilic substitutions, effect of substituents on orientation and reactivity.

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

**Pericyclic Reactions:**
Introduction to pericyclic reactions, frontier orbital theory, mechanisms of electrocyclic, cycloaddition and sigmatropic reactions.

**CHEM-361 Lab.**
Experiments involving aromatic substitution, oxidation/reduction reactions and pericyclic reactions, nitration of nitrobenzene to meta-dinitrobenzene, reduction of meta- dinitrobenzene to meta-nitroaniline, sulphonation of aniline, oxidation of benzaldehyde, oxidation of cyclohexanol to cyclohexanone. Preparation of benzoic acid and benzyl alcohol from benzaldehyde using Cannizzaro's reaction.

## Recommended Books:


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

13. Smith, M. B., *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure,* 7th ed., John-Wiley & Sons, Inc., (2013).
14. Ansari, F. L., Qureshi, R. and Qureshi, M. L., *Electrocyclic Reactions: From Fundamentals to Research,* Wiley-VCH, Germany, (1999).
15. Kürti, L. and Czakó. B., *Strategic Applications of Named Reactions in Organic Synthesis: Background and Detailed Mechanisms,* Elsevier Inc., (2005).

# BS 3rd Year
# Semester-VI

**Course Title:** **PHYSICAL CHEMISTRY**
**Code:** **CHEM-371**
**Credit Hours:** **3+1**

## Course Objectives:

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

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

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

**Surface Chemistry:**
Interfaces, Gibbs surface excess, curved surfaces, capillary action, adsorption and adsorption isotherms, Freundlich and Langmuir adsorption isotherms, catalysis, colloids, emulsion and 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-371 Lab.**

Spectroscopic determination of Cu percentage in the given sample.
Conductometric determination of Cu (II)- EDTA mole ratio in the complex.
To determine the effectiveness of an extraction of $I_2$ solution by using Solvent Extraction method.
Determination of molecular weight of a polymer by viscosity method.
Determination of percentage composition of $KMnO_4$/ $K_2Cr_2O_7$ in a given solution by spectrophotometry.
Evaluation of $pK_a$ value of an indicator by spectrometric method.
Conductometric determination of hydrolysis constant ($K_h$) of conjugate base of a weak acid.

## Recommended Books:


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


# BS 3rd Year
# Semester-VI

**Course Title:** **APPLIED CHEMISTRY**
**Code:** **CHEM-322**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

**Water Treatment, Steam Production and Scale Removal:**
Sources of water hardness, water treatment and conditioning for municipal and industrial purposes, steam production and its utilization for power and energy generation, boiler water treatment, chemistry involved in the formation of scale and its prevention.

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

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

**CHEM-322 Lab**
Measurement of water hardness with EDTA Titrations.
Estimation of total solids in water.
Estimation of chloride in water.
Estimation of Ferrous and Ferric ions in drinking water by redox titration.
Extraction of capsicum oil (soxhlet extraction).
Extraction of clove oil from cloves.
Preparation of liquid detergents.
Study of the kinetics of dissolution of Magnesium metal in dilute HCl.
Estimation of Manganese in Steel.
Estimation of Ferric Iron in Cement.

## Recommended Books:


1. Erwin D. L., *Industrial Chemical Process Design,* McGraw-Hill, (2002).
2. Chawla, K. K., *Composite Materials: Science and Engineering,* 3rd ed., Springer, (2012).
3. Methews, F. L., Rawlings, R. D., *Composite Materials: Engineering and Sciences,* CRC Press, (2003).
4. Deborah, D. L., *Composite Materials: Science and Applications,* 2nd ed., Springer, (2010).
5. Gay, D. and Hoa, S. V., *Composite Materials: Design and Applications,* 2nd ed., CRC Press, LLC, (2007).
6. Kister, H., *Distillation Operation,* 1st ed., McGraw-Hill Professional, (1990).
7. Kister, H., *Distillation Design,* 1st ed., McGraw-Hill Professional, (1992).

8. Tchobanoglous, G., Burton, F. L. and Stensel, H. D., *Wastewater Engineering: Treatment and Reuse,* 4th ed., McGraw-Hill, (2003).
9. Callister, W. D. Jr., *Materials Science and Engineering: An Introduction,* 7th ed., John-Wiley & Sons, Inc., (2007).
10. Roussak, O. V. and Gesser, H. D., *Applied Chemistry: A Textbook for Engineers and Technologists,* 2nd ed., Springer, (2013).
11. Mizrahi, J., *Developing an Industrial Chemical Process: An Integrated Approach,* CRC Press, (2002).
12. Prakash, N. B., *Applied Chemistry Lab Manual*, LAP Lambert Academic Publishing, (2013).
13. Vermani, O. P., *Applied Chemistry : Theory And Practice*, 2nd ed., New Age International, (2006).
14. Goostray. S and Schwenck. R. J., *Experiments in Applied Chemistry*, Collier-Macmillan, (1966).

# BS 3rd Year
# Semester-VI

**Course Title:** **BIOCHEMISTRY**
**Code:** **CHEM-331**
**Credit Hours:** **3 +1**

## Course Objectives:

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

## Course Contents:

**Intermediary Metabolism and Bioenergetics:**
Biological oxidation-Reduction including respiratory carriers, cell bioenergetics, Oxidative phosphorylation, free energy change and redox system.

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

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

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

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

**Metabolism of Nucleic Acids:**
Biosynthesis and catabolism of purines and pyrimidines and their regulation, synthesis, catabolism of nucleosides, DNA polymerases and other enzymes involves in metabolism.

**CHEM-331 Lab.**
Separation of proteins by Electrophoresis.
Separation of Nucleic Acids by Electrophoresis.
Column chromatographic separations of protein Resolution.
Blood Glucose estimation, RFT, LFT, Lipid Profile, Cardiac Markers, Bone Markers, Pancreatic Markers, Anemia profile, Trace Elements, Urine CSF.
Immunochemical Techniques.
Determination of type of inhibition.
Determination of Michaelis constant in the presence and absence of inhibitors.

## Recommended Books:


1. Voet, D. and Voet, J. D., *Biochemistry*, 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
2. Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry*, 6th ed., Freeman, (2012).
3. Murray, R., Bender, D., Botham, K.M., Kennely, P. J., Rodwall, V. and Weil, P.A., *Harper's Biochemistry*, 29th ed., (2012).
4. Zubay, G. L., *Biochemistry,* 4th ed., illustrated. Publisher: WMC. Brown Publishers, (1998), digitized, (2008). ISBN: 0697219003. 9780697219008.
5. Guyton, A. C. & Hall, J. E., *Guyton & Hall Text Book of Medical Physiology*, 12th ed., Publishers: Saunders Elsevier, (2011).
6. Plummer, D.T., *An Introduction to Practical Biochemistry*, 3rd ed., TATA MCGraw-Hill Publishing Company LTD, (2010).
7. Sawhney, S. K. and Sing, R., *Introductory Practical Biochemistry*, 2nd ed., Narosa Publishing House, New Delhi, (2005).

8. Robert A. Copeland, *Enzymes: A Practical Introduction to Structure, Mechanism, and Data analysis,* 2nd ed., Publishers: John-Wiley & Sons, (2000) ISBN: 0-471-35929-7
9. R. C. Alkire, D. M. Kolb, J. Lipkowski, *Biselectro chemistry, volume 13,* 13th ed., Publisher: Wiley-VCH Verlag GmbH & Co. ISSN: 0938-5193.
10. Nelson,D.L., *Lehninger's Principles of Biochemistry,* 6th ed., Publisher: Macmillan Higher Education, (2008). ISBN: 149222638, 9781429222631.
11. Voet, D. and Voet, J.D., *Biochemistry,* 4th ed., illustrated. Publisher: John-Wiley & Sons Canada, Limited, (2011). ISBN: 0470917458, 9780470917459.
12. Murray, R.M. and Harper, H.A., *Harper's Biochemistry,* 25th ed., Publisher:Appleton & Lange, (2000). ISBN: 0838536840, 9780838536841.
13. Harvey, R. A., Ferrier, DR, Karandish S., *Lippincott's illustrated Reviews: Biochemistry,* 5th ed., *and Biochemistry Map (Med maps)* Bundle. Publisher: Lippincott Williams & Wilkins, (2010). ISBN: 1451116314, 9781451116311.

# BS 3rd Year
# Semester-VI

**Course Title:** **Fuel Chemistry**
**Code:** **Chem-381**
**Credit Hours:** **3+1**

## Course Objectives:

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

## Course Contents:

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

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

**CHEM-381 Lab**

Determination of moisture contents of coal mined in different parts of Pakistan.
Determination of Ash contents of coal mined in different parts of Pakistan.
Determination of Volatile matter of coal.
Determination of fixed carbon contents of coal.
Determination of hydrogen and nitrogen contents of the coal.
Determination of chlorine and oxygen in coal.
Determination of various forms of sulfur in coal.
Determination of specific and API gravity of petroleum fractions.
Estimation of carbon residue in petroleum products (Conradson method).
Determination of ash content in petroleum products.
Determination of sulfated ash in lube oil.
Estimation of water, sediments and oil in crude oil by centrifuge method.
Determination of cloud and pour point of Lube-oil.
Estimation of asphalt in road samples

## Recommended Books:


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


# BS 4th Year

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

## Course Objective:

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

## Course Contents:

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

## Recommended Books:


1. Huheey, J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th ed., Prentice Hall, (1997).
2. Shriver, D. F., Atkins, P. W., *Inorganic Chemistry*, 3rd ed., Oxford University Press, (2001).
3. Wilkins, R. G., *Kinetics and Mechanism of Reactions of Transition Metal Complex*, 2nd ed., (Rev.), Wiley-VCH, (1991).
4. Jolly, W. L., *Modern Inorganic Chemistry*, 2nd ed., McGraw-Hill Company, (1991).
5. Jordan, R. B., *Reaction Mechanisms of Inorganic and Organomettalic Systems*, 2nd ed., Oxford University Press, New York, (1998).
6. Atwood, J. D., *Inorganic and Organometallic Reaction Mechanisms,* 2nd ed., Wiley-VCH, Inc., (1997).
7. Sharma, S. K., *Inorganic Reaction Mechanisms,* Discovery Publishing House, (2007).


# BS 4th Year

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

## Course Objective:

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

## Course Contents:

### π-Acceptor Ligands:

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

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

## Recommended Books:


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


# BS 4th Year

**Semester-VII** **(INORGANIC CHEMISTRY)**
**Course Title:** **INORGANIC SPECTROSCOPY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

## Recommended Books:


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


# BS 4th Year

**Semester-VII** **(INORGANIC CHEMISTRY)**
**Course Title:** **Lab-I**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Contents:

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

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

## Recommended Books:


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

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

# BS 4th Year

**Semester-VII (ORGANIC CHEMISTRY)**
**Course Title: HETEROCYCLIC AND ORGANOMETALLIC COMPOUNDS**
**Code: CHEM-**
**Credit Hours: 3**

## Course Objectives:

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

## Course Contents:

**Aromatic Heterocycles:**

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

**Organometallic Compounds:**

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

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

## Recommended Books:

1. Claydem, J., Greeves,N. and Warren, S., *Organic Chemistry,* 2nd ed., Oxford University Press, (2012).
2. Coxon, J. M. Norman, R. O. C., *Principles of Organic Synthesis*, 3rd ed., CRC Press, (1993).
3. Joule, J. A., Mills, K., *Heterocyclic Chemistry*, 5th ed., John-Wiley & Sons, UK, (2010).
4. Crabtree, R. H., *The Organometallic Chemistry of the Transition Metals,* 5th ed., John-Wiley & Sons, New Jersey, (2009).

# BS 4th Year

**Semester-VII** **(ORGANIC CHEMISTRY)**
**Course Title:** **REACTIVE INTERMEDIATES**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

**Reactive Intermediates:**

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

**Rearrangement Reactions:**

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

## Recommended Books:


1. Clayden, J., Greeves, N. and Warren, S., *Organic Chemistry*, 2nd ed., Oxford University Press, (2012).
2. Coxon, J. M. and Norman, R.O.C., *Principles of Organic Synthesis*, 3rd ed., Chapman and Hall, UK, (1993).
3. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry*, 6th ed., Brooks/Cole Learning, (2012).
4. John, E. M., *Organic Chemistry,* 8th ed., Brooks/Cole Publishing Co., USA, (2012).
5. Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6th ed., Prentice Hall, New Jersey, (1992).

# BS 4th Year

**Semester-VII** **(ORGANIC CHEMISTRY)**
**Course Title:** **ORGANIC SPECTROSCOPY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

**UV-Visible:**

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

**IR spectroscopy:**

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

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

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

**Mass Spectrometry:**

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

## Recommended Books:


1. Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1st ed., Alpha Science Int. Ltd., (2003).
2. Kalsi, P. S., *Spectroscopy of Organic Compounds,* 6th ed., New Age International, New Delhi, India, (2007).
3. Yadav, L. D. S., *Organic Spectroscopy*, Springer, UK, (2005).
4. Kemp, W., *Organic Spectroscopy*, 3rd ed., W. H. Freeman & Company, New York, USA, (1991).
5. Younas, M., *Organic Spectroscopy*, Ilmi Kitab Khana, Urdu Bazar Lahore, Pakistan, (2006).
6. Hollas, J. M., *Modern Spectroscopy,* 4th ed., John-Wiley & Sons, Inc., (2004).

7. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., *Introduction to Spectroscopy,* 4th ed., Brooks/ Cole Cengage Learning, (2009).
8. Silverstein, R. M., Webster, F. X. and Kiemle, D., *Spectrometric Identification of Organic Compounds,* 7th ed., John-Wiley & Sons, Inc., (2005).
9. Williams, D. H. and Flemming, I., *Spectroscopic Methods in Organic Chemistry,* 6th ed., McGraw-Hill Higher Education, (2008).

# BS 4th Year

**Semester-VII** **(ORGANIC CHEMISTRY)**
**Course Title:** **Lab.I**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Contents:

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

## Recommended Books:

1. Mohan, J., *Organic Analytical Chemistry: Theory and Practice*, 1st ed.,Alpha Science Int.Ltd., (2003).
2. Williams, D. H. and Flemming, I., *Spectroscopic Methods in Organic Chemistry,* 6th ed., McGraw-Hill Higher Education, (2008).
3. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques*, 5th ed., Brooks/Cole Laboratory Series, Cengage Learning, (2013).
4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5th edition, Longman, UK, (1989).

# BS 4th Year

**Semester-VII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

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

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

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

## Recommended Books:


1. Gasser, R. P. H., *Entropy and Energy Level,* Rev. ed., Oxford University Press, New York, (1986).
2. Wayatt, P. A. H., *The Molecular Basis of Entropy and Chemical Equilibrium,* Royal Institute of Chemistry London, UK, (1971).
3. Bockris J. O. M., and Reddy, A. K. N., *Modern Electrochemistry: Ionics*, Vol. I, 2nd ed., Plenum Press, London, (1998).
4. Seddon, J. M. and Gale, J. D., *Thermodynamics and Statistical Mechanics,* Royal Society of Chemistry, (2001).
5. Engel, T., Reid, P., *Thermodynamics, Statistical Thermodynamics, and Kinetics,* 3rd ed., Prentice Hall, (2012).
6. Bard, A. J. and Faulkner, L. R., *Electrochemical Method*: *Fundamentals and Applications* 2nd ed., John-Wiley & Sons, New York, (2001).
7. Kondepudi D., *Introduction to Modern Thermodynamics,* John-Wiley & Sons, (2008).
8. Hamann, C. H., Hamnett, A. and Veilstich, W., *Electrochemistry,* 2nd ed., Wiley-VCH Verla Gnb H and Co. KGaA, (2007).
9. Braun R. D. and Walters F., *Application of Chemical Analysis,* McGraw-Hill, (1982)
10. McQuarrie, D. A., *Statistical Mechanics*, Viva Books Private Ltd. (2008).

# BS 4th Year

**Semester-VII** **(PHYSICAL CHEMISTY)**
**Course Title:** **POLYMER CHEMISTRY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

**Polymer Chemistry:**

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

## Recommended Books:


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

# BS 4th Year

**Semester-VII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **QUANTUM CHEMISTRY AND MOLECULAR SPECTROSCOPY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

### Quantum Chemistry:

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

### Molecular Spectroscopy:

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

## Recommended Books:


1. Fayer, M. D., *Elements of Quantum Mechanics,* Oxford University Press, London, UK, (2001).
2. Becker, E. D., *High Resolution NMR; Theory & Chemical Application*, 3rd ed., Academic Press, New York, USA, (2000).
3. Graybeal, J. D., *Molecular Spectroscopy*, 1st ed., McGraw-Hill, New York, (1988).
4. Hayward, D. O., *Quantum Mechanics for Chemists*, Royal Society Of Chemistry, (2002).
5. House, J. E., *Fundamentals of Quantum Mechanics* 2nd ed., Elsevier-Academic Press, New York, USA, (2004).
6. Kirsten, H. J. W. M., *Introduction to Quantum Mechanics: Schrodinger Equation and Path Integral* 1st ed., World Scientific Publishing Co. Pvt. Ltd., (2006).
7. Barrow, G. M., *Physical Chemistry,* 6th ed., McGraw-Hill Book Company, (1996).

8. Straughan, B. P., and Walker, S., *Spectroscopy*, Vol. 1 and 2., Chapman and Hall Ltd., (1976).
9. Coulson C. A., *Vanlence*, Oxford University Press (1980).
10. Sathyanarayana, D. N., *Vibrational Spectroscopy, Theory and Applications*, New Age International Publishers (2004).

# BS 4th Year

**Semester-VII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **Lab-I**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Objectives:

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

## Course Contents:

Determination of partial molar properties.
Determination of free energy changes, standard free energies.
Verification of Kohlrausch's law.
Study of temperature dependence of electrode potentials.
Determination of heat of solution, ionic reactions and other experiments from thermochemistry.
Determination of molecular weight of a polymer by viscosity method.
Precipitation value of electrolytes.Measurement of IR spectra of simple compound and their interpretation.
Measurement of cyclic voltammogram of an organic compound and its interpretation.
Determination of dipole moment of an organic liquid.
Determination of percentage composition of $KMnO_4$-$K_2Cr_2O_7$ in given solution by spectrometry.
Evaluation of pKa value of an indicator by spectrometric method.
Synthesis of metal oxide nanoparticles and their characterization using IR and XRD techniques.

## Recommended Books:

1. Garland, C. W., Shoemaker, D. P., and Nibler, J. W., *Experiments in Physical Chemistry*, 8th ed., McGraw-Hills, New York, (2003).
2. James, A. M., Prichard, F. E., *Practical Physical Chemistry,* 3rd ed., Prentice Hall Press, (1974).
3. Halpern, A., McBane, G., *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd ed., W. H. Freeman, (2006).

4. Athawale, V. D., and Mathur. P., *Experimental Physical Chemistry*, New Age International (2001).
5. Farrington, D., *Experimental Physical Chemistry*, BiblioBazaar, (2011).
6. Palmer, W. G., *Experimental Physical Chemistry,* 2nd ed., Cambridge University Press (2009).

# BS 4th Year

**Semester-VII (APPLIED CHEMISTRY)**
**Course Title: COMMON INDUSTRIES-I**
**Code: CHEM**
**Credit Hours: 3**

## Course Objectives:

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

**Sugar Industry:**

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

**Starch Industry:**

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

**Leather Industry:**

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

## Recommended Books:

1. Rao, G. P., Mogarey, R. C., Solomn, S., Rewal, S. S. and Li,Y-., *Sugar Cane: Production Managemnet and Agro-Industrial Imperatives*, Ibdc Publisher, (2005).
2. Covington, A. D., *Tanning Chemistry: The Science of Leather,* Royal Society of Chemistry, (2009).
3. Kent, J. A., *Riegel's Handbook of Industrial Chemistry,* 10th ed., Kluwer Academic/ Plenum Publishers, (2003).

# BS 4th Year

**Semester-VII** **(APPLIED CHEMISTRY)**
**Course Title:** **AGRO BASED INDUSTRIES AND POLLUTION CONTROL**
**Code:** **CHEM**
**Credit Hours:** **3**

## Course Objectives:

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

**Fertilizers:**

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

**Agrochemicals:**

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

**Industrial Pollution and Its Abatement:**

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

## Recommended Books:


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

# BS 4th Year

**Semester- VII (APPLIED CHEMISTRY)**
**Course Title: COMMON INDUSTRIES-II**
**Code: CHEM**
**Credit Hours: 3**

## Course Objectives:

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

**Oils and Fats:**

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

**Soaps and Detergents:**

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

**Paints:**

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

## Recommended Books:


1. Vermani, O. P, Narula, A.K, *Applied Chemistry, Theory and Practice*, 2nd ed., New Age International. Publisher, India, (1995).
2. Balasaraf, V. M, *Applied Chemistry*, I. K. International House Pvt. Ltd, India, (2009).
3. P. K. Chattopadyay, *Modern Technology of Soaps, Detergents and Toilries: with formulae and project profile, 2nd ed.,* National Institute of Industrial Research, India, (2003).
4. Bockisch M., *Fats and Oils Handbook,* American oil Chemists and Society, (1998).
5. Gunstone F., *Oils and Fats in Food Industry,* Wiley Black Well, (2008).
6. Gunstone F., *Vegetable Oil in Food Technology: Composition, Properties and Uses,* John-Wiley & Sons, (2011).
7. Lambourme, R., Strivens, T.A., *Paint and Surface Coatings: Theory and Practice, 2nd ed.,* Woodhead Publishing Limited, (1999).

8. Board. B, *Paint, Pigment, Solvent, Coating, Emulsion, Paint additives and formulations,* Engineers India Research Incorporation, (2008).
9. Kent, J. A., *Riegel's Handbook of Industrial Chemistry,* 10th ed., Kluwer Academic/Plenum Publishers, (2003).

# BS 4th Year

**Semester- VII** **(APPLIED CHEMISTRY)**
**Course Title:** **Lab-I**
**Code:** **CHEM**
**Credit Hours:** **1**

## Course Objectives:

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

## Course Contents:

Determination of iodine value of the given oil.
Determination of acid value of the given oil.
To find out the percentage purity of fatty acid.
Preparation of gum sample.
Preparation of liquid detergent or liquid soap.
To determine the temporary and permanent hardness of a given water sample by EDTA method.
To determine the alkalinity of given water sample.
Determination of magnesium and aluminum by EDTA titration.
Analysis of caustic soda and soda ash in mixtures.
Analysis of effluents from tanneries.
Preparation and Testing of: Varnish and Enamel Paints. Adhesives. Emulsion Paints.

## Recommended Books:

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

7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBNO-07-112 721-6 Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.
8. Vogel's Textbook of Qantitative chemical analysis 6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

# BS 4th Year

**Semester-VII (ANALYTICAL CHEMISTRY)**
**Course Title: ATOMIC SPECTROSCOPY**
**Code: CHEM-**
**Credit Hours: 3**

## Course Objectives:

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

## Course Contents:

### Flame Photometry:

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

### Atomic Fluorescence Spectrometry:

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

### Atomic Absorption Spectrophotometry:

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

### Atomic Emission Spectrophotometry:

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

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

## Recommended Books:


1. Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry*, Bios Scientific Publishers Limited, Oxford, UK, (2002).
4. Sharma, B. K., *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Skoog, D. A. and West., D. M., *Fundamentals of Analytical Chemistry*, 8th ed., Hot Reinehart Inc., London, (2008).
6. Ebdon,L., Evaus, E.H, Fischer, A., and Hill, S.J., *An Introduction to Analytical Atomic Spectrometry,* John Wiley & Sons, England. (1998).
7. Bernhard Welz, Michael Sperling, *Atomic Absorption Spectrometry,* 3rd ed., Wiley-VCH, Germany, (1998).
8. Farrukh, M. A., *Atomic Absorption Spectroscopy,* In Tech, (2012).
9. Kellner, R., Mermet, J. M, Otto, M., Valcarcel, M., Widmer, H.M., *Analytical Chemistry : A Modern Approach to Analytical Science*, Wiley-VCH,(2004)


# BS 4th Year

**Semester-VII** **(ANALYTICAL CHEMISTRY)**
**Course Title:** **ELECTROANALYTICAL TECHNIQUES**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

**Potentiometry:**

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

**Coulometry and Electrogravimetry:**

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

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

## Recommended Books:


1. Christian, G. D., *Analytical Chemistry,* 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis 8*th ed.,W.H. Freeman and Company, New York, (2009).
3. Kealey, D. and Haines , P. J., *BIOS Instant Notes in Analytical Chemistry,* Bios Scientific Publishers Limited, Oxford, UK, (2002).
4. Sharma, B. K., *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Skoog, D. A. and West, D. M., *Fundamentals of Analytical Chemistry,* 8th ed., Hot Reinehart Inc., London, (2008).
6. Fritz, Schulz, *Electranalytical Methods: Guide to Experiments and Applications.* 2nd revised, Springer-Verlag Berlin, Germany, (2010).
7. Monk,P.M.S, *Fundamentals of Electroanalytical Chemistry,* John-Wiley & Sons Ltd, England, (2001).


# BS 4th Year

**Semester-VII (ANALYTICAL CHEMISTRY)**
**Course Title: ADVANCED SEPARATION TECNIQUES**
**Code: CHEM-**
**Credit Hours: 3**

## Course Objectives:

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

## Course Contents:

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

**Gas Liquid Chromatography:**
General principle, sample preparation/derivatization, separation process, and instrumental aspects and its applications.

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

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

## Recommended Books:


1. Skoog, D. A., West, P. M., Holler, F. J. and Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9th ed., Cengage Learning, (2013).
2. Christian, G. D., *Analytical Chemistry*, 6th ed., John-Wiley & Sons, New York, (2004).
3. Kealey, D. and Haines, P. J., *BIOS Instant Notes in Analytical Chemistry,* 1st ed., Taylor & Francis, (2002).
4. Sharma, B.K. *Instrumental Methods of Chemical Analysis*, 24th ed., Goel Publishing House, Meerut, India, (2005).
5. Grob, R. L., Eugene, F. Barry, *Modern Practice of Gas Chromatography,* 4th ed., John-Wiley & Sons, USA, (2004).
6. Kellner, R., Mermet, J-. M., Otto, M., Valcarcel, M. and Widmer, H. M., *Analytical Chemistry: A Modern Approach to Analytical Science,* Wiley-VCH, (2004).
7. Meyer, V. R., *Practical High-Performance Liquid Chromatography,* 5th ed., John-Wiley & Sons, Ltd., (2010).
8. Lindsay, S., *High Performance Liquid Chromatography,* 2nd ed., John-Wiley & Sons, Ltd., (1992).
9. Braitwaite, A. and Smith, F. J., *Chromatographic Methods,* 5th ed., Kluwer Academic Publishers, (1999).
10. Miller, J. M., *Chromatography: Concepts and Contrasts,* 2nd ed., John-Wiley & Sons, Inc., (2005).
11. Camilleri, P., *Capillary Electrophoresis: Theory and Practice,* 2nd ed., CRC Press, (1998).

# BS 4th Year

**Semester-VII** **(ANALYTICAL CHEMISTRY)**
**Course Title:** **Lab-I**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Objectives:

Separation of hydrocarbons using GLC, Separation of essential oils, fatty acids, To determine pKa values for the given samples of weak acids by potentiometric method. Quantitative determination of sodium hydroxide by potentiometric titration. Preparation of buffer solutions of definite pH.
Electrogravimetric determination of copper in given samples. Study of thermal decomposition of copper sulfate pentahydrate and calcium oxalate monohydrate.

## Recommended Books:


1. Harris, D. C., *Quantitative Chemical Analysis*., 8th ed., W. H. Freeman and Company, New York, (2011).
2. Braitwaite, A. and Smith, F. J., *Chromatographic Methods,* 5th ed., Kluwer
3. Camilleri, P., *Capillary Electrophoresis: Theory and Practice,* 2nd ed., CRC Press, (1998).
4. Weinberger, R., *Practical Capillary Electrophoresis,* 2nd ed., Academic Press, (2000).


# BS 4th Year

**Semester-VII** **(BIOCHEMISTRY)**
**Course Title:** **BIOMEDICAL CHEMISTRY**
**Code:** **CHEM-**
**Credit Hours:** 3

## Course Objectives:

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

## Course Contents:

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

**Blood and Other Body Fluids:**
General composition of blood, function of blood plasma, plasma protein, composition and functions, composition, development and functions of red

blood cells, white blood cells and platelets, Hemoglobin, chemistry properties, synthesis, functions and derivatives, degradation of hemoglobin, respiration and gas transport, blood coagulation and clotting of blood, blood pressure, blood groups, composition of urine, extracellular fluids like: cerebrospinal fluid, lymph, sweat, tears, synovial and interstitial fluid.

## Recommended books:


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


# BS 4th Year

**Semester-VII** **(BIOCHEMISTRY)**
**Course Title:** **MOLECULAR BIOLOGY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

## Recommended Books:


1. Watson, J. D., Baker, A. T., Bell, S. P., Gann A., Levine, M. and Losick, M. R., *Molecular Biology of the Gene,* 7th ed., Benjamin Cummings, (2013).

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

# BS 4th Year

**Semester-VII (BIOCHEMISTRY)**
**Course Title: PHYSICAL TECHNIQUES IN BIOCHEMISTRY**
**Code: CHEM**
**Credit Hours: 3**

## Course Objectives:

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

## Course Contents:

**Extraction, Fractionation and Purification of Macrobiomolecules:**
Homogenization, solubilization and concentration including ultrasonication, lyophilization and ultradecantation, purification based on differential solubility techniques, ion-exchange chromatography, gel chromatography, affinity chromatography, paper & thin layer chromatography and HPLC.

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

**Electrofocusing:**
Preparative and analytical electrofocusing.

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

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

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

**Enzyme linked immunosorbent assay (ELISA):**
Basic principle, instrumentation and applications.

## Recommended Books:


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


# BS 4th Year

**Semester-VII** **(BIOCHEMISTRY)**
**Course Title:** **Lab-I**
**Code:** **CHEM**
**Credit Hours:** **1**

## Course Contents:

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

## Recommended Books:


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

# BS 4th Year

**Semester: VII** **(FUEL CHEMISTRY)**
**Title of the Course:** **CHEMISTRY OF COAL CONVERSION PROCESSES-I**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

**Environmental Aspects:**

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

**Gasification:**

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

## Recommended Books:


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

# BS 4th Year

**Semester-VII** **(FUEL CHEMISTRY)**
**Title of the Course:** **PETROLEUM AND PETROCHEMICALS-I**
**Code** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

**Petrochemicals:**

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

## Recommended Books:


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

# BS 4th Year

**Semester-VII** **(FUEL CHEMISTRY)**
**Title of the Course:** **CHARACTERIZATION OF FOSSIL FUELS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

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

## Recommended Books:


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


# BS 4th Year

**Semester: VII** **(FUEL CHEMISTRY)**
**Title of the Course:** **Lab-I**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Objective:

Determination of the electrical conductivity of aviation and distillate fuels, containing static dissipator additives. Determination of the total base number of petroleum products by potentiometric titration. Determination of total salt content in crude petroleum by conductivity method. Determination of the kinematic viscosity of asphalt (bitumen). Determination of heat of combustion

of liquid hydrocarbon fuels. Determination of neutralization number of lubricating oils by potentiometric titration. Determination of the calorific value of coal by bomb calorimeter. Determination of total sulfur in coal by bomb calorimeter. Determination of chlorine in coal by bomb calorimeter. Determination of the distillation behavior of petroleum fractions. Determination of sulfur in petroleum products by bomb calorimeter method. Determination of sulfur in petroleum products by lamp method.

## Recommended Books:


1. Speight, J. G Handbook of Petroleum Analysis Wiley-Interscience, (2002)
2. Speight, J. G. Handbook of Coal Analysis. John Wiley and Sons, New Jersey, (2005)
3. ASTM, 2000, Annual Book of ASTM Standards, American Society for Testing and Materials, West Consbohockm, PA, USA


# BS 4th Year

**Semester-VIII** **(INORGANIC CHEMISTRY)**
**Course Title:** **ORGANOMETALLICS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

## Recommended Books:


1. Powell, P., *Principles of Organometallics Chemistry*, 2nd ed., Springer, (1998).
2. Yamamoto A., *Organotransition Metal Chemistry*: *Fundamental Concepts and Applications,* 1st ed., John-Wiley & Sons, Inc., (1986).
3. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Intersceince, New York, (1999).
4. Miessler, G. L., Fisher, P. J. and Tar, D, A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).

5. Douglas, B., McDaniel, D. and Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons, Inc., (1994).
6. Haiduc, I. and Zuckerman, J. J., *Basic Organometallic Chemistry,* Walter De Gruyter Inc., (1985).
7. Jolly, W. L., *Modern Inorganic Chemistry,* 2nd ed., McGraw-Hill Company, (1991).
8. Porterfield, W. W., *Inorganic Chemistry: A Unified Approach,* 2nd ed., Academic Press, (1993).
9. Vincet, A., *Molecular Symmetry and Group Theory:* 2nd ed., John-Wiley & Sons, Ltd., (2001).
10. Malik, W. U., Tuli, G. D., Madan, R. D., *Selected Topics in Inorganic Chemistry, S. Chand and Co. Ltd.,* (2010).

# BS 4th Year

**Semester-VIII (INORGANIC CHEMISTRY)**
**Course Title: SYMMETRY AND MAGNETOCHEMSITRY**
**Code: CHEM-**
**Credit Hours: 3**

## Course Objectives:

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

## Course Contents:

**Symmetry and Group Theory:**

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

**Magnetochemistry:**

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

## Recommended Books:

1. Douglas, B., McDaniel, D., Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd ed., John-Wiley & Sons Inc., (1997).
2. Huheey, J. E, Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity*", 4th ed., Prentice Hall, (1997).
3. Mackay, K. M., Mackay, R. A. and Henderson, W., *Introduction to Modern Inorganic Chemistry*, 6th ed., CRC Press, (2002).
4. Miessler, G. L., Fisher, P. J. and Tar, D, A., *Inorganic Chemistry*, 5th ed., Prentice Hall, (2013).

5. Purcell, K. F., Kotz, J. C., *An Introduction to Inorganic Chemistry*, W. B. Saunders, Company Holt-Saunders, International ed., (1980).
6. Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry*, 6th ed., Wiley-Intersceince, New York, (1999).
7. Jolly, W. L., *Modern Inorganic Chemistry*, 2nd ed., McGraw-Hill Company, (1991).
8. Carter, R. L., *Molecular Symmetry and Group Theory*, 1st ed., John-Wiley & Sons, Inc., New York, (1997).
9. Orchin, M., Jaffe, H. H., *Symmetry, Orbitals, and Spectra,* John-Wiley & Sons, Inc., New York, (1971).
10. McWeeny, R., *Symmetry: An Introduction to Group Theory and its Applications,* Dover Publications, Inc., (2002).
11. Vincet, A., *Molecular Symmetry and Group Theory*, 2nd ed., John Wiley & sons Ltd, (2001).

# BS 4th Year

**Semester-VIII** **(INORGANIC CHEMISTRY)**
**Course Title:** **RADIO AND NUCLEAR CHEMISTRY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

## Recommended Books:

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

# BS 4th Year

**Semester-VIII (INORGANIC CHEMISTRY)**
**Course Title: Lab-II**
**Code: CHEM-**
**Credit Hours: 1**

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

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

## Recommended Books:


1. Angelici, R. J. (1977). *Synthesis and technique in inorganic chemistry*, pp. 157-168 Philadelphia: W. B. Saunders Company.
2. Elschenbroich, Ch., & Salzer, A. (1992). *Organometallics*. VCH Weinheim.
3. Hartley, F. R. (1974). *Elements of organometallic Chemistry*. London
4. Lucas, C. R., & Walsh, K. A. (1987). Organometallic chemistry of molybdenum. *Journal of Chemical Education*, *64*, 265–266.
5. McNeese, T. J., & Ezbiansky, K. A. (1996). Photochemical preparation and reactivity of cis- Cr(CO)4(CH3CN)2. *Journal of Chemical Education*, *73*, 548–550.
6. Miessler, G. L., & Spessard, G. O. (1991). Organometallic chemistry – A course designed for sophomore chemistry students. *Journal of Chemical Education*, *68*, 16–18.
7. Rabideau, P. W. (1989). The metal–ammonia reduction of aromatic compounds.
8. *Tetrahedron*, *45*, 1579–1603.
9. Spessard, G. O., & Miessler, G. L. (1996). *Organometallic chemistry*. Upper Saddle River, New Jersey: Prentice Hall.
10. Szafran, Z., Pike, R. M., & Singh, M. M. (1991). *Microscale inorganic chemistry*. New York: John Wiley & Sons.
11. ZAVIX Holzbecher and other, Hand Book of Organic reagents in Inorganic Analysis Ellis Hurwod Limited, London. (1976)
12. J. Bassett, R. C. Denny, G. H. Jeffery and J. Mendham, Vogel's Text Book of qualitative Inorganic Analysis, the English Language Book Society and Longman, New York, (2008)
13. James S. Pritz, George H. Sehenk, Quantitative Analysis Chemistry, Alby and Becon Inc. London. (2001)
14. Pass, G., Sutcliffe, H., *Practical Inorganic Chemistry: Preparation Reactions and Instrumental Methods,* 2nd ed., Chapman and Hall, (1974).

# BS 4th Year

**Semester-VIII** **(ORGANIC CHEMISTRY)**
**Course Title:** **NATURAL PRODUCTS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

**Alkaloids:**

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

**Terpenoids:**

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

**Steroids:**

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

**Flavonoids:**

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

## Recommended Books:


1. Dewick, P. M., *Medicinal Natural Products: A Biosynthetic Approach,* 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd., (2009).
2. Sell, C. S., A *Fragrant Introduction to Terpenoid Chemistry*, The Royal Society of Chemistry, UK, (2003).
3. De la Rosa, L. A., Parrilla, E. A. and Aguitar, G. A. G., *Fruit and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability,* Wiley-Blackwell, (2009).
4. Shahidi, F. and Naczk M., *Phenolics in Food and Nutraceuticals*, CRC Press, (2004).
5. Oyvind, M. A., and Kenneth, R. M., *Flavonoids: Chemistry, Biochemistry and Applications*, CRC, Taylor & Francis, New York, (2010).
6. Finar, I. L., Organic Chemistry, Vol. 2, *Stereochemistry and the Chemistry of Natural Products,* 5th ed., Pearson Education Ltd., Delhi, (2008).
7. Hesse, M., *Alkaloid Chemistry,* John-Wiley & Sons, New York, (1981).

8. Bhat, S. V., Nagasampagi, B. A. and Sivakumar, M., *Chemistry of Natural Products,* Narosa Publishing House, (2005).

# BS 4th Year

**Semester-VIII** **(ORGANIC CHEMISTRY)**
**Course Title:** **ORGANIC SYNTHESIS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

**Synthetic strategies:**

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

## Recommended Books:

1. Warren, S. and Wyatt, P., *Workbook for Organic Synthesis: The Disconnection Approach*, 2nd ed., John-Wiley & Sons, Inc., (2010).
2. Fox, M. A. and Whitsell, J. K., *Organic Chemistry*, 3rd ed., Jones & Bartlett Publishers (1997).
3. Clayden, J., Greeves, N., and Warren, S., *Organic Chemistry*, 2nd ed., Oxford University Press, New York, (2012).
4. Loudon, M., *Organic Chemistry,* 5th ed., Roberts Company Publishers, (2009).
5. Smith, J. G., *Organic Chemistry*, 3rd ed., McGraw-Hill, (2010).
6. Norman, R. O. C. and Coxon, J. M., *Principles of Organic Synthesis,* 3rd ed., CRC Press, (1993).

# BS 4th Year

**Semester-VIII** **(ORGANIC CHEMISTRY)**
**Course Title:** **MEDICINAL CHEMISTRY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

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

## Recommended Books:


1. Paul, M. D., *Medicinal Natural Products: A Biosynthetic Approach*, 3rd ed., Medicinal Natural Products, John-Wiley & Sons, Ltd, (2009).
2. Wolff, M. E., *Burger's Medicinal Chemistry,* 4th ed., Part III, John-Wiley & Sons, New York, (2006).
3. Williams, D. A. and Lemke, T. L., *Foye's Principles of Medicinal Chemistry*, 6th ed., Lippincott Williams & Wilkins, New York, (2008).
4. D. Sriram, P. Vogeeswari, *Medicinal Chemistry,* 2nd ed., BITS Pilani, Pearson, Publisher: Darling Kindernley, India, (2010).
5. Carins D., *Essential of Pharmaceutical Chemistry,* 3rd ed., Pharmaceutical Press, London, (2008)


# BS 4th Year

**Semester-VIII** **(ORGANIC CHEMISTRY)**
**Course Title:** **Lab-II**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Contents:

Experiments based on isolation of natural products from plants are recommended. These may include isolation of caffeine from tea, isolation of nicotine from tobacco, isolation of carvone from mint, isolation of limonene from orange peels, isolation of piperine from black pepper, etc.
Experiments involving multi-step synthesis may also be included, such as the synthesis of methyl orange.

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

## Recommended Books:


1. Clarke, H. T., *A Handbook of Organic Analysis-Qualitative and Quantitative*, John-Wiley & Sons, New York, (2007).
2. Mann, F. G. and Saunders, B. C., *Practical Organic Chemistry*, 4th ed., Longman, London, (1960).
3. Vogel, A. I., *Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis*, Longman, London, (1987).
4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., *Vogel's Text Book of Practical Organic Chemistry*, 5th ed., National Book Foundation, Islamabad, (2008).
5. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., *The Systematic Identification of Organic Compounds*, 7th ed., John-Wiley & Sons, (1997).
6. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., *Vogel's Text Book of Chemical Analysis*, Prentice Hall, (2000).
7. Beckett, A. H. and Stenlake, J. B., *Practical Pharmaceutical Chemistry,* Part II, 4th ed., Continuum International Publishing Group, (1988).


# BS 4th Year

**Semester-VIII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **REACTION DYNAMICS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

**Reaction Dynamics:**

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

**Reactions in solutions:**

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

## Recommended Books:


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


# BS 4th Year

**Semester-VIII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **RADIATION AND PHOTOCHEMISTRY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

**Radiation Chemistry:**

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

**Photochemistry:**

Principles of photochemistry, laws of photochemistry, Einstein's law of photochemical equivalence, rates of intramolecular processes, chemical reactions and quantum yields with examples, energy transfer in photochemical reaction, quantum yield of emission process radiation and nonradiation process, kinetics and quantum yields of radiative and nonradiative process

(fluorescence, phosphorescence, inter-system crossing, internal conversion, quenching) and Stern-Volmer reactions, photosensitized reactions.

## Recommended Books:


1. Spinks, J. W. T. and Woods, R. J., *An introduction to Radiation Chemistry*, 3rd ed., Wiley Inter Si. Pub., USA, (1990).
2. Aziz, F. and Rodgers, M. A. J., *Radiation Chemistry Principles and Applications,* 1st ed*.,* VCH Publishers, Inc., (1987).
3. Choppin, G., Liljenzin, J-O., Rydberg, J., *Radiochemistry and Nuclear Chemistry,* 3rd ed., Butterworth-Heinemann, (2002).
4. Mostafavi, M., Douki, T., *Radiation Chemistry: From Basic to Applications in Material and Life Sciences,* EDP Science, (2008).
5. Dunkin, I., *Photochemistry,* Vol. 36, RSC Publishing, (2007).
6. Dickson, D. P. E., Berry, F. J., *Mossbauer Spectroscopy,* Cambridge University Press, (1986).
7. Scaglia, B., *The Fundamentals: An Understanding of Photochemistry, B*iblio Bazaar, (2011).
8. Konya, J. and Nagy, N. M., *Nuclear and Radiochemistry,* 1st ed., Elsevier, (2012).


# BS 4th Year

**Semester-VIII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **COLLOID AND SURFACE CHEMISTRY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

**Colloid and Surface Chemistry:**

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

Solid surfaces, surface structures, clean surface structures, gas solid interface, thermodynamics of adsorption, heterogeneous catalysis, kinetic and mechanisms of catalyzed reactions, adsorption at liquid surfaces, chemisorption, physiosorption and dynamics, enzymatic catalysis, organized molecular assemblies, experimental probes for surface and adsorbent

structures, scanning probe techniques, low energy electron diffraction (LEED), electron spectroscopy, and other surface analysis techniques.

## Recommended Books:


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


# BS 4th Year

**Semester-VIII** **(PHYSICAL CHEMISTRY)**
**Course Title:** **Lab-II**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Objectives:

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

## Course Contents:

Sugar analysis and inversion studies by polarimetry.
Study of isotherms and experiments of surface chemistry.
Kinetics of fading of phenolphthalein in alkaline solution.
Study of the effect of pH on the rate constant of the reaction between iodide and persulphate ions.
Study of the salt effect on the rate constant of the reaction between similar charges of ions.
Kinetics of autocatalytic reaction between permanganate and oxalate ions.
Determination of energy of activation of the reaction between similar charged ions.
Kinetics of the reaction between methyl orange and peroxodisulphate ions in presence of bromide ions.
Stoichiometry of a complex in solution by Job's method using spectroscopic methods.

## Recommended Books:


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


# BSc 4th Year

**Semester-VIII** **(APPLIED CHEMISTRY)**
**Course Title:** **ORGANIC BASED INDUSTRIES**
**Code:** **CHEM**
**Credit Hours:** **3**

## Course Objectives:

Students will acquire knowledge to understand the structure, mechanism, properties and synthesis of various polymers. The course will also provide technical know- how about perfumes and cosmetics and surface coating industries.

## Course Contents:

**Paper and Pulp:**
Raw materials for pulp and paper industries, classification of paper products, chemistry involved in the processing of Kraft pulp, sulphite pulp and semi-chemical pulp, manufacture of paper and regeneration of spent liquor.

**Polymers:**
General classification and characterization of polymers, mechanism and chemistry of polymerization, thermoplastic and thermosetting polymerization, A brief outline for the production and applications of polymers i.e. polyethylene, polystyrene, polyurethanes, polyesters and urea phenol formaldehyde resins, and production of drug delivery polymers.

**Cosmetics and Perfumes:**
Chemistry and production of hair products and shampoos, chemistry involved in hair curling and styling products, hair tonics and depilatory products, production of cold cream, vanishing cream, bleach cream and shaving creams, tooth paste and face powders, production of nail polish, lipsticks and mascaras.

## Recommended Books:


1. Odian, G., *Principles of Polymerization*, 4th ed., John-Wiley & Sons, Inc., (2004).
2. Carraher, C. E. Jr., *Polymer Chemistry,* 6th ed., Marcel Dekker Incorporation, New York, (2003).
3. Roussak, D. V., Gesser, H. D., *Applied Chemistry; A Textbook of Engineers and Technologists,* 2nd ed., Springer, (2013).
4. Bajpai, P., *Environmentally Friendly Production of Pulp and Paper,* John-Wiley & Sons, Inc., (2010).
5. Schueller, R. and Romanowski, P., *Beginning Cosmetic Chemistry: Practical Knowledge for the Cosmetic Industry,* 3rd ed., Allured Publishing Corporation, (2009).
6. Barel, A. O., Paye, M. and Maibach, H. I., *Handbook of Cosmetic Science and Technology,* 3rd ed., Informa Healthcare, (2009).


# BS 4th Year

**Semester-VIII** **(APPLIED CHEMISTRY)**
**Course Title:** **INDUSTRIAL PROCESSES**
**Code:** **CHEM**
**Credit Hours:** **3**

## Course Objectives:

Students will acquire knowledge about pharmaceutical industries and nuclear industry as well as about oil refinery and production of various petrochemicals.

## Course Contents:

**Pharmaceuticals:**

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

**Petroleum and Petrochemicals:**

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

## Recommended Books:


1. Austin, G. T., Nelson, W. L., *Petroleum Refinery Engineering*, 4th ed., Aukland. Mcgraw Hill, (1985).
2. Shreve, R. M., George, T. A., *Shreve's Chemical Process Industries*, 5th ed., McGraw-Hill Book Company Inc., New York, (1984).
3. Kent, J. A., *Riegel's Handbook of Industrial Chemistry*, 10h ed., Kluwer Academic/Plenum publishers, (2003).

4. Vermani, O. P., Narula. A. K, *Applied Chemistry*, Theory and Practice, 2nd ed., New Age International Publisher, India, (1995).
5. D. G. Watson, *Pharmaceutical Chemistry, Churchill Living Stone,* (2007).
6. Cairms, D., *Essentials of Pharmaceutical Chemistry,* Pharmaceutical Press, (2003).
7. Loveland, W. D., Morrisey, D. J, *Modern Nuclear Chemistry,* Wiley Interscience, (2005).
8. Speight, J. G., *The Chemistry and Technology of Petroleum, 3*rd ed., Taylor & Francis, (2013).

# BS 4th Year

**Semester-VIII** **(APPLIED CHEMISTRY)**
**Course Title:** **METALLURGY AND EXPLOSIVES**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

The course is designed to give sufficient knowledge about iron, steel and its alloys. The course also provides the knowledge about corrosion and its preventions. The course will also give the knowledge about organic Dyes industries, different lubricants used in industrial processes.

## Course Contents:

**Iron, Steel and Alloys:**

Iron ores, constituents and their classification, manufacture of iron and steel, types of iron and steel, metal extractions and production of Alloys.

**Explosives and Propellants:**

Raw materials, manufacture of industrial explosives and propellants, types of explosives and their safety measures, chemistry involved in production of military explosives.

**Nuclear Materials:**

Extraction of uranium from rocks, importance of nuclear technology, nuclear energy and its peaceful applications, production of nuclear energy and control of nuclear reactors, chemistry of fission and fusion reactions, reprocessing of nuclear spent fuel, industrial application of nuclear radiations.

## Recommended Books:

1. Akhawan, J., *The Chemistry of Explosives,* 2nd ed., Royal Chemical Society, (2004).
2. Campball, F. C., *Elements of Metallurgy and Engineering Alloys,* ASM. International, (2008).
3. Davis, T. L., *The Chemistry of Powder and Explosives,* Angriff Press, (2012).

4. Reddy, L. K., *Principles of Engineering Metallurgy,* 2nd ed., New Age Publishers, (2009).
5. Loveland, W., Morrissey, D. J. and Seaborg, G. T., *Modern Nuclear Chemistry,* John-Wiley & Sons, Inc., (2006).
6. Choppin, G., Liijenzin, J-O. and Rydberg, J., *Radiochemistry and Nuclear Chemistry,* 3rd ed., Butterworth-Heinemann, (2002).
7. Vermani, O. P, Narula, A. K, *Applied Chemistry, Theory and Practice*, 2nd ed., New Age Publishing House,India, (1995).
8. Balsaral, V. M, *Applied Chemistry*, I.K. International House Pvt. Ltd., India, (2009)

# BS 4th Year

**Semester-VIII** **(APPLIED CHEMISTRY)**
**Course Title:** **Lab-II**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Contents:

Analysis of Lithium in industrial effluents, barium in ores, potassium in soil samples.

**Spectrophotometry:**
Iron in pharmaceuticals, chromium in steel, phosphate in fertilizers.

**Preparations:**
Calcium gluconate, detergents, cosmetics and vanishing creams. Analysis of Steel and Industrial Alloys. Purification and analysis of waste lubricating oils. Evaluation of edible and industrial oils. Determination of acid value. Saponification value and Iodine value. Extraction and characterization of essential oils from fragment plants. Preparation and characterization of Nylon. Analysis of effluent form industrial wastes. Recovery of chromium from tannery effluents. Preparation of Shaving creams. To determine the percentage of available chlorine in the supplied sample of bleaching powder. To determine the iron contents in the given iron ore solution by using external indicator.

## Recommended Books:

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

7. Chemical Engineering series, 5th Edition, McGraw-Hill, Inc. ISBNO-07-112 721-6 Vogels Text book of Inorganic analysis 4th edition revised by J. Bassett. ELBS William Clowes Limited Beccles and London.
8. Vogel's Textbook of Qantitative chemical analysis 6th edition., J.Mendham, RC Denney, JD Barnes, MJK Thmas. The School of Chemical and Life Sciences University of Greenwich London.

# BS 4th Year

**Semester-VIII (ANALYTICAL CHEMISTRY)**
**Course Title: LUMINESCENCE SPECTROSCOPY AND THERMAL ANALYSIS**
**Code: CHEM-**
**Credit Hours: 3**

## Course Objectives:

Students will acquire knowledge about the theoretical and instrumental aspects of luminescence spectroscopy and thermal techniques of analysis in addition to learning about their applications.

## Course Contents:

**Luminescence Spectrophotometry:**

Introduction, origin of fluorescence and phosphorescence spectra, Jablonski diagram, activation, deactivation, fluorescence spectrum, fluorescent and phosphorescent species; photoluminescence and structure, factors affecting fluorescence and phosphorescence, fluorescence quenching, quantum yield, instrumentation for fluorescence measurement, sources, wavelength selectors, sampling, detectors, read out devices, instrumentation for phosphorescence measurement, sampling, recording procedure, applications of fluorescence and phosphorescence.

**Thermal Methods of Analysis:**

Introduction, instrumentation, sources of errors, interpretation of data, Factors affecting curve, applications of TGA, DTA and DSC.

## Recommended Books:

1. Christian, G. D., *Analytical Chemistry.* 6th ed., John-Wiley & Sons, New York, (2006).
2. Harris, D. C., *Quantitative Chemical Analysis*, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Braun, R. D., *Introduction to Chemical Analysis*, International Student Edition, (1985).
4. Haines, P. J., Whitby, On Canada Mcgraw Hill Ltd., *Thermal Methods of Analysis Principles, Applications and Problems,* 1st ed., Springer, (1995).
5. Lakowicz, J. R., *Principles of Fluorescence Spectroscopy,* 3rd ed., Springer (2006).

6. Gabbot, P., *Principles & Applications of Thermal Analysis,* Wiley-Blackwell, (2007).
7. Brown, M. E., *Introduction to Thermal Analysis: Techniques and Applications,* 2nd ed., Kluwer Academic Publishers, (2001).
8. Skoog, D. A., West, D. M. and Holler, F. J. and Crouch, S. R., *Fundamentals of Analytical Chemistry,* 8th ed., (Int.), Cengage Learning, (2004).
9. Burgess, C. and Jones, D. G., *Spectrophotometry, Luminescence and Colour; Science and Compliance,* Vol. 6, Elsevier Science, (1995).

# BS 4th Year

**Semester-VIII** **(ANALYTICAL CHEMISTRY)**
**Course Title:** **NUCLEAR ANALYTICAL TECHNIQUES**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

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

## Course Contents:

Radiotracer techniques, choice of radiotracers, factors affecting choice of radiotracers, isotope dilution analysis (IDA), principle and equation, instrumentation, applications, advantages and limitations, sub-stoichiometric isotope dilution analysis (SIDA), activation analysis (AA), principle of NAA, neutron sources, interferences, sensitivity and detection limits, classification, instrumentation, applications, advantages and limitations, comparison of NAA and IDA with other methods, radiometric titrations (RT), procedure, advantages and limitations, radio chromatography and radioimmunoassay.

## Recommended Books:

1. Friedlander, G., Kennedy, J. W., Macias, E. S. and Miller. M. J., *Nuclear and Radiochemistry*, 3rd ed., Wiley, New York, (1981).
2. Arnikan, H. J., *Essentials of Nuclear Chemistry*, 4th ed., New Age International Pvt. Ltd.(1995)
3. Harvey, B. G., *Nuclear Physics and Chemistry,* 2nd ed., Prentice Hall Inc., (1969).
4. Naqvi, I. I., Farrukh, M. A, *Radiotracers in Chemical Applications: Radiochemistry, VDM* Verlog Dr. Muller, (2010).

# BS 4th Year

**Semester-VIII** **(ANALYTICAL CHEMISTRY)**
**Course Title:** **FOOD AND DRUG ANALYSIS**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

Students will acquire knowledge about sample preparation, derivations and analysis of different types of foods, pharmaceuticals and forensics.

## Course Contents:

**Food Products:**

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

**Pharmaceuticals:**

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

**Forensics:**

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

## Recommended Books:


1. Skoog, D. A., West, D. M. and Holler, F. J., *Fundamentals of Analytical Chemistry*, 7th ed., Saunders College Publishing, (1995).
2. Christian, G. D., *Analytical Chemistry*, John-Wiley & Sons, Inc., 6th ed., (2004).
3. Eckert, W. G., *Introduction to Forensic Science*, 2nd ed., CRC Press, (1997).
4. Nielsen, S. S., *Food Analysis,* 4th ed., Springer, (2010).
5. Thomas, G., *Medicinal Chemistry: An Introduction,* 2nd ed., John-Wiley & Sons, (2007).
6. Kobilinsky, L. F., *Forensic Chemistry Handbook, 1st ed.,* John-Wiley & Sons, USA, (2012).
7. Watson, D. G., *Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists,* Elsevier, (2012).
8. Stuart H. Barbara, *"Forensic Analytical Techniques",* 1st ed., John-Wiley & Sons, (2013).
9. Jackson, A. R. W. and Jackson, J. M., *Forensic Science,* 2nd ed., Pearson Education, (2008).

# BS 4th Year

**Semester-VIII** **(ANALYTICAL CHEMISTRY)**
**Course Title:** **Lab-II**
**Code:** **CHEM-**
**Credit Hours:** **1**

## Course Contents:

Determination of fat content in milk.
Quantification of Proteins.
Determination of cholesterol in food.
Quantification of reducing sugars and total sugars.
Water analysis for drinking purpose.
Determination of caffeine.
Determination of heavy metals in food items.
Determination of citric acid in juices.
Determination of ascorbic acid in fruit juices.
Evaluation of Rancidity of edible oil [Acid value].
Evaluation of Iodine value of edible oils.
Evaluation of Ester value of edible oils.
Determination of Aflatoxin in grains.
Extraction of DNA from Saliva, Cheek cells and blood.
Detection of Saliva by α-amylase activity.
Finger print analysis by $AgNO_3$, iodine vapour method.
Spot test/TLC of arsons and explosive (i.e. picric acid, nitrobenzenes and nitro-toluene)
Calibration and validation of HPLC system as per requirements of British or US pharmacopoeia.
Analysis of the binary mixture of pharmaceutical dosage by HPLC and statistical evaluation of data (RSD, CV, precision, accuracy, LOD, LOQ, resolution, Tailing factor).

## Recommended Books:


1. Latimer, Jr., G. W., *AOAC Official Methods of Analysis,* 19th ed., (2012).
2. Ranganna, S., *Handbook of Analysis & Quality Control for Fruits & Vegetables,* 2nd ed., TATA McGraw-Hill Education, (1986).
3. Stuart H. Barbara, *"Forensic Analytical Techniques",* 1st ed., John-Wiley & Sons, (2013).

# BS 4th Year

**Semester-VIII** **(BIOCHEMISTRY)**
**Course Title:** **MICROBIOLOGY AND IMMUNOLOGGY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

Students will learn about fundamentals of microbiology and immunology as well as the related disorders such as microbial borne infectious diseases, allergy, inflammation, and hypertension and their control.

## Course Contents:

**Fundamentals of Microbiology:**

Prokaryotic cell structure and function, Prokaryotic growth and nutrition, prokaryotic genetics. Virus and eukaryotic microorganisms, virus, bacteria, fungi and parasites. Bacterial diseases, airborne, foodborne and waterborne bacterial diseases. Industrial microbiology and biotechnology, microorganism in industry, alcoholic beverages, other important microbial products.

**Immunology:**

Chemistry of immunoglobulins, myeloma and hybridoma immunoglobulins, immune system and its abnormalities, allergy and inflammation, complement system, Peripheral leucocytes and macrophages, Type I lgE-mediated hypersensitivity, other types of hypersensitivity autoimmune disorders, immunodeficiency disorders.

## Recommended Books:


1. Nester, E., Nester, M., Anderson, D. and Roberts, C. E. Tr., *Microbiology: A Human Perspective,* 7th ed., McGraw-Hill, (2011).
2. Duan, T., Melvold, R., Viselli, S. and Waltenbaugh, C., *Lippincott's Illustrated Reviews, Immunology,* 2nd ed., Lippincott William & Wilkins, (2012).
3. Harvey, R. A., Cornelissen, C. N. and Fischer, B. D., *Lippincott's Illustrated Reviews: Microbiology,* 3rd ed., Lippincott William & Wilkins, (2012).
4. Wiley, J. M., Sherwood, L. M. and Woolnerton, C. J., *Prescott's Microbiology,* 7th ed., McGraw-Hill Education, (2011).
5. Male, D., Brostoff, J., Roth, D. B. and Roitt, I. M., *Immunology,* 8th ed., Elsevier, (2012).

# BS 4th Year

**Semester-VIII** **(BIOCHEMISTRY)**
**Course Title:** **BIONANOTECHNOLOGY**
**Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

The aim of the course is to acquire knowledge about bionanotechnology in general and its potential applications in particular. Bionanotechnology aims to exploit attributes of new materials like biosensors for medical applications. Understanding of the structure and assembly of nanoparticles opens some exciting possibilities to construct artificial structures in applied nanotechnology, which will mimic the functions of the biological systems.

## Course Contents:

Introduction to nanoparticles, overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, bionanotechnology systems, protein based nanostructures, nanobiosensors, challenges and opportunities associated with biology on the nanoscale, green nanoparticle production, self-assembly and templating, surface patterning and functionalization, characterization techniques of nanostructures.

## Recommended Books:


1. Ratner, M.A. and Ratner, D., *Nanotechnology: A Gentle Introduction to the Next Big Idea*, Prentice Hall Professional, upper saddle river, New Jersey (2003).
2. Goodsell, D.S., Bionanotechnology: Lessons from Nature, Wiley-Liss, Inc., Hoboken, New Jersey (2004).
3. Papazoglou, E. S., *Bionanotechnology*, Morgan & Claypool Publishers, California, USA (2007).
4. Renugopalakrishnan V., Lewis, R. V., *Bionanotechnology: Proteins to Nanodevices*, Springer (2006).
5. Iqbal, S., *Bionanosensors*, Morgan & Claypool Publishers, California USA (2008).
6. Kotov, N. A., *Nanoparticle Assemblies and Superstructures*, CRC press, USA (2006).
7. Dinh, T.V., *Nanotechnology in Biology and Medicine: Methods, Devices and Application* CRC press, USA (2007).
8. Kumar, C., *Nanomaterials for Biosensors,* Wiley-VCH, Germany (2007).
9. Niemeyer, C.M., and Mirkin, C.A., *Nanobiotechnology: Concepts, Applications and Perspectives,* Wiley-VCH, Germany(2004).

# BS 4th Year

**Semester-VIII (BIOCHEMISTRY)**
**Course Title: NUTRITIONAL CHEMISTRY**
**Code: CHEM-**
**Credit Hours: 3**

## Course Objectives:

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

## Course Contents:

**Major Dietary Constituents:**

Nutritional importance of carbohydrates, proteins and amino acids, lipids, and dietary fiber.

**Energy Needs:**

Assessment and requirement of energy in different age groups nutrition in growth and aging, nutritional requirement during infancy and childhood, diet, nutrition and adolescence, nutrition in the elderly minerals, biochemical role of Calcium, Chromium, Copper, Iron, Iodine, Magnesium, Phosphorous, Selenium and Zinc, their dietary source daily requirements and deficiency diseases.

**Vitamins:**

Role of vitamins as coenzymes structure, physiological functions, deficiency diseases and recommended dietary allowances of the following vitamins, fat soluble vitamins: A, D, E, and K, water soluble vitamins: Thiamine, Riboflavin, Niacin, Pantothenic acid, Folic acid, Blotin and Ascorbic acid.

## Recommended Text Books:


1. Wilson, K. and Walker, J., *Principles and Techniques of Biochemistry,* 5th ed., Cambridge University Press, (2000)
2. Belitz, H. D., Grosch, W. and Schieberle, P., *Food Chemistry,* 4th ed., Springer-Verlag Berlin, Germany, (2009).
3. Spallholz, J. E., Boylan, L. M. and Driskell, J. A., *Nutrition: Chemistry & Biology,* 2nd ed., CRC Press Inc., USA, (1999).
4. Ross, A. C., Caballero, B., Cousins, R. J., Tucker, K. L. and Ziegler, T. R., *Modern Nutrition in Health and Disease,* 11th ed., Lippincott Williams & Wilkins, (2012).
5. McDowell, L. R., *Vitamins in Animal and Human Nutrition,* 2nd ed., Iowa State University Press, (2000).
6. Zempleni, J., Rucker, R. B., McCormick, D. B. and Suttie, J. W., *Handbook of Vitamins,* 4th ed., CRC Press, (2007).

7. Nelson, D. L. and Cox, M. M., *Lehninger's Principles of Biochemistry, 6*th ed., W. H. Freeman, (2012).

# BS 4th Year

**Semester-VIII (BIOCHEMISTRY)**
**Course Title: Lab-II**
**Code: CHEM-**
**Credit Hours: 1**

## Course Contents:

Estimation of $Na^{+1}$ ions in blood.
Estimation of $K^{+1}$ ions in blood.
Determination of blood group of the patient.
Determination of serum aldolase in heart patient
Determination of protease activity of bacterial enzymes
Enzyme purification by ion-exchange chromatography
Synthesis of silver nanoparticles by using plant extracts
Synthesis of nanoparticles and study of surface plasmon response by UV-Visible Spectrophotometry

## Recommended Text Books:

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

# BS 4th year

**Semester-VIII** **(FUEL CHEMISTRY)**
**Course Title:** **CHEMISTRY OF COAL CONVERSION PROCESSES-II**
**Course Code:** **CHEM-**
**Credit Hours:** **3**

## Course Objectives:

The students will acquire knowledge about the coal conversion processes like solvent extraction, hydrogenation, and importance of catalysis in such reactions, product up gradation and analysis and environmental problems relating to synthetic fuels obtained from coal.

## Course Contents:

Liquefaction of Coal
Historical Developments: Historical developments of coal liquefaction, earlier coal liquefaction processes; (a) Pott and Broch Process (b) Bergius process.

Solvent Extraction: Solvent extraction of coal, some experiments on solvent extraction, mechanism of solvent extraction, types of solvent extraction, solvent systems, super critical gas extraction, commercial processes of solvent extraction like SRC-I, SRC-II, EDS, Super critical gas extraction.

Direct Liquefaction: Direct liquefaction of coal through catalytic hydrogenation, mechanism, catalysts' system, catalyst poisoning, catalytic role of coal minerals, commercial processes of catalytic hydrogenation like H-coal and Synthoil process.

Indirect Liquefaction: Indirect liquefaction through Fischer Tropsch synthesis, methanol synthesis and MTG (Methanol to Gasoline ) processes.

Effect of Parameters: Effect of coal properties, catalyst and solvent on liquefaction behaviour of coal, effect of coal properties like rank, maceral components and mineral matter on liquefaction, effect of operating condition like temperature, pressure, residence time, solvent, catalyst, etc.

Processing of Coal Liquids: Purification of liquefaction products, solid-separation, fractionation, upgrading and characterization of coal derived liquids, properties of coal derived liquids.

Liquefaction Reactor: Description of high pressure coal liquefaction reactor and auxiliary devices, ebulated bed reactor, fluidization.
Environmental Aspects: Environmental consideration, aerial emissions, water effluents, solid waste disposal.

## Recommended Books:


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


# BS 4th year

**Semester-VIII** **(FUEL CHEMISTRY)**
**Course Title:** **PETROLEUM AND PETROCHEMICALS-II**
**Course Code:** **CHEM-**
**Credit Hours:** **3**

## Course objectives:

The students will acquire knowledge about the modern thermodynamics and combustion of hydrocarbons fuels. The students will also be able to learn about the safe storage and transportation of hydrocarbons fuels.

## Course Contents:

Thermo chemistry and Combustion of Hydrocarbon Fuels: Basic thermodynamics principles, standard enthalpy of formation, standard enthalpy of reaction, enthalpy of combustion products, mechanism of combustion of gaseous and liquid hydrocarbon, theory of flame propagation, method of measuring flame speed, fuel performances in reciprocating piston engines, environmental pollution from hydrocarbon fuel utilization.

Storage and Handling of Hydrocarbon Fuels: Various types of storage tanks, different methods of transportation of crude and refined petroleum products. Health hazards associated with petroleum handling, volatility losses, fire hazards and its prevention. Extinguishing of oil fire methods.

## Recommended Books:


1. Hobson, G. D. *Modern Petroleum Technology*. Part 2, John Wiley and Sons, New York. (1984).
2. Gates, B. C, Katzer, J. R, and Schuit, G. C. A. *Chemistry of Catalytic Processes*.. McGraw Hill Book company, London (1979).
3. List, H. L. *Petrochemical Technology*. Printice-Hall Englewood Cliffs, New Jersey. (1986).
4. Goodger, E. M. *Hydrocarbon Fuels*. Union Brothers Ltd, London. (1975).
5. Maleev, V. L. Internal Combustion Engines. McGraw Hill Book Company London, (1985).

6. Hughes, J.R., and Swindells, N. S. *Storage and Handling of Petroleum Liquids*. Charless Griffin and Company Ltd, London (1987).

# BS 4th Year

**Semester-VIII** **(FUEL CHEMISTRY)**
**Course Title:** **ALTERNATE ENERGY RESOURCES**
**Course Code:** **CHEM-**
**Credit Hours:** **3**

## Course objectives:

This course will enable students to know about the challenging sources of alternate sources of energy. The students will also be able to learn about the safe uses of natural resources.

## Course Contents:

**Biomass Resources:** Biomass conversion processes, bio gas technology. Various traditional methods of alcohol production. Alcohols and its uses as alternative fuel.

**Biofuels:** Production of Bio-ethanol and biodiesel, uses of bioethanol as supplement with petroleum gasoline as $E_{10}$ and $E_{20}$ etc

**Hydrogen:** Hydrogen production, storage, handling and its uses as alternative fuel. Fuel cells: Fuel Cells and its application,

**Solar Energy:** Photovoltaic power conversion & solar energy collectors.

**Nuclear fuels:** Nuclear fuels processing, fission and fusion, nuclear reactors.

**Hydel Energy:** introduction to Hydel energy. Prospecting of hydel powers in Pakistan.

## Recommended Books:

1. Gyngell, E. bS. *Applied Chemistry for Engineers*. Edward Arnold Publisher, Ltd. London. (1989).
2. Harker, J.b . and Backurst, J.R. *Fuel and Energy*. Academic Press, London and New York (1988).
3. Goodger E. M. *Alternative fuels (chemical energy resources)*. The Macmillan press Ltd, London, (1980).
4. Twidell, J. and Weir, T. *Renewable Energy Resources*. John Wiley and Sons, London, New York, (1986).

# BS 4th Year

**Semester-VIII** **(FUEL CHEMISTRY)**
**Course Title:** **Lab-II**
**Course Code:** **CHEM**
**Credit Hours:** **1**

## Course Contents:

Determination of ash in petroleum products.
Determination of calcium and barium in lube-oil.
Determination of the acidity and alkalinity of greases.
Determination of mercaptane sulfur in motor fuels, kerosene, and similar petroleum products.
Determination of total solids in used engine oils.
Determination of total sediments in residual fuel oils.
Determination of total sulfur in coal and coke by Eschka mixture method.
Determination of chlorine in coal by Eschka mixture method.
Cleaning of coal using gravity separation and froth flotation method.
Determination of aniline point, diesel index and approximate Cetane number of diesel fuel.

## Recommended Books:


1. Speight, J. G Handbook of Petroleum Analysis Wiley-Interscience, (2002)
2. Speight, J. G. Handbook of Coal Analysis. John Wiley and Sons, New Jersey, (2005)
3. ASTM, 2000, Annual Book of ASTM Standards, American Society for Testing and Materials, West Consbohockm, PA, USA

# MS/MPhil Chemistry
# SCHEME OF STUDIES

## MS/MPhil Two Years Program
## Year 1 (Two Semesters): Course Work
## Year 2 (Two Semesters): Research Work

| **Course Work** | |
|---|---|
| **Course Code and Title** | **Credit Hours** |
| Semester – I | |
| CHEM- | 3 |
| CHEM- | 3 |
| CHEM- | 3 |
| CHEM- | 3 |
| Total | 12 |
| Semester – II | |
| CHEM- | 3 |
| CHEM- | 3 |
| CHEM- | 3 |
| CHEM- | 3 |
| Total | 12 |
| | |
| Research Work | |
| Semester – III & IV | |
| Research, Thesis and Defence* | |
| Total | 6 |
| | |
| Total Credit Hours: | 30 |

*Institutions may increase the credit hours of research work as per their requirement

## PROPOSED COURSES:

Institutions shall have to offer courses of 24 credit hours out of the following list. New courses may also be designed according to the expertise available.

## GENERAL COURSES (CHEM-701-705)

Chemical Education
Research Methodologies
Computational Chemistry
Statistical Data Handling and Mathematics
Assessment in Higher Education
Forensic Chemistry

## COURSES OF INORGANIC/ANALYTICAL CHEMSITRY (CHEM-711-25)

Advanced Spectroscopic Techniques
Advanced Chromatographic Techniques
Bioanalytical Chemistry
Solid State Chemistry
Chemistry of Organometallics
Metal-based drugs
Nanochemistry
Green Chemistry Techniques
Thermal Analysis
Validation of Analytical Methods.
Nuclear medicine.
Food, pharmaceutical and Forensic analysis.
Advanced Electroanalytical Techniques
Inorganic Material Chemistry
Characterization of Natural Antioxidants and Essential Oils

## COURSES OF ORGANIC CHEMSITRY (CHEM-726-40)

Natural ProductsChemistry
Synthetic Applications of Named Reactions
Advanced Spectroscopy
Advanced Heterocyclic Chemistry
Organic Polymer Chemistry
Pharmaceutical Chemistry
SupramolecularChemistry
Phytochemical Techniques
Modern Trends in Asymmetric Synthesis
Advanced Stereochemistry
PericyclicChemistry
Organic Compoundscontaining S, P & Si
Dyes and Pigments
Physical Organic Chemistry

## COURSES OF PHYSICAL CHEMSITRY (CHEM-741-55)

Polymers and Advanced Composite Materials
Advanced Quantum Chemistry
Advanced Photochemistry and Radiation Chemistry
Advanced Electrochemistry
Surface Chemistry
Advanced Statistical Thermodynamics
Biophysical Chemistry
Chemistry of Atmosphere
Advanced Solid State Chemistry and Characterization Techniques
Advanced Reactions Dynamics
Nanomaterials
Magnetic Spin Dynamics

Applied Nuclear Chemistry

## COURSES OF BIOCHEMISTRY (CHEM-756-770)

Enzymes Kinetics
Drug-Protein and Drug-DNA Interaction
Cell Signaling
Bioassays
Bioinformatics
Biosensors
Radio-immuno Assay
PCR and ELISA Techniques
NutraceuticalsTissue Culture Techniques
Cell Biology
Biotransformations
Industrial Microbiology
Clinical Biochemistry

## COURSES OF APPLIED CHEMSITRY (CHEM-771-785)

Environmental Impact of Chemical Industries
Nanomaterials and their applications
Chemistry of Dyes and Pigments
Pharmaceutical Chemistry
Advanced Polymer Chemistry
Agrochemicals
Physical Structure of Porous Materials
Industrial Process Chemistry
Advances in Petrochemical Industries
Coal Gasification and Liquefaction
Alternative Fuels
Nuclear Fuel Processing and waste management
Alternative Energy Sources

**Note:** Any other course according to the availability of facilities, expertise in the institution may be offered.

**Annexure "A"**

# COMPULSORY COURSES IN ENGLISH FOR BS (4 YEAR) IN BASIC & SOCIAL SCIENCES

## English I (Functional English)

**Objectives:** Enhance language skills and develop critical thinking.

### Course Contents:

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

### Comprehension

Answers to questions on a given text

### Discussion

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

### Listening

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

### Translation skills

**Urdu to English**

### Paragraph writing

Topics to be chosen at the discretion of the teacher

### Presentation skills

Introduction

*Note: Extensive reading is required for vocabulary building*

### Recommended books:

1. **Functional English**
   a) Grammar
   1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492

2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

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

d) Speaking

## English II (Communication Skills)

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

## Course Contents

**Paragraph writing**
Practice in writing a good, unified and coherent paragraph

**Essay writing**
Introduction

**CV and job application**

Translation skills
Urdu to English

**Study skills**
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

**Academic skills**
Letter/memo writing, minutes of meetings, use of library and internet

**Presentation skills**
Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review*

## Recommended Books:

### Communication Skills

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

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

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

## English III (Technical Writing and Presentation Skills)

**Objectives:** Enhance language skills and develop critical thinking

## Course Contents

### Presentation skills

### Essay writing
Descriptive, narrative, discursive, argumentative

### Academic writing
How to write a proposal for research paper/term paper

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

### Technical Report writing

### Progress report writing

*Note: Extensive reading is required for vocabulary building*

## Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing
   1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).

   2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
   3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills
c) Reading
   The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

# Annexure "B"

## Pakistan Studies (Compulsory)

### Introduction/Objectives:

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

### Course Outline:

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

### Recommended Books:


1. Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development.* Lahore, 1994.
5. Wilcox, Wayne.*The Emergence of Banglades.,* Washington: American Enterprise, Institute of Public Policy Research, 1972.

6. Mehmood, Safdar. *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan,* Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development.* Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research, 1993.

## Annexure "C"

# ISLAMIC STUDIES
# (Compulsory)

## Objectives:

This course is aimed at:

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

## Detail of Courses:

### Introduction to Quran Studies

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

### Study of Selected Text of Holly Quran

1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5) Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

### Study of Selected Text of Holly Quran

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

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

1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
2) Life of Holy Prophet (S.A.W) in Makkah
3) Important Lessons Derived from the life of Holy Prophet in Makkah

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

1) Life of Holy Prophet (S.A.W) in Madina
2) Important Events of Life of Holy Prophet in Madina
3) Important Lessons Derived from the life of Holy Prophet in Madina

## Introduction To Sunnah

1) Basic Concepts of Hadith
2) History of Hadith
3) Kinds of Hadith
4) Uloom –ul-Hadith
5) Sunnah & Hadith
6) Legal Position of Sunnah

## Selected Study from Text of Hadith

## Introduction to Islamic Law & Jurisprudence

1) Basic Concepts of Islamic Law & Jurisprudence
2) History & Importance of Islamic Law & Jurisprudence
3) Sources of Islamic Law & Jurisprudence
4) Nature of Differences in Islamic Law
5) Islam and Sectarianism

## Islamic Culture & Civilization

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

## Islam & Science

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

## Islamic Economic System

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

## Political System of Islam

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

## Islamic History

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

## Social System of Islam

1) Basic Concepts of Social System of Islam
2) Elements of Family

3) Ethical Values of Islam

## Reference Books:


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

# Annexure "D"

*Note: One course will be selected from the following six courses of Mathematics.*

## COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

## *(FOR STUDENTS NOT MAJORING IN MATHEMATICS)*

## 1. MATHEMATICS I (ALGEBRA)

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

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

## Course Outline:

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression.

*Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices.

*Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

## Recommended Books:

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

**Boston (suggested text)**
Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)

**Credit Hours:** 3 + 0

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

## Course Outline:

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

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

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

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

## Recommended Books:

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

## 3. MATHEMATICS III (GEOMETRY)

**Prerequisite(s):** Mathematics II (Calculus)

**Credit Hours:** 3 + 0

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

## Course Outline:

*Geometry in Two Dimensions:* Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

*Circle*: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
*Conic Sections:* Parabola, ellipse, hyperbola, the general-second-degree equation

## Recommended Books:

Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969
Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

## 4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

| | | |
|---|---|---|
| *Title of subject*: | | MATHEMATICS |
| *Discipline* | : | BS (Social Sciences). |
| *Pre-requisites* | : | SSC (Matric) level Mathematics |
| *Credit Hours* | : | 03 + 00 |
| *Minimum Contact Hours* | : | 40 |
| *Assessment* | : | written examination; |
| *Effective* | : | 2008 and onward |

**Aims** : To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

**Objectives** : After completion of this course the student should be able to:

- Understand the use of the essential tools of basic mathematics;

- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

**Contents**:

1. *Algebra*: *Preliminaries:* Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations*: Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.
2. *Statistics* : *Introduction*: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation, mean deviation, standard deviation, variance, moments, skewness and kurtosis.

## Recommended Books:


1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.
4. Wilcox, R. R., '*Statistics for The Social Sciences'*,

# INTRODUCTION TO STATISTICS

## Specific Objectives:

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

Unit 1. What is Statistics?

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

Unit 2. Presentation of Data

Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Histogram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

Unit 3. Measures of Central Tendency

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

Unit 4. Measures of Dispersion

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

Unit 5. Probability and Probability Distributions.

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

Unit 6. Sampling and Sampling Distributions

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

Unit 7. Hypothesis Testing

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

Unit 8. Testing of Hypothesis- Single Population

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

Unit 9. Testing of Hypotheses-Two or more Populations

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

Unit 10. Testing of Hypothesis-Independence of Attributes

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

Unit 11. Regression and Correlation

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

## Recommended Books:


1 Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.

2 Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar, Faisalabad.


*Note:* ***General Courses from other Departments***

**Detail of courses may be developed by the concerned universities according to their Selection of Courses as recommended by their Board of Studies.**