CURRICULUM OF M. Sc. CHEMISTRY

(2-YEAR PROGRAM)

INSTITUTE OF CHEMICAL SCIENCES

UNIVERSITY OF SWAT

2016

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Introduction

The 1st meeting of the Board of Studies of the Institute of Chemical Sciences, University of Swat was held on 16th September 2015 in committee room of the Odigram campus. The meeting was attended by all worthy members of the board which include:

Dr. Behramand, Institute of Chemical Sciences, University of Swat (Convener)

Dr. Jasmin Shah, Institute of Chemical Sciences, University of Peshawar (Expert Member)

Mr. Sarwar Khan, Department of Chemistry GPGJC Swat (Expert Member)

Dr. Ihsan Ullah, Institute of Chemical Sciences, University of Swat (Secret./Member)

Dr. Faiz M. Khan, Department of mathematics & Statistics University of Swat (Member)

Dr. Ahmad Ali, Center for Plant Science and Biodiversity University of Swat (Member)

Mr. Abdul Waheed Kamran, Department of Chemistry University of Malakand (Member)

Mr. Muhammad Ali, Department of Chemistry GPGJC Swat (Member)

Mr. Nazir Ahmad, Department of Zoology GPGJC Swat (Member)

The meeting was presided by Dr. Behramand (In-Charge, Institute of Chemical Sciences, University of Swat). Agenda of the meeting was to discuss various aspects of the curriculum designed for the M.Sc. Chemistry Program. The Board decided that the HEC baseline will be followed for the curriculum. Members of the board thoroughly discussed the program structure, scheme of studies and detailed contents and, after minor changes, recommended the proposed curriculum of M.Sc. for approval by the respective bodies of the University.

Mission Statement

Our mission is the generation of quality human resources in the area of chemistry by producing highly skilled and well trained graduates and researchers capable enough to address the future challenges at both regional and international levels. Apart from teaching to develop the conceptual and problem-solving skills in our students, our mission is to cultivate an enthusiastic research culture by establishing laboratories equipped with sophisticated research facilities and establishing strong collaborations with other national and international institutions. We envision our Institute to play a leading role in teaching and research and expect our graduates will serve the nation and humanity.

Objectives:

1. To impart knowledge and training to the students of M.Sc. in the field of chemistry to create a corps of chemists who could perform adequately in their area.
2. To educate students to be scientifically literate and provide them opportunities for professional growth through designing and executing chemical research projects.
3. To establish research collaborations with relevant departments/institutes/research centers at national and international level.

Key to the Course Coding:

i) The course codes are composed of both letters and digits separated by hyphen. Each letter code and the following digits convey specific information as summarized below.

CHEM: Chemistry Courses

CHEM - A B C. X

- X — Area of Chemistry/Subject identity
- C — Paper No in a particular semester
- B — Semester No in a particular Academic year
- A — Course level with respect to SSC, e.g. "5" for 1st and 2nd Semesters whereas "6" for 3rd and 4th Semester course works.

ii) For the Chemistry Courses, the digit specifying the subject identity will be as follows:

Analytical Chemistry	1
Applied / Industrial Chemistry	2
Biochemistry	3
Environmental Chemistry	4
Inorganic Chemistry	5
Organic Chemistry	6
Physical Chemistry	7
Special Topics in Chemistry	8

For example the course code CHEM-523.7 is assigned to the course of Physical Chemistry which will be the 3rd course offered in the 2nd semester of the 5th academic year after SSCScheme of Studies for M.Sc.

Semester-wise Breakup

Semester: I					
S. No	**Course Title**	**Course Code**	**Credit Hours**		**Marks**
			Theory	**Practical**	
1	Inorganic Chemistry-I	CHEM-511.5	3	1	100
2	Organic Chemistry-I	CHEM-512.6	3	1	100
3	Physical Chemistry-I	CHEM-513.7	3	1	100
4	Optional Subjects Analytical Chemistry-I Applied Chemistry-I Biochemistry-I	CHEM-514.1 CHEM-514.2 CHEM-514.3	3	1	100
5	Mathematics for Chemists	CHEM-515	2	0	100
	Total		**14**	**4**	**500**

Semester: II					
S. No	**Course Title**	**Course Code**	**Credit Hours**		**Marks**
			Theory	**Practical**	
1	Inorganic Chemistry-II	CHEM-521.5	3	1	100
2	Organic Chemistry-II	CHEM-522.6	3	1	100
3	Physical Chemistry-II	CHEM-523.7	3	1	100
4	Optional Subjects Analytical Chemistry-II Applied Chemistry-II Biochemistry-II	 CHEM-524.1 CHEM-524.2 CHEM-524.3	3	1	100
	Total		**12**	**4**	**400**

Semester: III (Specialization in any of the offered fields)					
S. No	**Course Title**	**Course Code**	**Credit Hours**		**Marks**
			Theory	**Practical**	
1	Specialization Paper-I (from any of the selected fields) Analytical Chemistry Applied Chemistry Biochemistry Inorganic Chemistry Organic Chemistry Physical Chemistry	CHEM-631.1 CHEM-631.2 CHEM-631.3 CHEM-631.5 CHEM-631.6 CHEM-631.7	3	0	100
2	Specialization Paper-II (from any of the selected field) Analytical Chemistry Applied Chemistry Biochemistry Inorganic Chemistry Organic Chemistry Physical Chemistry	CHEM-632.1 CHEM-632.2 CHEM-632.3 CHEM-632.5 CHEM-632.6 CHEM-632.7	3	0	100
3	Specialization Paper-III (from any of the selected field) Analytical Chemistry Applied Chemistry Biochemistry Inorganic Chemistry Organic Chemistry Physical Chemistry	CHEM-633.1 CHEM-633.2 CHEM-633.3 CHEM-633.5 CHEM-633.6 CHEM-633.7	3	0	100

<table>
<tr><th rowspan="2">S. No</th><th rowspan="2">Course Title</th><th rowspan="2">Course Code</th><th colspan="2">Credit Hours</th><th rowspan="2">Marks</th></tr>
<tr><th>Theory</th><th>Practical</th></tr>
<tr><td>4</td><td>Specialization Paper-IV (from any of the selected field)

Analytical Chemistry
Applied Chemistry
Biochemistry
Inorganic Chemistry
Organic Chemistry
Physical Chemistry</td><td>CHEM-634.1
CHEM-634.2
CHEM-634.3
CHEM-634.5
CHEM-634.6
CHEM-634.7</td><td>3</td><td>0</td><td>100</td></tr>
<tr><td>5</td><td>Environmental Chemistry-I</td><td>CHEM-635.4</td><td>2</td><td>1</td><td>100</td></tr>
<tr><td>6</td><td>Special Practicals-I /Research project/ Review-article/ Internship

Analytical Chemistry
Applied Chemistry
Biochemistry
Inorganic Chemistry
Organic Chemistry
Physical Chemistry</td><td>CHEM-636.1
CHEM-636.2
CHEM-636.3
CHEM-636.5
CHEM-636.6
CHEM-636.7</td><td>0</td><td>3</td><td>100</td></tr>
<tr><td></td><td colspan="2">Total</td><td>14</td><td>4</td><td>600</td></tr>
</table>

Semester: IV (Specialization in any of the offered fields)					
S. No	**Course Title**	**Course Code**	**Credit Hours**		**Marks**
			Theory	**Practical**	
1	Specialization Paper-V (from any of the selected fields) Analytical Chemistry Applied Chemistry Biochemistry Inorganic Chemistry Organic Chemistry Physical Chemistry	CHEM-641.1 CHEM-641.2 CHEM-641.3 CHEM-641.5 CHEM-641.6 CHEM-641.7	3	0	100
2	Specialization Paper-VI (from any of the selected field) Analytical Chemistry Applied Chemistry Biochemistry Inorganic Chemistry Organic Chemistry Physical Chemistry	CHEM-642.1 CHEM-642.2 CHEM-642.3 CHEM-642.5 CHEM-642.6 CHEM-642.7	3	0	100
3	Specialization Paper-VII (from any of the selected field) Analytical Chemistry Applied Chemistry Biochemistry Inorganic Chemistry Organic Chemistry Physical Chemistry	CHEM-643.1 CHEM-643.2 CHEM-643.3 CHEM-643.5 CHEM-643.6 CHEM-643.7	3	0	100

<table>
<tr><th rowspan="2">S.No</th><th rowspan="2">Course Title</th><th rowspan="2">Course Code</th><th colspan="2">Credit Hours</th><th rowspan="2">Marks</th></tr>
<tr><th>Theory</th><th>Practical</th></tr>
<tr><td>4</td><td>Specialization Paper-VIII (from any of the selected field)

Analytical Chemistry
Applied Chemistry
Biochemistry
Inorganic Chemistry
Organic Chemistry
Physical Chemistry</td><td>CHEM-644.1
CHEM-644.2
CHEM-644.3
CHEM-644.5
CHEM-644.6
CHEM-644.7</td><td>3</td><td>0</td><td>100</td></tr>
<tr><td>5</td><td>Environmental Chemistry-II</td><td>CHEM-645.4</td><td>2</td><td>1</td><td>100</td></tr>
<tr><td>6</td><td>Special Practicals-II/ Research project /Review-article/ Internship

Analytical Chemistry
Applied Chemistry
Biochemistry
Inorganic Chemistry
Organic Chemistry
Physical Chemistry</td><td>CHEM-646.1
CHEM-646.2
CHEM-646.3
CHEM-646.5
CHEM-646.6
CHEM-646.7</td><td>0</td><td>3</td><td>100</td></tr>
<tr><td></td><td colspan="2">Total</td><td>14</td><td>4</td><td>600</td></tr>
</table>

Total Duration: 4 Semesters (2 Years)

Total Credit Hours: 70

Total Marks: 2100

Analytical Chemistry

M.Sc. 1st –Year, Semester –I

Course Title: Analytical Chemistry-I **Code: CHEM-514.1**

Credit Hours: 3+1 **Marks: 100**

Course Objectives

To introduce basic vocabulary and concepts used in analytical chemistry, stoichiometry, solutions, equilibrium, a brief review of classical methods of analysis, steps involved in sampling process, and use of statistical methods to determine the precision and accuracy of experimental results.

Course Outcomes

After completion of this course, the students will have acquired acquaintance with basic concepts of analytical chemistry and its scope, the ability to make calculations and prepare solutions of different concentrations, sampling methods for analysis, volumetric methods of analysis and statistical knowledge for calculations.

Course Contents

Fundamental Concepts of Analytical Chemistry

Introduction and scope of analytical chemistry, analytical problems and their solutions; recent trends in analytical methods; solutions, concentration units and their conversions, stoichiometric relationships.

Sampling

Types of sampling techniques, sampling of gas, liquid and solid, treatment of samples to obtain homogenous solutions.

Errors in Chemical Analysis and Minimization

Steps in analytical procedures, errors, precision, accuracy, types of errors, steps involved in minimization of errors.

The Law of Mass Action and Its Applications

Electrolytes, weak electrolytes, weak acids/bases, complex formation, buffer solutions, buffer capacity, Henderson Hassel Balch equation, hydrolysis of salts and pH calculations.

Gravimetric Methods of Analysis

Solubility and solubility product of sparingly soluble salts, separation by precipitation, formation and size of precipitates, types of precipitates, impurities in precipitates, quantitative calculations, stoichiometric reactions.

Titrimetric Methods of Analysis

Neutralization Titration: Theory of neutralization titration, titration curve, theories of indicator, choice of indicator, buffer, preparation of buffer, buffer capacity and buffer mechanism. Application of neutralization titration. Hydrolysis of salt and pH calculation.

Complexometric and precipitation titration: Complex formation reaction, titration with chelating agents, indicators used in complexometric titration. Precipitation titration, endpoint location in precipitation titration, Applications of complexometric and precipitation titration.

Oxidation Reduction titrations: Oxidizing and reducing agents, titration curve, choice of indicator and colour change mechanism, applications of redox titrations.

Practicals

Laboratory work illustrating topics covered in the lectures of Chem-514.1

1. Calibration of volumetric glassware, electronic and analytical equipments.
2. Neutralization titrations
   a. Determination of sodium carbonate in commercial washing soda
   b. Determination of acetic acid in commercial vinegar sample.
   c. Quantitative analysis of mixture of NaOH and Na_2CO_3.
   d. Determination of Pka and Pkb of weak acid and base.
3. Redox titrations
   a. Determination of Fe(II) in the given sample.
   b. Determination of sulphite in the given sample.
   c. Determination of oxalic acid in the given sample.
   d. Determination of ascorbic acid in citrus juice.
4. Complexometric titrations
   a. Hardness of water
   b. Calcium and magnesium in a sample
   c. Zinc in a given sample
5. Back titrations
   a. Determination of ammonia in ammonium chloride sample
   b. Bicarbonate in a sample
6. Determination of chloride in tap water Sample.

Recommended Books

1. Barun, R.D., "Introduction to Chemical Analysis", International Student Edition, 1985.
2. Skoog, D.A., West, P.M., F.J. Holler and S. R. Crouch, "Fundemantals of Analytical Chemistry", 8th Edition, Holt, Rinehart and Winston, New York, 2004.
3. Vogel, A.I., "A Text Book of Quantitative Inorganic Analysis", 3rd Edition, The English Language Book Society, 1961.
4. Kolthoff, I.M., and Sandell, E.B., "Text Book of Quantitative Inorganic Analysis", The MacMillan Company, New York, 1943.
5. Chistian, G.D., "Analytical Chemistry", 6th Edition, John Wiley and Sons, Inc., New York, 1999.

Analytical Chemistry

M.Sc. 1st –Year, Semester –II

Course Title: Analytical Chemistry-II **Code: CHEM-524.1**
Credit Hours: 3+1 **Marks: 100**

Course Objectives

Major objective of this course is to develop understanding of:

- The fundamental concepts in electrochemistry.
- Use electrochemical techniques and data analysis of redox systems.
- Basic principles of potentiometry with special emphasis of pH meter and learning applications of ion selective and bio electrodes.
- Electrolytic conduction, distinction between electrolytes and non-electrolytes, strong and weak electrolytes, molar and equivalent conductivities.
- The principle of electrogravimetry, ohmic potential (IR drop) and polarisation and their significance in electrodeposition.
- The principles of coulometry, its types and analytical applications.

Course Outcomes

After taking this course, the students will have acquired knowledge about the basic concept and types of electrochemical cells, redox reactions, Nernst equation and their uses, the use of pH meter, conductometer and coulometric measurements.

Course Contents

Introduction to Electrochemical Methods

The Electrochemical cells, electrode potential, oxidation reduction reactions, Nernst equation and its use for half-cell potential, standard potentials

Potentiometry

Standard electrodes and different kinds of working 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 electrogravimetry. Consequences of electrogravimetry, Ohmic drop, activation over potential, concentration and gas polarization, basic difference and merits/demerits of coulometry and electrogravimetry.

Conductometry

Conductance in Solutions; Specific conductance; molar conductance; factors upon which the conductance of solution depends; Measurement of conductance; cell constant; Analytical applications of conductance measurement.

Spectroscopy

Introduction to spectroscopic techniques, basic concepts of UV-visible spectroscopy, Beer-Lambert law and its limitations.

Recommended Books

1. Barun, R.D., “Introduction to Chemical Analysis”, International Student Edition, 1985.
2. Skoog, D.A., West, P.M., F.J. Holler and S. R. Crouch, “Fundamentals of Analytical Chemistry”, 8th Edition, Holt, Rinehart and Winston, New York, 2004.
3. Vogel, A.I., “A Text Book of Quantitative Inorganic Analysis”, 3rd Edition. The English Language Book Society, 1961.
4. Kolthoff, I.M., and Sandell, E.B., “Text Book of Quantitative Inorganic Analysis”, The MacMillan Company, New York, 1943
5. Christian, G.D., “Analytical Chemistry”, 6th Edition, John Wiley and Sons, Inc., New York, 1999.
6. Christian, Gary D., and O.Reilly, James E., “Instrumental Analysis”, Allyn and Bacon, 1986.
7. Skoog, D.A. and West, D.M., “Principles of Instrumental Analysis”, Holt, Rinehart and Winston Inc, 1971.

Practicals

Laboratory work illustrating topics covered in the lectures of Chem-524.1

1. Determination of strength of strong acid using potentiometric titration.
2. Determination of strength of Weak acid using potentiometric titration.
3. Determination of strength of a mixture of strong acid and weak acid using potentiometric titration.
4. Determination of strength of strong acid using conductometric titration.
5. Determination of strength of weak acid using conductometric titration.
6. Determination of strength of a mixture of strong acid and weak acid using conductometric titration.

7. Determination of pKa values of a polyprotic acid using potentiometric titration.
8. Determination of optimum wavelength for quantitative determination of a colored compound using spectrophotometric method.
9. Verification of Beer's Law and evaluation of molar extinction coefficient.
10. Separation and quantification of Copper in Brass using constant-current electrolysis.

Specialization Courses

Analytical Chemistry

M.Sc. 2nd –Year, Semester –III

Specialization Paper-I: Elementary Analytical Chemistry **Code: CHEM-631.1**
Credit Hours: 3+0 **Marks: 100**

Course Objectives

Major objectives of this course is to enable the students to

- Know the sources of errors and how to avoid them.
- Stoichiometric calculations.
- Rounding of data and report results.
- Calculating and interpreting central tendency, dispersion, and relative standing including variance, standard deviation, co-variance, confidence limits, correlation and regression from a given data set.
- Testing a null hypothesis with student-t test, F-test, Q test, Gaussian distribution, least square method, quality assurance and calibration methods.
- Complexes, chelating agents, their use for determination of metals and masking.
- Electrolytes, activity, and activity coefficients, solvents effect, calculation and computation of dissociation constants from experimental data, preparation and uses of buffers.

Course Outcomes

At the end of this course, the students will be able to:

- Identify the sources of error and their elimination in analysis.
- Calculate analyte from a given method and result reporting
- Perform various statistical tests to verify a given data.
- Determine metals using chelating agents and masking of interfering ion during analysis.
- Prepare and use buffers, can calculate activity of and know the use of various solvents.

Course Contents

Elementary Statistics

The task of statistics in chemical analysis, sources of variation and error, random and systematic error, presentation of results and rounding off the data Averages; the arithmetic mean, medium, mode and geometric mean, dispersion, standard deviation, mean deviation and their significances, confidence limits for the mean and standard deviations, comparison of standard deviations, inference from the tests, correlation and regression. Ways of expressing accuracy and precision using statistical tests, student-t test, F-test, Q test, Gaussian distribution, least square method, quality assurance and calibration methods.

Complexation

Chelate formation; competing reactions in complexation. The computation of stability constant from various experimental data. The use of complexes in analytical chemistry as reagents. Organic chelating agents for metal ion determination, Masking agents and metal ion buffers.

Equilibrium

The energetic and kinetic aspects of chemical equilibrium, equilibrium constants and their computation from various sources of experimental data, the effect of temperature, pressure, concentration, pH of medium and solvents on equilibrium. Conditions for selection of a method of analysis.

- Ionic substances: Strong electrolytes and weak electrolytes, activity, mean activity and activity coefficients.

Acids and bases and the effect of various solvents on acidity and basicity, protic, aprotic and amphiprotic solvents, calculation and computation of stepwise dissociation constants, calculation and dissociation of stepwise dissociation constant from experimental data, the preparation use and effectiveness of buffers, different techniques of pH determinations

Books Recommended

1. Gary D. Christian; Analytical Chemistry, 6th ed. 2004; John Wiley & Sons, Inc.
2. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, Reinholt, New York.
3. Robert D. Braun, Introduction to Chemical Analysis, McGraw Hill Book Co. New York.
4. I.M. Kolthoff, Sandell, Text Book of Quantitative Inorganic Analysis, Macmillan and Co. New York.
5. Harris, D. C., Quantitative Chemical Analysis, 5th ed. W. H. Freeman and Company, NY, USA, (1999).

Specialization Paper-II: Chromatographic Techniques **Code: CHEM-632.1**
Credit Hours: 3+0 **Marks: 100**

Course Objectives

- Objective of this course is to introduce to the students principles of important chromatography techniques and their applications
- Knowledge of chromatographic techniques for the application in analytical labs and in industries.
- Be prepared to use these techniques in their own development work.
- Can use LC, GC and HPLC as well as have sound knowledge of different parts of them

Course Outcomes

After taking this course, the students will have acquired knowledge about the theory of chromatographic techniques (such as LC, GC, GC-MS, HPLC) and their applications in analytical labs and in industries.

Course Contents

Introduction to Analytical Separations: Masking, Precipitation and Filtration, Solvent Extraction

Classical Chromatographic Techniques

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

The chromatographic processes, rate theory of chromatography, van-Deemter equation and its significance in evaluating column efficiency.

Gas Chromatography

General principle, separation process, sample preparation, sample injection, detectors and method development. GC-MS.

High Performance Liquid Chromatography (HPLC)

General principle, separation process, sample preparation, sample injection, detectors and method development for normal phase and reverse phase separation, isocratic and gradient elution. LC-MS, LC-FTIR

Electrophoresis

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

Books Recommended

1. Miller, James M., "Chromatography Concepts and Contrasts, John Wiley and Sons, New York, 1988.
2. Braithwaite, A. and Smith, F.J., "Chromatographic Methods", Chapman and Hall, 1985.
3. Ahuja, S., Editor "Chromatography and Separation Chemistry", Advances and Developments, ACS, Washington, DC 1986.
4. Skoog, D.A. and West, D.M., "Principles of Instrumental Analysis", Holt, Rinehart and Winston Inc. 1971.

Specialization Paper-III: Molecular Spectroscopic Techniques Code: CHEM-633.1
Credit Hours: 3+0 Marks: 100

Course Objectives

To impart knowledge about

- Different regions of the electromagnetic spectrum and their energies.
- Basic theories behind UV-Vis, IR spectroscopy, mass spectrometry etc.
- Knowledge of the principal factors that govern the electronic absorption process in UV-Vis and fluorescence spectroscopy and vibrational frequencies of bonds in IR spectroscopy.
- Different types of UV-Vis and IR spectrometers.
- Instrumentation and function of typical mass spectrometers.

Course Outcomes

After successful completion of this course, the students will be able to understand the basic theory behind different spectroscopic techniques as well as be able to interpret the simple spectra.

Course Contents

Ultraviolet absorption Spectroscopy

Electromagnetic radiation, electronic excitation, absorption by molecules, magnitude of absorption of radiation, selection rules. Instrumentation, various sources of light, filters and monochromators and their efficiency, detectors. Single beam and double beam spectrophotometers. Sources of errors and optimum conditions. Analytical applications in quantitative analysis of organic, inorganic and bioanalytical compounds.

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.

Infra-red spectroscopy

Introduction, molecular vibrations, Hook's law, selection rules, Group frequencies and factors influencing vibrational frequencies. Instrumentation, light sources, monochromators, detectors. FTIR single beam and double beam instruments. Applications in qualitative analysis.

Mass Spectrometry

Principle of mass spectrometry; Inlet system, ionization, acceleration, Drift Chamber, Detection systems; Advancements in equipment; Analytical uses of mass spectrometry, Quadrupole mass spectrometry; Interpretation of mass spectra. Correlation of mass spectra with Molecular structure.

Books Recommended

1. F.W. Fifield and D. Kealy, Principles and Practice of Analytical Chemistry I.T.B, London.
2. Christian, Gary D., and O.Reilly, James E., "Instrumental Analysis", Allyn and Bacon, 1986.
3. Skoog, D.A. and West, D.M., "Principles of Instrumental Analysis", Holt, Rinehart and Winston Inc, 1971.
4. Ewing, Galen W., "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw-Hill International Editions 1985.
5. Braun, Robert D., "Introduction to Instrumental Analysis", McGraw-Hill Book Company, Singapore, 1987.
6. Willard, H.H., Merit, D.L., Dean, J.R.J.A., Settle, F.A., "Instrumental Methods of Analysis", 7th Edition Wadsworth Publishing Company, 1988.

<u>Specialization Paper-IV: Electronics and Radiochemical Methods   Code: CHEM-634.1</u>
Credit Hours: 3+0   Marks: 100

Course Objectives

To impart fundamental knowledge about alternating and direct current, types of circuits, resisters, inductors, capacitors and measuring devices for voltage and impedance, thermos ionic emission tubes, thermistors and transistors and their uses, nuclear radiation and its types, methods of radiochemical analysis.

Course Outcomes

After taking this course, the students will have acquired knowledge about alternating and direct current and their applications, applications of circuits, resistors, inductors and capacitors in different electronic devices, different ionic emission tubes for various applications of samples, nuclear radiation and their applications in analysis.

Course Contents

Elements of electricity and electronics

The characteristics of alternating and direct current. Series and parallel circuits involving resisters, inductor and capacitor current, voltage and impedance measuring devices.

The thermos-ionic emission tubes

The thermos-ionic emission tubes, introduction to the diode, triode, tetrode and pentode vacuum tubes. Characteristic curves for these tubes. Simple circuits involving rectification, amplification and power stabilization. Special electron tubes such as cathode ray tube, phototube, and gas filled tubes etc. and their ordinary uses.

The transistors and thermistors

Introduction to thermistors and transistors and their uses.

Radiochemical methods

Nuclear emission: alpha particles, β particles, γ-rays. Detectors: gas ionization, scintillation and semiconductor. Radiochemical analysis: neutron activation analysis, isotope dilution method, radiometric titrations, radioactive tracers.

Books Recommended

1. K. C. Thompson and R. J. Reynold, Basic electronics, Charles Griffin and Co, London.
2. A. Marcus and Gendler, Basic electronics, Engle Wood Printice Hall.
3. Willard, H.H., Merit, D.L., Dean, J.R.J.A., Settle, F.A., "Instrumental Methods of Analysis", 7th Edition Wadsworth Publishing Company, 1988.

Environmental Chemistry-I **Code: CHEM-635.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry, atmospheric and air pollution, water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of environmental pollution and their consequences as well as how to be able to overcome such problems.

Course Contents

The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmosphere photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulations, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen photochemicals smog, airborne load, control of automobile emissions.

Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophiction, detergents and phosphates, importance of micro-organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

Practicals

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of fluoride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New DelhiJ.
2. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. S. K. Banerji, Environmental chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental chemistry, Brooks, California

Special Practicals-I/Research Project/Review-article/ Internship CHEM-636.1

Credit Hours: 0+3 Marks: 100

1. Spectroscopic determination of Fe, Mg, Ca, and Zn in the given sample.
2. Spectroscopic determination of stability and stability constant of complexes.
3. Flurometric determination of Riboflavin. Separation of amino acids using TLC.
4. Determination of total Hardness of water.
5. Determination of Ni by gravimetric analysis.
6. Simultaneous determination of Cr^{+3} and Mn^{+2} in a given solution.
7. Analysis and quantitation of various pharmaceutical samples.
8. Determination of stepwise ionization constant of H_3PO_4.
9. Conductometric titration of mixture of acids.
10. Ion exchange separation of selected cations and anions.
11. Separation of the given mixture by TLC.
12. Determination of nicotinic acid in cigarette smoke by HPLC using reverse phase chromatography.
13. Separation of aromatic hydrocarbons by gas chromatography using FID.
14. Effect of concentration on the fluorescence intensity of fluorescence.
15. Evaluation of pK_a value of an indicator by spectrometric method.
16. Simultaneous determination of two components by spectroscopic method.
17. Determination of Cr(VI) in the presence of Cr(III) by spectrophotometetric method.
18. Preconcentration, solvent extraction and determination of heavy metals by available methods.
19. Determination of vitamin C in the given sample by available methods.

Books Recommended

1. I.M. Kolthoff, Sandell, Macmillan; Text Book of Quantitative Inorganic Analysis.
2. W. J. Blaedal and V. W. Medloche; Quantitative Analysis, Harper & Row, N.Y
3. Gary D. Christian; Analytical Chemistry, 6th ed. 2004; John Wiley & Sons, Inc.
4. Robert D. Braun, Introduction to Chemical Analysis, McGraw Hill Book Co. New York.
5. F.W. Fifield and D. Kealy, Principles and Practice of Analytical Chemistry I.T.B, London.

Specialization Courses

Analytical Chemistry

M.Sc. 2nd –Year, Semester –IV

Specialization Paper-V: Automation in Analysis **Code: CHEM-641.1**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Major objective of this course is to impart knowledge to the students about automation in instruments of process control in laboratories and industries, the principles of flow injection analysis, its components and applications, the principles, instrumentation and applications of thermogravimetry.

Course Outcomes

By taking this course, the students will get acquaintance of automation and its use in various analytical methods, flow injection system in various analytical instruments and different other instruments used in thermogravimetric analysis.

Course Contents

Automation in analytical chemistry

Introduction to automation in analytical chemistry, significance of automation, instrumental parameters for automated instrument, automated process. Instruments and process control and clinical laboratory.

Flow injection analysis

Introduction to Flow injection analysis (FIA), components of FIA, injection methods, sequential injection, the programmable flow and online-sample pretreatments, applications of FIA.

Thermal analysis

Basic principles, instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), thermometry, calorimetry, differential scanning calorimetry (DSC), thermo-mechanical analysis (TMA)

Books Recommended

1. Braun, Robert D., "Introduction to Instrumental Analysis", McGraw-Hill Book Company, Singapore, 1987.
2. Kolev, Spas D., Mckelvie, Ian, D. (Editors), "Advances in flow injection analysis and related techniques" of Barcelo, D "Comprehensive analytical chemistry" volume 54, Wilson & Wilson's by Elsevier, UK.
3. Christian, Gary D., and O.Reilly, James E., "Instrumental Analysis", Allyn and Bacon, 1986.
4. Skoog, D.A. and West, D.M., "Principles of Instrumental Analysis", Holt, Rinehart and Winston Inc. 1971.
5. Dodd, J. W. and Tonge, K.H., "Thermal Methods", Analytical Chemistry by Open Book

Specialization Paper-VI: Electro-Analytical Techniques Code: CHEM-642.1

Credit Hours: 3+0 Marks: 100

Course Objectives

Objective of this course is to let the students learn in detail about the theoretical aspects, instrumentation and applications of voltammetry, polarography, amperometry and different electrochemical sensors.

Course Outcomes

After taking this course, the students will have a strong theoretical background of voltammetry, polarography, amperometry and different electrochemical sensors which will help them in utilizing these techniques for analysis.

Course Contents

Polarography

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. Kinetic, catalytic currents and, its applications. Applications of polarography in the analysis of inorganic and organic compounds.

Voltammetry

Basic principle, voltammogram, polarizable and non-polarizable electrodes, solid electrodes, their scope and limitations, cyclic voltammetry, anodic stripping voltammetry. Voltammetric equation. Voltammetric detectors in chromatography and flow injection analysis

Amperometric Titrations

Principle, nature of titration curves, advantages of amperometric titrations, applications.

Electrochemical Sensors

Principle, major components and characteristics of electrochemical sensors, effect of temperature and pressure, selectivity of electrochemical sensors, life expectancy of electrochemical sensors.

Books Recommended

1. Braun, Robert D., "Introduction to Instrumental Analysis", McGraw-Hill Book Company, Singapore, 1987.
2. Christian, Gary D., "Analytical Chemistry", 6th Edition, John Wiley and Sons, Inc New York, 2004.
3. Christian, Gary D., and O.Reilly, James E., "Instrumental Analysis", Allyn and Bacon, 1986.
4. Ewing, Galen W., "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw-Hill International Editions 1985.
5. Skoog, D.A. and West, D.M., "Principles of Instrumental Analysis", Holt, Rinehart and Winston Inc, 1971.
6. Willard, H.H., Merit, D.L., Dean, J.R.J.A., Settle, F.A., "Instrumental Methods of Analysis", 7th Edition Wadsworth Publishing Company, 1988.

Specialization Paper-VII: Atomic Spectroscopic Techniques Code: CHEM-643.1
Credit Hours: 3+0 Marks: 100

Course Objectives

To impart essential knowledge about theoretical aspects of absorption and emission process, difference between atomic absorption and atomic emission process and their corresponding spectra, the underlying principles, instrumentations and applications of flame photometry, atomic absorption spectrophotometry and atomic emission spectrophotometry.

Course Outcomes

The students will get acquaintance with fundamental principles of flame photometry, atomic absorption spectrophotometry and atomic emission spectrophotometry, their instrumentations and applications which will enable them to use these techniques for analytical purpose.

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.

Books Recommended

1. Thompson, K.C., and Reynold, R.J., “Atomic Absorption, Fluorescence and Flame Emission Spectroscopy”, 2nd Edition, Charless Griffin and Co, Ltd, London, 1978.
2. Robinson, James W., “Atomic Absorption Spectroscopy”, 2nd Edition, Marcell Dekker, New York, 1975.
3. Welz, B., “Atomic Absorption Spectroscopy”, Verlag Chemie, Weinheim, New York 1976.
4. Christian, Gary D., and O.Reilly, James E., “Instrumental Analysis”, Allyn and Bacon, 1986.
5. Ewing, Galen W., “Instrumental Methods of Chemical Analysis”, 5th Edition, McGraw-Hill International Editions 1985.
6. Skoog, D.A. and West, D.M., “Principles of Instrumental Analysis”, Holt, Rinehart and Winston Inc, 1971.
7. Braun, Robert D., “Introduction to Instrumental Analysis”, McGraw-Hill Book Company, Singapore, 1987.

Specialization Paper-VIII: Nanomaterial and Nanochemistry Code: CHEM-644.1
Credit Hours: 3+0 Marks: 100

Course Objectives

To impart theoretical knowledge about nanotechnology, Nanochemistry and nanomaterials, thee synthesis, characterization and applications of different nanomaterials. The role of imprinted and conducting polymers in nanotechnology will also be emphasized.

Course Outcomes

The students will get a theoretical foundation about the Nanochemistry, molecular level structure, synthesis, characterization (using different analytical techniques e.g. FTIR, XRD, EDX, NMR etc.) and various applications of nanomaterials especially in chemical analysis.

Course Contents

Nanomaterial and Nanochemistry

Introduction to Nanochemistry, chemical approach to nanomaterials and nanotechnology, properties of nanomaterials, microporous and mesoporous materials, synthesis and characterization of nanomaterials, applications of nanomaterials.

Imprinted Polymers

Introduction to imprinted polymers (IPs), molecular imprinted polymers (MIPs) - for organic compounds and ion imprinted polymers (IIPs) – for inorganic metal ions and their applications

Conducting Polymers

Introduction to conducting polymers, applications of conducting polymers

Books Recommended

1. Robert D. Braun, Instrumental Analysis, McGraw Hill Book Co. New York.
2. Robert D. Braun, Introduction to Chemical Analysis, McGraw Hill Book Co. New York.
3. S. M. Khopkar, Basic Concepts of Analytical Chemistry, New Age International. Bern Kahn, Radio-analytical Chemistry, Springer.
4. Prasanna Chandrasekhar, Conducting Polymers, Fundamentals and Applications: a practical approach, Springer.
5. Kenneth J. Klabunde, Nanomaterials in Chemistry, John Wiley and Sons, Inc.
6. Borje Sellergren, Molecularly Imprinted Polymers, Elsevier, Amsterdam Lausanne-New York-Oxford-Shannon-Singapore-Tokyo.

Environmental Chemistry-II **Code: CHEM-645.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry especially related to various energy resources, use of fuels and their consequences on atmospheric air and water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of various energy resources, different fuels and the consequences of their uses on the environment.

Course Contents

Energy Sources

Fossil Fuels

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, and environmental problems associated with petroleum.

Soils and Mineral Resources

Estimating reserves of mineral resources of earth, extraction of metal-general principles, iron, steel, aluminum, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Other Sources

Nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

Practicals

1. Determination of nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
2. Determination of caffeine in tea leaves by HPLC.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-II/Research project/Review-article **Code: CHEM-646.1**

Credit Hours: 0+3 **Marks: 100**

Practicals

1. Determination of Fe and Mn in soil by spectrophotometric method.
2. Determination of phenol in a given sample by spectrophotometric method.
3. Determination of tannin in tea leaves by spectrophotometric method.
4. Determination of nitrates and nitrite in a given water sample by spectrophotometric method.
5. Determination of ammonia in polluted water samples by spectrophotometric method.
6. Determination of the formula and stability constants by spectrophotometric method.
7. Determination of organic matter in a given sample by spectrophotometric method.
8. Determination of sulphanilamide in the given drug by spectrophotometric method.
9. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. I.M. Kolthoff, Sandell, Macmillan; Text Book of Quantitative Inorganic Analysis.
2. W. J. Blaedal and V. W. Medloche; Quantitative Analysis, Harper & Row, N.Y
3. Gary D. Christian; Analytical Chemistry, 6th ed. 2004; John Wiley & Sons, Inc.
4. Robert D. Braun, Introduction to Chemical Analysis, McGraw Hill Book Co. New York.
5. Gary D. Christian, James E. O'Reilly, Instrumental Analysis, Allyn and Bacon Inc. New York.
6. Douglas A. Skoog, Stanley R. Crouch, Instrumental Analysis, Reinholt, New York.
7. F.W. Fifield and D. Kealy, Principles and Practice of Analytical Chemistry I.T.B, London.

Applied Chemistry

M.Sc. 1st –Year, Semester –I

Course Title: Applied Chemistry-I **Code: CHEM-514.2**
Credit Hours: 3+1 **Marks: 100**

Course Objectives:

This course will introduce to the students basic knowledge about various unit operations of the industries such as filtration, size reduction, distillation, crystallization and drying etc.

Course Outcomes:

After successful completion of the course the students will acquire the knowledge about basic unit operation such as filtration, size reduction, distillation, crystallization and drying etc. The students will understand the water qualities and removal of impurities from it.

Course Contents

Fundamentals of Chemical Industries

Basic principles and parameters for industrial plant location; Elementary treatment of general unit operations commonly used in industries such as size reduction; evaporation, filtration, distillation, crystallization and drying; Chemical unit processes like carbonation, sulfiation, defecation, nitration, etc. in chemical process industries.

Unit operations

Crushing, grinding, size separation, filtration, evaporation and distillation.

Water

Physical properties of water, soft and hard water, Water hardness; its measurement and removal; methods used for water softening including ion-exchange and reverse osmosis, distillation and precipitation.

Fuels

Natural gas purification, manufacture and synthesis of producer gas, carbonization of coal, fractional distillation of crude petroleum, refining of petroleum fractions.

Practicals

Chemical examination of:

1. Water (Water hardness; its measurement and removal),
2. Fertilizer,
3. Brass,
4. Bronze,
5. Steel,
6. Cement,
7. Soap,
8. Coal.

Books recommended

1. Howard L.White, Introduction to Industrial Chemistry, 1986.
2. Badger L.W. and T.J. Banchero. (1955) "Introduction to Chemical Engineering" Student ed. McGraw-Hill Book Company, New york.
3. Riegel, E.R. (1956)." Industrial Chemistry" 5th ed. Reinhold Publishing Corporation, New York.
4. R. N. Shreve, The chemical process industries, McGraw-Hill Book Company.
5. Howard L. White, Introduction to Industrial Chemistry (1992).
6. G. O. Jones, Glass, 2nd Ed., (1971).

Applied Chemistry

M.Sc. 1st –Year, Semester –II

Course Title: Applied Chemistry-II **Code: CHEM-524.2**

Credit Hours: 3+1 **Marks: 100**

Course Objectives

Objective of this course is to impart the knowledge about the various aspects of basic and heavy chemical industries.

Course Outcomes

After successful completion of the course the students will get the knowledge about the raw materials needed and chemistry involved in various heavy chemical industries and their production

Course Contents

Basic and Heavy Chemical Industries

Raw materials and chemicals; Flow sheet diagrams and commercial production of sulphuric acid, nitric acid, hydrochloric acid, oxalic acid, formic acid, caustic soda and washing soda; Applications of these chemicals in chemical industries.

Industries

Introduction to Sugar industries, Paper and pulp industries, Fats, oil, and soap industries, Leather industries, Fermentation industries, Fertilizer industries, Cement and glass industries.

Ceramics Industry

Raw material used for ceramics; Chemistry involved in the production of ceramics articles and wares; Types and classification of ceramic products; Manufacture of ceramics products.

Practicals

Water analysis, Analysis of oil and fats, Testing and analysis of vegetable ghee, Synthesis of soap and its analysis, Analysis of bleaching powder, Fertilizer analysis and testing of raw materials such as phosphate rock and ores. Various other practicals may be included in accordance with the available facilities.

Books Recommended

1. Coulson & Richardson., Chemical Engineering, 1st Ed, (1985).
2. Walter. L. Badger & Julius T. Banchero, Introduction to Chemical Engineeing, (1955).
3. George T. Austin., Shreve's Chemical Process Industries, 5th Edition, (1984).
4. Riegel, E. R., Industrial Chemistry, 5th Ed, (1997).
5. Wyatt, Metal Ceramics & Polymers, (1974).

Specialization Courses

Applied Chemistry

M.Sc. 2^{nd} –Year, Semester –III

Specialization Paper-I: Unit Operations **Code: CHEM-631.2**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objective of this course is to acquaint the students in detail about the different unit operations such as filtration, size reduction, distillation, crystallization, drying, transportation and flow of heat in various industrial processes.

Course Outcomes

After successful completion of the course in 1^{st} semester the students in 3^{rd} semester will get more in depth knowledge about the unit operation such as filtration, size reduction, distillation, crystallization, drying, transportation and flow of heat in various industrial processes

Course Contents

Crushing and Grinding

Mechanism of size reduction, Kicks law Rittenger's law and Bond's Law of size reduction Particle size distribution.

Evaporation

Construction and working of different types of evaporators, Heat transfer of evaporators, methods of feeding of multiple effect evaporators, Improved efficiency in evaporators.

Distillation

Vapor liquid equilibrium, Daltons, Roult's and Henry's Law of Partial Pressures, relative volatility, differential distillation, equilibrium distillation and rectification Number of plates required in a distillation column, reflux ration and its importance in distillation.

Crystallization

Growth and properties of crystals, crystallization rate, effect of impurities of crystal formation, fractional crystallization and different types of crystallizers.

Drying

Principle of drying rate of drying, theories of drying, different types of dryers

Transportation

Theory of filtration, flow of filtrate through cloth and cake, Types of filters, filter auxiliaries, Transportation of fluids and solids in industrial process.

Flow of Heat

Classification of heat flow processes, Laws of heat flow.

Books Recommended

1 J. M. Coulson and J. F. Richardson, Chemical engineering, Vol. I and II, Pergamon Press, New York.
2 Badger and Benchero, An introduction to chemical engineering, Mcgraw Hill Book Co, New York.

Specialization Paper-II: Agrochemical Industry **Code: CHEM-632.2**
Credit Hours: 3+0 **Marks: 100**

Course Objectives

Major objective of this course is to impart knowledge to students about the unit operations and chemistry involved in the production of various agrochemicals. And also various kinds of pesticides, their classification, formulation and its toxicity in agrochemical industry.

Course Outcomes

After completion of this course, the students would have acquired knowledge about the unit operations and chemistry involved in the production of various fertilizers and pesticides. Moreover toxicity associated with various kinds of pesticides will also be known to them.

Course Contents

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. Urea, Raw materials, manufacture of urea, assimilation in soil, Calcium Fertilizers, Calcium ammonium nitrate, calcium cyanamide, calcium super phosphate and triple super phosphate. Potash Fertilizers, Manufacture and use of potash fertilizers.

Pesticides

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.

Books Recommended

1. Beat Meyer, Urea Formaldehyde Resins, 1979.
2. George T. Austin., Shreve's Chemical Process Industries, 5th Edition. McGraw Hill Book Company Inc. New York, (1984).
3. Riegel, E. R., Industrial Chemistry, 5th Ed., Reinhold Publishing Corporation NewYork, (1997).
4. Fertilizers and Soil Fertility, U.S.Jones, Reston Publishing Co. Virginia, 1979.
5. Jain. P. C., A Textbook of Applied Chemistry, (1993).K. Wark Cecil F. Warner, Air Pollution its origin & Control.(1976).
6. Henry C. Perkin, Air Pollution, (1974).
7. Glele Mamantov W. D. Shults, Determination of Air Quality, (1974).
8. Nelson L. Nemerow, Industrial Water Pollution, (1978).

Specialization Paper-III: Polymer Industry **Code: CHEM-633.2**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Major objective of this course is to impart knowledge to students about the various types of polymers and their uses and industrial processes used for their manufacturing.

Course Outcomes

After taking this course, students would have acquired knowledge about the various types of polymers and their uses and industrial processes used for their manufacturing.

Course Contents

Introduction to Polymers

General classification of polymers, characteristics and significance of polymers, various mechanisms of polymerization process, Polymer processing like intrusion, injection, modeling and blow molding of plastics, Thermoplastic and thermosetting polymerization, Brief description and uses of Polyethylene, polystyrene, epoxy resins, polyethylene tetrapthalate polymers, polyurethanes, polyesters and urea phenol formaldehyde resins; Production of drug delivery polymers.

Plastics

Celluloids, Phenol formaldehyde urea and melamine formaldehyde, Polyethylene, Polyvinyl acetates, Plastics fabrication

Rubber

Natural rubber processing, vulcanization of rubber, butadiene Acrylonitrile rubber, Butyl rubber, Silicone rubber, neoprene rubber, Thiokol rubber, Polyurethane rubber.

Books Recommended

1. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
2. Shereve's Chemical Process Industries, 5th Ed.1975, By G.T. Austin, McGraw Hill Book Co. New York.
3. An Introduction to Polymer Chemistry, W.R.Moor, London Press, London.
4. Principles of Polymer Systems, Rodri-Guez, McGraw Hill Book Co. New York.
5. Modern Technology of Plastics and Polymer Processing Industries, NIIR Board Petroleum Refining Technology, Ram Parsad (2002).
6. Wyatt, Metal Ceramics & Polymers, (1974).

Specialization Paper-IV: Chemistry of dyes and pigments Code: CHEM-634.2
Credit Hours: 3+0 Marks: 100

Course Objectives

The main objective of this course is that the students must know the chemistry of dyes and pigments in textile industries. Knowledge about the surface coating and leather tanning industries for the better understanding of these processes involved in these industries.

Course Outcomes

The students would have knowledge about the chemical nature of dyes and pigments and their uses in textile industry, surface coating and leather tanning industries.

Course Objectives

Dyes

Types of dyes, sources and classification of dyes; manufacture of dyes and dye intermediates, Organic dyes, Chemistry and production of various organic dyes, Application of dyeing. Dying of clothes in different shades using Acid dyes.

Surface Coating Industry

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.

Leather Tanning

Introduction, important steps in leather manufacturing, theory of leather tanning.

Finishing and dyeing of Textile

Color and chemical constitution, Important classes of chromogens, Classification and nomenclature of dyes, manufacturing of dye intermediates and dyes, Selection of dyes for wool, cellulosic and synthetic fibers, Theory of Coloration, Coloration of wool, cellulosic and synthetic fibers.

Books Recommended

1. Christie, R. M., Colour Chemistry. The Royal Society of Chemistry, 2001.
2. Dyes and Dyeing, C. E. Pellew, Abhishek Publishers (1998).
3. Terold M. Schultz, Polymer Materials Science, 1974.
4. Paul J. Flory, Principles of Polymer Chemistry, 1975.
5. George Ordian, Principles of Polymerization, Villey Inferences,Printed and published by Replika Press PVT Ltd. India, 2004.
6. Cowie J. M.G., Polymers Chemistry and Physics of Modern Material, 1st Ed. Intertext Book New York, 1973.
7. George T. Auston., Shreve's Chemical Process Industries, 5th Edition, McGraw Hill Book Company Inc. New York, 1984.
8. Riegel, E. R., Industrial Chemistry, Reinhold Publishing Corporation NewYork, 1997.
9. Dyes and Dyeing, C.E. Pellow, Abhishek Publishers, 1998.
10. Textile Dyes and Pigments, H. Panda, NIIR Publishers.
11. The Chemistry of Synthetic Dyes and Pigments, H. A. Lubs, Reinhold Publishing Corporation, 1955.*Chemistry*

Environmental Chemistry-I **Code: CHEM-635.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry, atmospheric and air pollution, water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of environmental pollution and their consequences as well as how to be able to overcome such problems.

Course Contents

The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmosphere photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulations, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen photochemicals smog, airborne load, control of automobile emissions.

Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophiction, detergents and phosphates, importance of micro-organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

Practicals

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of fluoride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi.
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. S. K. Banerji, Environmental chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental chemistry, Brooks, California

Special Practicals-I/Research Project/Review-article/ Internship CHEM-636.2

Credit Hours: 0+3 Marks: 100

Special Practicals

1. Chemical examination of various vegetable and animals oil.
2. Preparations of various cosmetics such as cold cream, shaving cream, nail polish, shoe polish etc.
3. Analysis of various Pakistani ores
4. Physical testing of cement
5. Analysis of leather.
6. Analysis of sugar

Specialization Courses

Applied Chemistry

M.Sc. 2nd –Year, Semester –IV

Specialization Paper-V: Petrochemical Industry and products Code: CHEM-641.2

Credit Hours: 3+0 Marks: 100

Course Objectives

The main objective of this course is that the students must know about the crude oil, its origin, petrochemicals and various industrial processes. Lubrication, its phenomena and its manufacture by different processes

Course Outcomes

The student would have acquired in depth knowledge about the crude oil, its origin, and various industrial processes for production of petrochemicals.

Course Contents

Processing of Crude Oil

Brief description of origin of petroleum, Migration, reservoir, exploration and drilling of crude petroleum; Various unit processes involved petroleum processing like surface operation, fractional distillation; refining, cracking; reforming, isomerization; Polymerization, alkylation and finishing processes.

Petrochemicals

Chemistry and importance of the following petrochemicals: Acetylene; ethylene; propylene, benzene, toluene, xylene and naphthalene. Oxidation halogenation and nitration of petrochemicals of industrial significance.

Lubrication

Lubrication Phenomena, fluid lubrication, boundary lubrication, extreme pressure lubrication. Manufacture of lubricants by solvent extraction methods and properties.

Books Recommended

1. Petroleum Refining Technology, Ram Parsad (2002).
2. Nelson, W. L., Petroleum Refinery Engineering, 4th Ed., (1985).
3. George T. Auston., Shreve's Chemical Process Industries, 5th Edition, McGraw Hill Book Company Inc. New York, (1984).

4. Riegel, E. R., Industrial Chemistry, 5th Ed., Reinhold Publishing Corporation New York, (1997).
5. Jain, P. C., A Textbook of Applied Chemistry, (1993).

Specialization Paper-VI: Metallurgy **Code: CHEM-642.2**
Credit Hours: 3+0 **Marks: 100**

Course Objectives

The main objective of this course is that the students must know about the raw form of metals, iron and formation of steel and their uses for different purposes. Corrosion and its prevention methods. Different methods involving electroplating, chrome plating and nickel plating.

Course Outcomes

After successful completion of the course the students will get the knowledge about the raw form of metals, iron and formation of steel and their uses for different purposes. Corrosion and its prevention methods. Different methods involving electroplating, chrome plating and nickel plating.

Course Contents

Introduction to metallurgy

Iron, Steel and Alloys Industries, Iron ores, constituents and their classification; Manufacture of iron and steel; Types of iron and steel; Metal Extractions and production of Alloys.

Iron and Steel

Manufacture of cast iron and steel, wrought iron, formation of alloys, heat treatment of steel, classification of steel, passivity, different theories of rusting of iron and its prevention.

Corrosion and its Prevention

Chemistry and causes of corrosion phenomena, Types and theories of corrosion, Corrosion prevention and inhibitors, Surfaces coating and electroplating.

Electroplating

Principle of electroplating, purpose of electroplating, different processes involved in electroplating, chrome plating, nickel plating and electroplating of plastics.

Books Recommended

1. Gyngell, E. S., Applied Chemistry for Engineers, 3rd Ed. Edward Arnold, Ltd London, 1972 Reprinted 1989.
2. Kuriacose J. C.; J. Rajaran., Chemistry in Engineering and Technology, Vol. II 1988.
3. Evans, U. R. An Introduction to Metallic Corrosion, 3rd Ed., Edward Arnold 1981.
4. Chemistry of iron and Steel Manufacture, C. Bodsworth, Longman Press, London, 1963.
5. Graham's Electroplating Engineering Hand Book, Ed. L.J. Durney, CBS Publkishers
6. Nickel and Chromium plating, J.K.Dennis & T.E.Such, Newness Butterworth, London (1972).

Specialization Paper-VII: Analytical Techniques in Applied Chemistry CHEM-643.2
Credit Hours: 3+0 Marks: 100

Course Objectives

The main objective of this course is that the students must know about different analytical techniques which are useful in quality control of raw materials, intermediates and final products in various industries

Course Outcomes

After successful completion of the course the students will get the knowledge about the different analytical techniques used for characterization and separation of material in various chmical industries.

Course Contents

Spectroscopy

Use of different spectroscopic techniques like FES, AAS and Spectrophotometry for the quality control of raw materials, intermediates and final products in various industries.

Chromatography

Use of Thin layer chromatography, gas chromatography and HPLC in pharmaceutical and other industries.

On-Line Analysis and Automation

Significance of on-line analysis and automation of analytical techniques in industry; Classification of techniques w.r.t. automation, Use of microprocessor in conjugation with automation and on-line analysis, different types of automatic analyzers.

Books Recommended

1. Instrumental method of Analysis, Willar Merritt Dean Settle, Seventh Edition (1986).
2. Text Book of Quantitative Inorganic Analysis, Vogal's Ed-4th, Longman Group Limited (1978).
3. Instrumental Analysis, Gary D. Christain, 1978, Introduction to Instrumental Analysis by Braun, McGraw-Hill Book company, 1987.
4. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
5. Shereve's Chemical Process Industries, 5th Ed.1975, G.T.Austin, McGraw Hill Book

   Co. New York.

<u>Specialization Paper-VIII: Miscellaneous Chemical Industries Code: CHEM-644.2</u>
Credit Hours: 3+0 Marks: 100

Course Objectives

The main objective of this course is to familiarize the students with unit operations, raw materials, chemical and physical processing in diverse industries.

Course Outcomes

After successful completion of the course the students will get the knowledge about unit operations, raw materials, chemical and physical processing in glass, cement, fermentation, cosmetic, sugar and other industries.

Course Contents

Sugar Industry

Raw materials and Schematics of production unit in Sugar industry

Starch Industry

Raw materials and Schematics of production unit in starch industry

Fermentation industry

Raw materials and Schematics of production unit.

Paper and Pulp Industry

Raw materials and Schematics of production unit.

Cement Industry

Raw materials and Schematics of production unit.

Cosmetics and Perfumes

Raw materials and Schematics of Cosmetics and Perfumes.

Glass Industry

Raw materials and Schematics of production unit.

Oils and Fats

Classification of oils and fats, vegetable oils, essential oils, various methods of extraction of oils, refining and hydrogenation of oils, Industrial applications of oils in resins, surfactants, lubricants and paints.

Books Recommended

1. Sugar: Science and Technology, G. G. Birch and K.. J. Parker, Applied Science Publishers Ltd., 1979.
2. Principles of Sugar Technology, Pieter Honig Vol I, Elsevier Publishing Company, 1953.
3. Pulp and Paper Technology, Testing and Applications, K.P. Rao (2003), CBS Publishers.
4. Chemistry of Pulp and Paper making, Edwin Sutermeister, Ed-3rd (1946).
5. Applied Chemistry Theory and Practice, O.P. Vermani & A.K. Narula, Wiley Eastern
6. Limited (1989).
7. T. B. of Quantitative Inorganic Analysis, Vogal's Ed-4th, Longman Group Limited (1978).
8. Practical Statistics for the Analytical Scientist, A Bench Guide, RSC Publishing, LGC Ltd 2009.
9. Experiments in Physical Chemistry, David P. Shoe Maker, McGraw Hill International (1996).
10. Food Oils and Fats, H.Lawson, CBS Publkishers and Distributors, New Delhi. (1997).
11. G.H.Jenkins, Intoduction to Sugarcane Technology (1965).
12. P. F. Stanbury & A. Whitaker, Principles of fermentation Technology, (1987).
13. G. C. Bye. Portland Cement, (1983).

Environmental Chemistry-II **Code: CHEM-645.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry especially related to various energy resources, use of fuels and their consequences on atmospheric air and water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of various energy resources, different fuels and the consequences of their uses on the environment.

Course Contents

Energy Sources

Fossil Fuels

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, and environmental problems associated with petroleum,

Soils and Mineral Resources

Estimating reserves of mineral resources of earth, extraction of metal-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Other Sources

Nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

Practicals

1. Determination of nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
2. Determination of caffeine in tea leaves by HPLC.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-II/Research project/Review-article Code: CHEM-646.2

Credit Hours: 0+3 Marks: 100

Practicals

1. Analysis of coal and petroleum fuels
2. Cement analysis and testing of raw materials
3. Milk analysis
4. Analysis of lime stone
5. Analysis of various Pakistani ores

Biochemistry

M.Sc. 1st –Year, Semester –I

Course Title: Biochemistry-I **Code: CHEM-514.3**
Credit Hours: 3+1 **Marks: 100**

Course Objectives

Objective of this course is to let the students get acquaintance of the field of biochemistry and major classes of biomolecules namely, carbohydrates, lipids, proteins and nucleic acids.

Course Outcomes

After taking this course, the students must be familiar with fundamental principles of biochemistry and have a base for further understanding of the subject.

Course Contents

Introduction

Introduction to biochemistry. Importance and Scope of Biochemistry. Physical principles of biochemistry. The molecular logic of life.

Cell structure and its functions

Structure and Functions of Cells. Forms, functions and brief classification of prokaryotes. Cellular architecture and diversity of eukaryotes. Cell wall Composition. A brief description on the isolation of cellular components.

Chemistry of Biomolecules

Carbohydrates: Occurrence, Nature, Structure and Classification of Carbohydrates. Aldoses and Ketoses Cyclic structure of monosaccharides. Stereoisomerism: optical isomerism of monosaccharides, Hawarth configurations, D and L configuration of monosaccharides, mutarotation of monosaccharides. Structures and functions of common Disaccharides and Polysaccharides. Disaccharides: Maltose, sucrose, lactose. Polysaccharides: Starch, glycogen, cellulose, dextrans, chitins and mucopolysaccharides.

Lipids: Classification of lipids, fatty acid, saturated & unsaturated, essential and non-essential Fatty acids. Structures and functions of lipids. Phospholipids. Sterol/steroids. Lipid with specific biological activities. Prostaglandins: Structure and function. Properties of lipid aggregates: Micelles and Bilayers. Biological membranes. Membrane proteins, Membrane structure and Assembly. Fluid Mosaic model. The erythrocyte membrane.

Proteins: Amino acids, their Structure, Chiral Center, and stereoisomerism. Classification of amino acids. Acid base properties. Structure and properties of protein. Peptide bonds. Amino acid sequence. Proteins: Biological significance of Proteins. Classification of proteins. Primary. Secondary, Tertiary and Quaternary structure of proteins, as Keratins, Collagens and elastin. Conformation and function of globular proteins with special reference to structure and function of Hemoglobin and Myoglobin.

Nucleic acids: Purines and Pyrimidines bases. Nucleosides & Nucleotides. Structure and functions of Nucleic Acids (RNA, DNA). Different type of RNA.

Books Recommended

1. Lehninger, A. L, "Principles of Biochemistry", Worth Publisher, New York, (2001).
2. Voet, D. and Voit J. G., "Biochemistry", John Wiley & Sons, New York, (2000).
3. Murray, R. K., Mayes P. A., Granner, D. K. and Rodwell, V. W., Harper's Biochemistry", Appleton & Lange (2000).
4. Robert, Harper's Biochemistry", 25th Ed, (2000).
5. West, Text Book of Biochemistry", 4th Ed., (2000).
6. Zubay, G., Biochemistry, 4th Ed., Macmillan Publishing Co. (1999).
7. Bhagavan. N. V., Biochemistry, 2nd Ed., J.B. Lippincott Company (1978)
8. Smith, E.L., R.L. Hill, I.R. Lehman, R.J. Lefkowitz, P. Handler, and A. White. Principles of Biochemsitry (Mammalian Biochemistry) McGraw-Hill Companies Inc.
9. Gowenlock, A. H., Varley's Practical Clinical Biochemistry, 6th Ed., Heinemann Professional Publishing, Oxford (1988).
10. Gosling, J. P., Immunoassay: Laboratory Analysis and Clinical application (1994).

Practicals

1. Study of cell structure under light microscope.
2. Qualitative test for carbohydrates
3. Distinction between pentoses and hexoses, aldoshexoses and ketohexoses.
4. Reducing and non-reducing sugar and mono and disaccharides. Estimation of reducing sugars.
5. Qualitative test for fats, sterols and phospholipids, estimation of cholesterol
6. Hydrolysis of proteins and qualitative tests for amino acid estimation of proteins by Biuret, Folin-Ciocalteau and Kjedahl's methods.
7. Fractionation of proteins by precipitation with salt and organic solvents.

Books Recommended

1. Wilson, A. Practical Biochemistry: Principle and techniques (2000).
2. Swotzer, Experiment Biochemistry theory and exercises in fundamental method (2000).
3. Dryer, R. L. and G. F. Lata, Experimental Biochemistry, Oxford University Press.
4. Plummer, D. T., Introduction to Practical Biochemistry, , McGraw Hill Book Co., New York (1986).
5. Alexander, R. R., J. M Griggiths and M. L. Wikinson, Basic Biochemical Methods, John Wiley & Sons.
6. Wooton, I. D. P., Microanalysis in Medical Biochemistry, J&A Churchill.
7. Sawhney, S. K. and R. Sing (Editors), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, (2005).
8. Gosling, J. P., Immunoassay: Laboratory Analysis and Clinical application (1994).

Biochemistry

M.Sc. 1st –Year, Semester –II

Course Title: Biochemistry-II **Code: CHEM-524.3**
Credit Hours: 3+1 **Marks: 100**

Course Objectives

Objective of this course is to let the students get acquaintance with major areas of the field of biochemistry including acids, bases, biological catalysts, nutrition and metabolism.

Course Outcomes

After taking this course, the students must be familiar with fundamental principles of biochemistry and have a base for further understanding of the subject.

Course Contents

Acids, Bases and Buffers

Structure, physical properties & importance of water. Ionization of water. Weak interactions in aqueous system. Weak acids and weak bases. pH and buffer systems. Different buffering agents. Importance of buffers in biological systems. Biologically important organic compounds / Solvents.

Enzymes

A brief introduction to the nature of enzymes and co-enzymes. Chemical nature, nomenclature and classification of enzymes. Cofactors and Coenzymes. Concepts of Active site. Substrate specificity. Effects of different factors on enzyme activity. Enzyme inhibition: Competitive, non-competitive and irreversible inhibition. Regulatory enzymes.

Vitamins

A discussion of the occurrence, chemistry, and physiological functions of vitamins. Metabolism of Vitamins deficiency symptoms and requirements of vitamins A, B Complex, C,D,E, and K.

Nutrition

Introduction to the science of nutrition: Nutrients and their functions. Sources and forms of Energy. Energy value of foods. Biological evaluation of proteins, carbohydrates and lipids. Digestion and absorption of food. Thermogenic effects of food. Energy requirements under different living and physiological conditions. Mal-nutrition.

Basis of Metabolism

Introduction to intermediary metabolism. Methods of metabolism study. Cell bioenergetics and Role of ATP. Biological oxidations and reductions. Electron Carriers involved in the oxidation of fuel molecules. Oxidative phosphorylation and regulation of ATP production. Uncouplers of oxidative phosphorylation. Inhibitors of electron transport chain.

Books Recommended

1. Voet, D. and J. G. Voet,. Biochemistry, John Wiley and Sons, New York (2001).
2. C. K. Mathews, K. E. Van Holde, & K.G. Ahern. Biochemistry 3rd Ed. by Prentice Hall (1999).
3. Harper's Illustrated Biochemistry, 27th Ed. by R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw Hill.
4. Lehninger Principles of Biochemistry (2008) 5th Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers.
5. Biochemistry by Lubert Stryer 2006 Pub: Freeman and Company
6. Lippincott's Biochemistry by Champe.P C; Harvey. R. A and Ferrier. D. R. 3rd ed., 2004 Pub: J. b. Lippincott Company.

Practicals

1. Preparation of Buffers: Phosphate buffer, Acetate buffer, Citrate buffer, Universal buffer.
2. Determination of pH of different samples and body fluids by pH meter.
3. Determination of pH of different samples and body fluids by pH strip/paper.
4. Determination of pH of different samples and body fluids by titrimetric methods.
5. Estimation of ascorbic acid, vitamin A and D.

Books Recommended

1. Wilson, A. Practical Biochemistry: Principle and techniques (2000).
2. Swotzer, Experiment Biochemistry theory and exercises in fundamental method (2000).
3. Dryer, R. L. and G. F. Lata, Experimental Biochemistry, Oxford University Press.
4. Plummer, D. T., Introduction to Practical Biochemistry, McGraw Hill Book Co., New York (1986).
5. Alexander, R. R., J. M Griggiths and M. L. Wikinson, Basic Biochemical Methods, John Wiley & Sons.
6. Wooton, I. D. P., Microanalysis in Medical Biochemistry, J&A Churchill.
7. Sawhney, S. K. and R. Sing (Editors), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, (2005).
8. Gosling, J. P., Immunoassay: Laboratory Analysis and Clinical application (1994)

Specialization Courses

Biochemistry

M.Sc. 2nd –Year, Semester –III

Specialization Paper-I: Biocatalysts **Code: CHEM-631.3**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Course will emphasize the all aspects of the biochemistry of enzymes. Importance of coenzyme and cofactors of the enzymes will also be covered.

Course Outcomes

At the end of this course, the students would have grasped a detailed understanding of all aspects of the biochemistry of enzymes which include structure, function of enzymes, mechanism of enzyme action, kinetics of enzymes.

Course Contents

Enzyme Structure and Functions

General characteristics and chemical nature of enzymes, Nomenclature and classification of enzymes. Riboenzyme, Oxidoreductases, transferases, hydrolases, lyases, isomerases, ligases.

Mechanism of Enzyme Action and catalysis

Use of kinetics in the analysis of mechanism, E-S-inert action and nature of the active site. Factor of proximity and orientation of substrate. Possible mechanism of enzyme catalysis. Coenzymes, Cofactors, Enzyme activity, Regulation of enzyme activity. Functional groups essential for catalysis, covalent catalysis, Acid base catalysis and factor of strain in enzyme catalysis. Substrate specificity, factors contributing catalytic efficiency. Mechanism of action of chymotrypsin and related enzymes. Bisubstrate reactions, multisubstrate reactions,

Enzyme kinetics

Enzyme activity and measurement of rate of enzyme catalyzed reaction. Effect of various factors on the rate of enzyme activity, the pre-steady state, the steady state, the equilibrium state. Derivation of Michaelis-Menten equation, Line-weaver Burk equation, Woolf and Hofstee (Eadie) equations for the determination of Km and Vmax. Significance -of Vmax and Km.

Isozymes

Electrophoretic separation, identification and their role in different tissues with special reference to LDH Isoenzymes.

Regulatory enzymes

Allosteric enzymes and covalently modulated enzymes, characteristics of alossteric enzymes and kinetics of allosteric enzymes.

Immobilized Enzyme

Advantages of Immobilized enzymes. Immobilization methods, selection of support medium, techniques for immobilizations and applications.

Enzyme Inhibition

Enzyme inhibitors, Types of inhibition, Feedback inhibition, Allosteric inhibition, irreversible inhibition, Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibitions. Kinetic tests for distinguishing competitive, non-competitive and uncompetitive inhibition.

Books Recommended

1. Biochemistry 6th edition by W.H. Freeman & Co. (2007)
2. Fundamentals of Biochemistry 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc. (2008).
3. Principles of Bio-Chemistry by White and Smith
4. Harper's Illustrated Biochemistry, 27th Ed. by R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw Hill.
5. Lehninger Principles of Biochemistry (2008) 5th Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers.
6. Biochemistry by Lubert Stryer 2006 Pub: Freeman and Company
7. Lippincott's Biochemistry by Champe.P C; Harvey. R. A and Ferrier. D. R. 3rd ed., 2004 Pub: J. b. Lippincott Company.

Specialization Paper-II: Nutrition **Code: CHEM-632.3**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

The course is designed to assist the students to acquire knowledge of biochemical composition and nutritional aspects of different foods, energy needs and nutritional requirements of different age groups. The course will also cover a comprehensive account on minerals and vitamins as essential components of nutrition.

Course Contents

After completion of this course, a student is expected to have a sound knowledge and understanding of the different aspects of the nutrition e.g. types of nutrients and nutritional needs of different age groups.

Course Contents

Introduction

Nutrition science, Nutrition, food, diet, nutritional status, nutritional care, Major Dietary Constituents

Energy Metabolism

Measurement of energy exchange of the body, fuel factors, direct and indirect calormetry, respiratory quotient (R.Q), basal metabolic rate (BMR), factors influence BMR. Calorigenic effect of food (SDA), factors influence the total energy requirement.

Nutritional aspects of Nutrients

Carbohydrate & lipids: Composition, classification, food source, requirement & function of lipid and carbohydrate.

Protein & Amino acids: Composition, classification, food source, food protein essential amino acids, nitrogen balance, biological value of protein, quality of food protein requirement and function.

Vitamins: Role of vitamins as coenzymes. Structure, physiological functions, deficiency diseases and recommended dietary allowances of the fat Soluble vitamins: A, D, E, and K. Structure, physiological functions, deficiency diseases and recommended dietary allowances of the water Soluble vitamins: Thiamine, Riboflavin, Niacin Pantothenic acid, Folic acid, Biotin and Ascorbic acid.

Minerals: Dietary sources, daily requirements, biochemical functions and deficiency diseases of Major minerals (Macro) calcium phosphorus, magnesium, sulfur, sodium, potassium and chloride. Dietary sources, daily requirements, biochemical functions and deficiency diseases of trace mineral (Micro), iron, iodine, copper, cobalt, zinc, Selenium.

Nutrition in Growth and Aging

Nutrients in growth and developments, Assessment and energy needs in different age groups. Nutritional requirement during infancy and childhood. Diet and nutritional requirement during adolescence. Nutrition in the Elderly ages.

Mal-Nutrition

Introduction of over nutrition and under nutrition, factors contributing to mal nutrition, susceptibility of individual, environmental factors, factors influence food intake and food habit, protein energy mal nutrition.

Therapeutic Nutrition

Introduction, purpose of modified diet, factors to consider in the study of diet therapy, effect of illness on food acceptance, action of drug on nutrition, effect of food on drug utilization, diet in coronary heart diseases.

Books Recommended

1. Human Nutrition by B.T. Burton.
2. Principle of nutrition by Wilson, Fisher and Fuqua.
3. Human Nutrition by V.H. Mettram.
4. Biochemistry by Orten and Neuhaus.
5. Text book of physiology and biochemistry by Bell, Davidson and Smith.
6. Shils, M.E., J.A. Olson and M. Shike. Modern Nutrition in Health and Disease. Lea & Febiger USA.
7. Passmore, R and M.A. Eastwood. Human Nutrition and Dietetics. Churchill Livingstone.
8. Murray, R.K., D.K. Grannar, P.A.Mayes and V.W. Rodwell. Harper's illustrated Biochemistry McGraw-Hill.
9. Shils, M.E., J.A. Olson and M. Shike. Modern Nutrition in Health and Disease. Lea & Febiger USA.
10. Passmore, R and M.A. Eastwood. Human Nutrition and Dietetics. Churchill Livingstone.

Specialization Paper-III: Bioenergetics and Metabolism of Biomolecules CHEM-633.2
Credit Hours: 3+0 Marks: 100

Course Objectives

To provide fundamental concepts about the energy production, metabolism of the macromolecules, regulation and inhibition of the metabolic pathways.

Course Outcomes

After taking this course, the students are expected to have a sound knowledge of bioenergetics and the metabolic pathways of amino acids, proteins, carbohydrates, nucleic acids and lipids.

Course Contents

Intermediary Metabolism and Bioenergetics

Methods of metabolism study. Cell bioenergetics and Role of ATP. Biological oxidation reduction including respiratory carriers. Cell bioenergetics. Oxidative Phosphorylation. Free energy change and redox System.

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 and their control. Regulation of carbohydrate metabolism.

Metabolism of Lipids

Digestion of Lipids. Absorption and Transport of lipids and fatty Acids. Oxidation of saturated, unsaturated. Odd Chain and Branched chain fatty acids. Biosynthesis of Fatty Acids and eicosanoids Biosynthesis of triglycerides, phospholipids, steroid and Bile Acids. Biosynthesis and utilization of Ketone bodies. Metabolism of essential fatty acids and their metabolic disorders. Control of fatty acid Metabolism. Phospholipids, steroids and Prostaglandins.

Metabolism of Amino acids and Proteins

Digestion of proteins. Absorption and Transport of Amino acids to the cell. . Biosynthesis of essential amino acids. Degradation and biochemical reaction of amino acids: Decarboxylation Deamination, Transamination and transmetylation of amino acids and their importance 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. Biosynthesis of nucleotides. Disorders linked to serum urate levels. Synthesis of Catabolism, of Nucleosides DNA Polymerases and other enzymes involves in metabolism.

Books recommended

1. Principles of Biochemistry by Lehninger AL, Nelson DL and Cox MN, 2000 Pub: worth Publishers
2. Biochemistry by Lubert Stryer 2006 Pub: Freeman and Company
3. Biochemistry by Voet, and Pratt, 2004, John wiley and sons Inc.
4. Lippincott's Biochemistry by Champe.P C; Harvey. R. A and Ferrier. D. R. 3rd ed., 2004 Pub: J. b. Lippincott Company
5. Harpers Biochemistry, 27th ed. 2006 Pub: McGraw Hill Inc.
6. Voet, D. and Voit J. G., "Biochemistry", John Wiley & Sons, New York, (2000).

Specialization Paper-IV: Molecular Biology **Code: CHEM-634.3**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objective of this course is to cover the fundamental concepts of molecular biology, molecular manipulations and associated applications. Focus is placed on understandings of the chemistry, and relations between structure and properties of the nucleic acids.

Course Outcomes

The students will have acquired fundamental concepts of the chemistry and relations between structure and properties of the DNA and RNAs and their role in genetics.

Course Contents

DNA

Nucleic Acid, Chemical constituent of nucleic acid. Eukaryote chromosome, Structure of chromatin and its functions. Theories of differentiation. Gene activation. Structure & Function. Chemical isolation and purification of nucleic acid. DNA; the primary genetic material. The structure of DNA, Biosynthesis of DNA, Replication of DNA in prokaryotes and comparison with eukaryotes. DNA sequencing. Chemical synthesis of polynucleotides. DNA repair and recombination. Mechanism of action of DNA polymerase, DNA ligase.

RNA

Different types of RNA. RNA polymerase. RNA biosynthesis Ribosome and Ribosomal RNA, transfer RNA, messenger RNA. Transcription and its regulation. Biosynthesis of RNA, nucleoside polymerase, Nucleoside catabolism, Hybridization studies, Protein Synthesis and genetic coding. Post transcriptional processing. Structure of transfer RNA. Protein synthesis inhibitors. Control of translation, Post translational modification.

Genetics

Genes and mutational units. Replication, transcription and translation. Restriction enzymes. Regulation of gene expression in Prokaryotes & Eukaryotes and Operon model. Constitutive, repressed and induced enzymes. Plasmids, bacteriophages, cosmids. . In vitro mutagenesis: Deletion, Insertion and Substitution. Methods of recombinant DNA and genetic diseases, Viruses. RNA Processing. Physical properties of mutagens. Antibody production. Virus replication and its protein regulation.

Books Recommended

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, Molecular Biology of the Gene 2004, Pearson Education, Inc.
2. Watson, J.D. Tooze, J and Kurtz, D.T. Recombinant DNA Scientific American Books. Freeman.
3. The Bio-Chemistry of the nucleic acids by David-Son's.
4. Principles of gene Manipulation (an introduction to genetic engineering) 3rd edition by R.W. Old and SB primrose (Blackwell scientific publications).
5. Lewin B. Gene VII. Oxford University Press.
6. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter Molecular Biology of the Cell 5th Edition Taylor &Francis.
7. T. A. Brown. Genomes 3rd Edition Taylor &Francis

Course Title: Environmental Chemistry-I **Code: CHEM-635.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry, atmospheric and air pollution, water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of environmental pollution and their consequences as well as how to be able to overcome such problems.

Course Contents

The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmosphere photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulations, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen photochemicals smog, airborne load, control of automobile emissions.

Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophiction, detergents and phosphates, importance of micro-organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

Practicals

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of fluoride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. S. K. Banerji, Environmental chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-I/Research Project/Review-article/ internship CHEM-636.3
Credit Hours: 0+3 Marks: 100

Special Practicals

1. Determination of blood group by chemical methods
2. Estimation of organic constituents like Uric acid, serum proteins, hemoglobin etc. by chemical methods.
3. Specific oxidation of sugar by periodate acid and enzymatic hydrolysis of polysaccharides
4. Estimation of glucose in a mixture of monosaccharides
5. Sequence determination of tripeptides.
6. Determination of free amino group of proteins,
7. Preparation of different media for growing micro-organisms
8. Sterilization techniques
9. Growth and identification of micro-organism
10. Enzymes: Study of functions and properties
11. Biochemical preparations (2-3 preparation) i.e:
    a. Preparation of cylcogen from liver
    b. Preparation of cytochrom-C
    c. Preparation of RNA from beef liver
    d. Preparation of DNA from calf spleen
    e. Preparation of LDA
    f. Preparation of phsophatase

Specialization Courses

Biochemistry

M.Sc. 2nd –Year, Semester –IV

Specialization Paper-V: Physical Techniques in Biochemistry **Code: CHEM-641.3**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

This course is designed to impart a fundamental understanding of biochemical techniques used to isolate and characterize various macromolecules.

Course Outcomes

After completing this course, the students will have acquired a detailed knowledge of the different techniques used for the extraction, purification and characterization in the field of biochemistry.

Course Contents

Extraction, fraction and purification of proteins

Homogenization, solubilization including ultrasonication, lyophilization and ultradecantation. Desalting and concentration of biomolecules, Purification based on differential solubility techniques. Principles of chromatography, Gel filtration, ion-exchange chromatography, affinity chromatography and gas chromatography. HPLC. Amino acid analyzer.

Electrophoresis

Gel electrophoresis, Polyacrylamide and agarose gel electrophoresis, paper electrophoresis and its application SDS-PAGE, Immunoelectrophoresis.

Electrofocussing

Preparative and analytical electofocussing.

Centrifugation

Principle, preparative centrifugation analytical centrifugation; application of analytical ultra-centrifugation.

Tracer Techniques

Detection and measurement of radioactivity. Application of radioisotopes in the Biological system.

X-Ray Diffraction

Introduction to basics of XRD and their applications in biochemistry

Ultra Violet Visible Spectrophotometry

Basic principles, instrumentation and applications.

Books Recommended

1. The tools of Bio-Chemistry by T.G.Cooper.
2. The text book of Bio-Chemistry by West & Todd.
3. Principles and Techniques of Practical Bio-Chemistry by William Edward and Arnold.
4. Bio-Chemistry by Lehninger.
5. Principles and techniques of practical Biochemistry by William Edward and Arnold.
6. Plummer, D.T., An introduction to practical biochemistry, TATA McGraw-Hill Publishing Company LTD.
7. Quantitative problems in Bio-Chemistry by Dawas.
8. A biologist's physical chemistry by J.,Gareth Morsis.
9. Protein purification, principle and practice by Robert K. Scope.

Specialization Paper-VI: Endocrinology and Body Fluids Code: CHEM-642.3
Credit Hours: 3+0 Marks: 100

Course Objectives

Objective of this course is to provide fundamental concepts related to biochemical and molecular aspects of endocrinology and chemistry of blood and other extracellular fluids.

Course Outcomes

The students will have acquired the fundamental concepts related to 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. Regulation and secretion of hormones. Functions and mode of action of hormones, Hormones receptors. Chemistry, biosynthesis, metabolism and biological functions of the parathyroid, gonadal hormones, pheromons. Hormones of GIT, Renal and Pienal glands.

Hormones of anterior lobe of pituitary gland (Adenohypophysis): Prolactin, leuteinizing hormone (LH), Adrenocarticotropic Hormone (ACTH), growth hormone, Follical Stimulation Hormones (F.S.H), Thyroid Stimulating Hormones (T.S.H).

Hormones of posterior lobe of pituitary gland (Neurohpophysis): oxytocin, vasopressin.

Hormones of thyroid gland: T3, T4 (Thyroxin).

Hormones of adrenal glands: Adrenal medulla, adrenaline, noradrenaline. Adrenal cortex; Steroid Hormones.

Hormones of Pancreas: Insulin

Body Fluids

General composition of the blood. Function of blood, blood plasma.

Blood proteins: 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 haemoglobin, respiration and gas transport. Blood coagulation and clotting of blood. Blood pressure. Blood groups.

Urine: Composition of Urine, Normal and Abnormal composition of urine and its biochemical effects.

Extracellular Fluids: cerebrospinal fluid, lymph, Sweat, Tears, Synovial and interstitial fluid.

Books Recommended

1. Lehninger, A. L, “Principles of Biochemistry”, Worth Publisher, New York, (2001).
2. Voet, D. and Voit J. G., “Biochemistry”, John Wiley & Sons, New York, (2000).
3. Murray, R. K., Mayes P. A., Granner, D. K. and Rodwell, V. W., Harper’s Biochemistry”, Appleton & Lange (2000).
4. Guyton, C and Hall J. C., Text Book of Medical Physiology, 9th Ed., W. B. Saunders Company, (1996).
5. Orten, J. M. & Neuhasus, O. W., Human Biochemistry, 9th Ed., The C. V. Mosby Company, Saint Louis (1975).
6. Devlin, T. M. (Editor), The Text Book of Biochemistry with Clinical Correlation, Wiley-Liss, New York (1997).
7. Wilhelm R. Frisell, “Human Biochemistry”, Macmillan Publishing Co., Inc. New York (1982).
8. A Biological Guide to Principles and Techniques of Practical Biochemistry by Bryan L. Williams and Keith Wilson Pub: Edward Arnold.

Specialization Paper-VII: Immunology **Code: CHEM-643.3**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

This course aims at providing basic knowledge of chemical, cellular and molecular immunology required to understand basic concepts of immune responses.

Course Outcomes

The students will possess basic knowledge of chemical, cellular and molecular immunology, antigens, antibodies, immunity disorders etc.

Course Contents

Introduction

The immune system, Historical background, general concepts and Principles of immunology, Innate and adaptive immunity; Inflammation, general properties. Structure, properties and functions of the immune cells & organs.

Antigens and haptens

Properties (foreignness, molecular size, heterogeneity). B and T cell epitopes. T-dependent and T- independent antigens.

Antibodies

Structure, function and properties of the antibodies; Different classes and biological activities of antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype). Genesis of antibody variability (definitions of combinatorial joining, junctional flexibility, somatic hypermutation, class switching, allelic exclusion, immunoglobulin superfamily). Introduction to antibody engineering (definitions of chimeric and hybrid monoclonal antibodies).

Cell mediated immunity

Cell types (CTLs, NK cells, macrophages and TDTH cells), effector mechanisms and effector molecules of cell mediated reactions. Assessment of cell-mediated cytotoxicity. Cytokine properties and functions of IL-1 to IL-5, IL-10, IL-12, IFN- γ. Regulation and modulation of immune response

Autoimmunity

Mechanisms of induction of organ specific (Hashimoto's thyroiditis, autoimmune anemias, Good pasture's syndrome, IDDM), and systemic (SLE, multiple sclerosis and rheumatoid arthritis) autoimmune diseases. Therapeutic approach.

Immune disorders

Type I IgE-Mediated Hypersensitivity, other types of hypersensitivity, Types and mechanism of hypersensitive reactions. Autoimmune disorders, Immunodeficiency disorders.

Transplantation immunology

Types of grafts, immunologic basis of graft rejection, properties and types of rejection, tissue typing, immunosuppressive therapy and transplants to immunologically privileged sites.

Books Recommended

1. Medical Immunology 10th Editon by T.G. Parslow, D.P.Stites, A.I. Terr & J. B. Imboden. Lange.
2. Immunology, 6th Editon by I. Riott, J. Brostoff, & D. Male. Publisher: C. V. Mosby.
3. Kuby Immunology,(2006) 6th Edition by T. J. Kindt, B. Osborne & R. A. Goldsby, W. H. Freeman
4. Principles of Microbiolgy,(1995) by R.M. Atlas
5. Advance Molecular Biology (1999) by W.Wisden & R. M. Twyman.
6. Doan T., R. Melvold, S. Viselli and C. Waltenbaugh. Immunology: Lippincott Illustrated Reviews Lippincott Williams& Wilkins.

Specialization Paper-VIII: Cell Biology **Code: CHEM-644.3**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

This course provides fundamental concepts about the cell biology like cell organelles, membrane transport, cell movements, cell division etc.

Course Outcomes

After completing this course, the students will have acquired fundamental concepts about the cell biology like cell organelles, membrane transport, cell movements, cell division etc.

Course Contents

The Cell

Cell theory; Structure and chemical composition of cell, Introduction to Prokaryotes and Eukaryotes,

Cell organelles

Lysosome, Micro-bodies, Mitochondrial structure and the conservation of chemical energy, Chloroplast structure, Plasma membrane, Cell wall, Mechanism of photosynthesis, Separation of cell organelles, Functions of cell organelles.

Membrane transport

The concept of the unit membrane, Fluid mosaic model, Surface receptors and membrane mediated control. Active and Passive transport, Actin filaments, Microtubules, Intermediate filaments.

Cell movements

Structure and function of cytoskeleton, Centriole, Cilia and Flagella, Mitotic apparatus.

Cell surface and cell communication

Cell adhesion and junctions, Signal transduction and receptor functions, Cell membrane receptors.

Cell division

Eukaryotic cell cycle, Mitosis and meiosis. Apoptosis and Necrosis.

Books Recommended

1. Molecular Biology of the Cell, (2008) 5th Editon .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter Garland Sciences.
2. Molecular Cell Biology (2000) 4th Edition. H. Lodish, A. Berk, L. Zipursky, P. Matsudaira, D. Baltimore & J. Darnell. W.H. Freeman.
3. Cell and Molecular Biology: Concepts and Experiments (2008) by G. Karp John Wiley & Sons.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter Molecular Biology of the Cell 5th Edition Taylor &Francis T. A. Brown. Genomes 3rd Edition Taylor &Francis

Environmental Chemistry-II **Code: CHEM-645.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry especially related to various energy resources, use of fuels and their consequences on atmospheric air and water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of various energy resources, different fuels and the consequences of their uses on the environment.

Course Contents

Energy Sources

Fossil Fuels

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, and environmental problems associated with petroleum,

Soils and Mineral Resources

Estimating reserves of mineral resources of earth, extraction of metal-general principles, iron, steel, aluminum, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Other sources

Nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

Practicals

1. Determination of nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
2. Determination of caffeine in tea leaves by HPLC.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-II/Research project/Review-article **Code: CHEM-646.3**
Credit Hours: 0+3 **Marks: 100**

Practicals

Paper chromatography

One dimensional and two dimensional for carbohydrates and protein

Thin layer chromatography

Silica gel and impregnated silica gel (with AgNO3 or borate) for lipids, fatty acids and sterols.

Ion exchange chromatography

Elements, Mg, Al, etc. found in the biological fluids or food

Spectrophotometry

Use of Spectronic-20 in the determination of blood glucose, uric acid, creatinine.

Polarimetry

Determination of sugars in food.

Flame photometry and Atomic absorption Spectroscopy

Analysis of Inorganic constituents in normal and abnormal urine by atomic absorption spectrometry, flame photometry and titration methods.

Analysis of blood constituent like, Calcium, sodium, potassium, Phosphate, Sugar, Urea, creatine, Biliuribin, Cholesterol, Triglycerides by chemical methods, flame photometry and atomic absorption spectroscopy.

Electrophoresis

The determination of proteins and lipoproteins of clinical interest

Potentiometry

To study the ionic properties of biological fluids

Conductometry

Determination of proteins/nucleoproteins and other biological compounds

Inorganic Chemistry

M.Sc. 1st –Year, Semester –I

Inorganic Chemistry-I **Code: CHEM-511.5**

Cr. Hours 3+1 **Marks 100**

Course Objectives

The basic knowledge of periodic table will be refreshed. The will know about chemical bonding, Hybridization and Non-aqueous solvents.

Course Outcomes

The student's knowledge about basic inorganic chemistry, periodic table, theories of bonding and Non-aqueous solvents will be enhanced.

Contents

Classification & Properties of Elements

Development of periodic law. The long from of periodic table. Electronic basis for the periodic classification, Term Symbols. Similarities of the elements, Modern trends in periodic table. The types of elements. Atomic and ionic radii, periodic trends of atomic radii, ionization potential, electron affinity, electronegativity, effective nuclear charge, oxidation states of elements.

Chemical Bonding and Hybridization

Bond and its types, Sigma and Pi bonds, Bonding and non-bonding orbitals, Octet rule, Valence shell electron pair repulsion theory and applications of VSEPR theory to selected molecules, Valence bond theory as applied to molecues, Crystal field theory and its application, Molecular orbital theory and its applications, Hybridization, types and rules of hybridization, shapes of some common molecules.

Non-aqueous solvents

Classification of solvents, types of reactions in different solvents, effect of physical and chemical properties of solvents on reactions, Physical properties of non-aqueous solvents, Chemical reactions in liquid NH_3, liquid H_2S, liquid HF and liquid SO_2 as solvents, Advantages and disadvantages of different non-aqueous solvents.

Books Recommended

1. J.E. Huheey., E.A Keiter, and R.L. Keiter. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001
2. F.A. Cotton., G.Wilkinson, and P. L. Gaus. "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
3. F.A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, "Advanced Inorganic Chemistry", 6th Ed., Wiley-Intersceince, New York, 1999.
4. E. M Larsen. "Transition Elements", W. A. Benjamin Inc., 1995

Practicals

1. Analysis of salts mixtures for anions and cations
2. Preparation of at least four coordination compounds in a pure state
3. Complexometric titrations
4. Estimation of the following metal ions by applying volumetric and gravimetric techniques.

   i) Ca^{2+} and Mg^{2+} ii) Fe^{2+} and Al^{3+} iii) Cu^{2+} and Ni^{2+} vi) Cu^{2+} and Zn^{2+}

Books Recommended

1. J. Bassette., G.H. Denney, and J. Mendham. "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4th Edition, 1981.
2. I. Vogel, "A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis" Longman Green & Co. 1995.

Inorganic Chemistry

M.Sc. 1st –Year, Semester –II

Inorganic Chemistry-II **Code: CHEM-521.5**

Cr. Hours 3+1 **Marks 100**

Course Objectives

The objectives of this course is to impart theoretical understanding about coordination chemistry and acceptor complexes and chemistry of f-block elements.

Course Outcomes

After this course the students will be able to understand chemistry of coordination and metal-carbonyl complexes and chemistry of lanthanides and actinides.

Contents

Coordination Compounds

Study of coordination compounds regarding their historical back ground, nomenclature, geometry, theories i.e. Jorgensen theory, Werner's theory, valence bond theory, crystal field theory and molecular orbital theory. Properties of coordination compound i.e. magnetic properties, Jahn Teller effect, Factors affecting stability of complexes, Applications of complexes.

Acceptor Complexes

Mononuclear and polynuclear metal carbonyls: Calculation of valance electrons, the eighteen electrons rule as applied to metal carbonyls, rationalization of molecular structure, evaluation of structures based on spectroscopic evidences, chemistry of metal carbonyls and their derivatives (nitrosyls, halides and hydrides)

Chemistry of f-Block Elements

a. Lanthanides: Electronic structure and position in the periodic table, Lanthanide’s contraction, oxidation states, spectral and magnetic properties, general characteristics, occurrence, extraction and general principles of separation, complexes and uses.

b. Actinides: Electronic structure and position in the periodic table, oxidation states, general characteristics, half-life and decay law.

Books recommended

1. J. E. Huheey., E.A. Keiter., and R.L. Keiter,., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper & Row, New York, 2001.
2. F.A. Cotton., G. Wilkinson., C.A.Murillo, and M. Bochmann.,"Advanced Inorganic Chemistry", 6th Ed., Wiley-Intersceince, New York, 1999.
3. N.N. Greenwood., and A Earnshaw. "Chemistry of the Elements", 2nd Ed., Pergamon Press, New York, 1992.
4. W. Willium. Porterfield. Inorganic chemistry, Unified approach, Elsevier Company, (2005)
5. K.M. Mackay., R.A., Mackay., and W. Henderson,., "Introduction to Modern Inorganic Chemistry", 5th Edition, Stanley Thomas Publisher Ltd. 1996.
6. K. Holliday, and A.G. Massey, "Inorganic Chemistry in Non-Aqueous Solvents", Pergamon Press, New York, 1990.

Practicals

1. Determination of halides in water samples Argentometrically
2. Redox Titration
3. Gravimetric estimation of Ba^{2+} and Fe^{3+} ions
4. Preparation of crystals of potash alum
5. Preparation of lead chromate

Books Recommended

1. J. Bassette., G.H Denney., and J. Mendham,. "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4th Edition, 1981.
2. A.I. Vogel. "A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis" Longman Green & Co. 1995.

Specialization Courses

Inorganic Chemistry

M.Sc. 2nd –Year, Semester –III

Specialization paper-I: Chromatographic Methods of Analysis Code: CHEM- 631.5
Credit Hours: 3+0 Marks: 100

Course Objectives

The objectives of this course is to impart theoretical understanding about basic theory of chromatography and different chromatographic techniques.

Course Outcomes

After this course the students will be able to understand different chromatographic techniques and their uses for purification of different kinds of mixtures.

Contents

Introduction

Chromatography history, Scope of chromatography, Importance of chromatography, partition and adsorption chromatography.

Paper chromatography

Historical background and basic principles, Modes of paper chromatography, Sample preparation and operational procedure, Importance

Thin layer chromatography

History, theory and basic principle, Mobile and stationary phase, R_f value and factors affecting R_f value, Stationary Phase selection, selection of adsorbent, Uses.

Gas chromatography

Introduction and basic principles, Gas-solid and Gas-Liquid chromatography, Components of gas chromatography, instrumentation, various types of detectors for gas chromatography and applications.

High pressure liquid chromatography

Theory, principle, types, instrumentation and applications.

Ion Exchange chromatography

Selectivity and classification of resins, instrumentation and applications.

Recommended Books

1. Skoog. Holler. Nieman. Principles of instrumental analysis, fifth edition, Thomson Learning Academic.
2. M.H. Willard, L.L. Merrite, Jr. J.A. Dean, instrumental methods of analysis, Van Nostrand. New York.
3. H.G. Gsssidy, fundamental chromatography, inters science publications, New York.

Specialization paper-II: Nuclear Chemistry   Code: CHEM-632.5

Credit Hours: 3+0   Marks: 100

Course Objectives

The objectives of this course is to impart theoretical knowledge about the importance and scope of nuclear chemistry, radio isotopes and their types and different techniques used in nuclear chemistry.

Course Outcomes

After this course the students will be able to understand the field of nuclear chemistry, their applications for energy production and their uses in medical sciences.

Contents

Nuclear Reactions

Nature of nuclear reactions, nuclear reaction mechanism, nuclear cross sections, excitation functions, types of nuclear reactions, fission and fusion reactions and photonuclear reactions,

Radioactivity decay, detection and interaction of radiations

Half-life and average life of radioactive species, types of radioactive equilibrium, units of radioactivity. Radioactive decay series, Determination of half-lives, radiation detection and measurements, Geiger mullar counters, scintillation counters. Interaction of radiation with matter. Determination of alpha and beta particles range.

Uses of Radio Isotopes

Basic assumptions for tracer use, Radio metric analysis, Isotopes dilution. Activation analysis, Reaction Kinetics and mechanism, structure studies, Diffusion studies, artificial elements, Organic reactions and photosynthesis.

Books Recommended

1. G. F. Friellander, J. W. Kennedy, and J. M. Miller, Nuclear and Radiochemistry, John Wiley and Sons, New York

3. Glasstone Samuel, Source book on atomic energy, von Nostrand, New York.

4. W. M. Gibbson, Nuclear reactions, Penguin books Inc., New York.

5. J. M. Reid, The atomic nuclear reactions, Penguin books Inc., New York.

6. Chopman and Ryedberg, Nuclear chemistry, Prentice Hall, New York.

Specialization paper-III: Bio-Inorganic Chemistry Code: CHEM-633.5
Credit Hours: 3+0 Marks: 100

Course Objectives

The objectives of this course is to impart theoretical knowledge about the chemistry of bio-inorganic compounds and their importance in human body regulation.

Course Outcomes

After this course the students will be able to understand the chemistry of bio-inorganic compounds especially Organoselenium and iron containing bio-inorganic compounds and their importance.

Contents

Fundamentals of Biochemistry

Proteins, protein structure, amino acid building blocks, protein sequencing and proteomics, protein functions, enzymes and enzyme kinetics.

Biochemistry of Selenium compounds

Biochemistry of selenium and organoselenium compounds, antioxidant activity of organoselenium compounds, and toxicology of organoselenium compounds.

Biochemistry of Iron and other metals

The biochemistry of iron, Iron storage and transfer in bacteria, ion transport, haemoglobin and myoglobin, nature of haemo-dioxygen , Model systems, cyto chromes, P/450 enzymes, iron sulphur protein , ferrodoxins, haemoerthrins, the biochemistry of Zn, Cu. Co, Mg and other Alkaline earth metals.

Books Recommended

1. F.A. Cotton, and S.W, Advanced inorganic chemistry, John Wiley and sons, New York.
2. F. Basolo and R. Johnson, Mechanism of inorganic reactions, John Wiley and sons, New York.
3. F. Basalo and R. Johnson, Coordination chemistry, W.A. Benjamen, Row Publishers, New York.
4. J. E. Huheey, Inorganic Harper and Row Publisher, New York.
5. D. Jonson, Mechanism of inorganic reaction in solutions, McGraw-Hill, London.
6. Nicolaou, K. C.; Petasi, N. A. Selenium in Natural Products Synthesis; CIS: Philadelphia, PA, 1984.
7. Paulmier, C. SeleniumReagents and Intermediates in Organic Synthesis; Pergamon: Oxford, U.K., 1986.
8. Patai, S.; Rappoport, Z. The Chemistry of Organic Selenium and Tellurium Compounds; Wiley: New York, 1986; Vol. 1.

Specialization paper-IV: Spectroscopic Techniques in Inorganic Chemistry

Code: CHEM-634.5 **Credit Hours: 3+0** **Marks: 100**

Course Objectives

The objectives of this course is to impart theoretical knowledge about the various spectroscopic techniques used in the field of inorganic chemistry and their applications.

Course Outcomes

After this course the students will be able to know about the formation and interpretation of different kinds of absorption and emission spectra for structure elucidation of inorganic compounds.

Contents

General introduction to spectroscopy

Origin of spectra, excitation methods spectrographs and its qualitative and quantitative applications.

UV/ Visible spectroscopy

Basic instrumentation of U.V/visible spectrophotometers, Spectra of transition metal complexes, applications of the principles related to electronic transition. Structural evidence from electronic spectra

Emission spectroscopy

Atomic emission spectroscopy, qualitative and quantitative applications in inorganic chemistry.

Infra-red spectroscopy

Basic instrumentation and applications to the determination of structure of inorganic compounds.

Raman spectroscopy

Theory, selection rule, instrumentation, Zeeman effect and its applications.

Atomic absorption spectroscopy

Theory, instrumentation and applications of Atomic Absorption Spectroscopy

Nuclear magnetic resonance spectroscopy

Properties of nuclei, principle, instrumentation, chemical shift, factor effecting chemical shift, spin-spin coupling, its origin, coupling constant, their use in structural determination. Interpretation of simple first order spectra.

Mass Spectrometry

Mass Spectrometry principle, instrumentation, ionization techniques, fragmentation processes.

Books Recommended

1. C.N.Banwale, Fundamentals of molecular spectroscopy, McGraw-Hill, New York.
2. Skoog. Holler. Nieman. Principles of instrumental analysis, fifth edition, Thomson Learning Academic.
3. M.H.willard, L.L.Merrite, J.J A.Dean, instrumental methods of analysis, Van Nostrand, New York.
4. R.D. Braun, introduction to instrumental analysis. Mc. Graw-Hill, New York, 1987.

Environmental Chemistry-I **Code: CHEM-635.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry, atmospheric and air pollution, water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of environmental pollution and their consequences as well as how to be able to overcome such problems.

Course Contents

The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmosphere photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulations, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen photochemicals smog, airborne load, control of automobile emissions.

Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophiction, detergents and phosphates, importance of micro-organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

Practicals

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of fluoride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. S. K. Banerji, Environmental chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental chemistry, Brooks, California

Special Particles-I /Research Thesis/ Review Article **CHEM-636.5**

Credit Hours: 0+3 **Marks: 100**

Special Practicals

1. Preparation and complex analysis of at least four inorganic complexes.
2. Chemical composition of minerals and ores, e.g. chromite, limestone.
3. Estimation of following anions with the help of adsorption indicators:

(i) Chloride (ii) Bromide (iii) Sulphate (iv) Chloride and Iodide in a mixture.

4. Separation of cations by ion-exchange chromatography.
5. Preparation of Sodium Cobaltinitrite.

Specialization Courses

Inorganic Chemistry

M.Sc. 2^{nd} –Year, Semester –IV

Specialization Paper-V: Inorganic Polymers **Code: CHEM-641.5**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

The objectives of this course is to impart theoretical knowledge about the various inorganic polymers and their important applications.

Course Outcomes

After this course the students will be able to know about various inorganic polymers including polycationic and polyanionic inorganic polymers and their applications.

Contents

Molecular Species

Introduction, homoatomic and heteroatomic inorganic polymers, Boron cage compounds (Boranes and Carboranes). Metal clusters (metallocarboranes)., phosphoros cage compounds, homocylic inorganic rings, hetcrocatenation, homocatenation, synthesis and applications of silicones. Synthesis, reactivity and applications of borazine, Synthesis, reactivity and applications of phosphonitrilic compounds, Synthesis, reactivity and applications of tetrasuphur tetranitride, coordination polymers.

Polycationic and Polyanionic Polymers

Introduction, Polycations, isoply and heteropoly anions of transition metals, Silicates, borates, condensed phosphates, zeolites.

Homo and Hetero chain polymers

Silicon-silicon, Germanium-Germanium, sulfur polymers, Tin-tin, Boron-nitrogen, Silicon-oxygen, Silicon-nitrogen, Phosphorus-nitrogen, Phosphorus-oxygen, Sulfur-oxygen polymers.

Books Recommended

1. Organotransition metal Chemistry by Akin Yamamto, 1996, A. Wiley Interscience Publication London.
2. Hand Book of Organic reagents in Inorganic Analysis by ZAVIX Holzbecher and other 1976 Ellis Hurwod Limited, London.
3. Structural Inorganic Chemistry by Wells, A.F. 1975, Charenden Press, London.
4. Stereochemistry and bonding in Inorganic Chemistry by by J.E. Ferguson 1974, Prentice Hall, New Jersy.
5. J H Huheey, Inorganic Chemisry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York 2008.
6. Cullen Dolphin and James, Biological aspects of Inorganic Chemistry, 2005.
7. Williams, An Introduction to Bioinorganic Chemistry, 2003.

Specialization Paper-VI: Inorganic Reaction Mechanism Code: CHEM-642.5

Credit Hours: 3+0 Marks: 100

Course Objectives

The objectives of this course is to impart theoretical knowledge about mechanisms of inorganic reactions like ligand substitution reactions of transition metal complexes and their stereochemistry.

Course Outcomes

After this course the students will be able to know about ligand replacement reactions and their mechanism as well as about the stereochemistry and bonding theories with respect to complexes.

Contents

Ligand replacement reactions

D, ID, Ia and A mechanisms, activation parameter, order and rates of reaction, formation of complexes from equations, acid and base hydrolysis, displacement reaction in square complexes, trans effect, substitution reactions and mechanism of substitution in tetrahedral complexes.

Stereochemistry and Bonding in Compounds of Transition and Non Transition Elements

Introduction, the valence shell electron pair repulsion (VSEPR) model and important rules, applications of VSEPR model concept, the hybridization or directed valence theory, rules of hybridization, types of hybridization and shapes of some common molecules, multicenter bonding in electron deficient molecules, (two–center, two–electrons (2c-2e) bond, three-center, four-electrons (3c-4e) bond model.

Ligand Substitution Reactions in Complexes

Introduction, transition state or activated complex, electphilic reagents, nucleoplilic reagents, types of substitution reactions SN1, SN2, SN1CB, limitation of SN1, SN2, hydrolysis reactions (acid hydrolysis, base hydrolysis), substitution reactions without breaking metal ligand bond, isomerization and racemization of tris chelate complexes. Ligand substitution reactions in square planer and in octahydral complexes. Mechanism of substitution reactions, determination of substitution reactions. Trans effect, trans effect series, use of trans effect, theories of trans effect, electrostatic polarization theory -bonding theory, factors affecting the rate of substitution reactions in square complexes

Books Recommended

1. F.A. Cotton, and S.W, Advanced inorganic chemistry, John Wiley and sons, New York.
2. F.Basolo and R. Johnson, Mechanism of inorganic reactions, John Wiley and sons, New York.
3. F.Basalo and R. Johnson, Coordination chemistry, W.A. Benjamen , Row Publishers, New York.
4. J.E. Huheey, Inorganic Harper and Row Publisher, New York.
5. D.Jonson, Mechanism of inorganic reaction in solutions, McGraw-Hill, London.

<u>Specialization Paper-VII: Group Theory Code: CHEM-643.5</u>

Credit Hours: 3+0 Marks: 100

Course Objectives

The objectives of this course is to impart theoretical knowledge about group theory and various symmetry operations and their application on various inorganic molecules.

Course Outcomes

After this course the students will be able to know about symmetry operations, group theory and their application on various inorganic molecules.

Contents

Definition of a group: The defining properties of group, some examples of groups, sub-groups, classes, group multiplication table. Molecular Symmetry and Symmetry Groups: Symmetry elements and operation, Symmetry plane and reflections, the inversion center, proper axis and proper rotations, improper rotation, product of symmetry operations, symmetry points groups, systematic procedure for symmetry classification of molecules, examples of points groups, H_2O, NH_3, H_2O_2, $[PtCl_4]^{2-}$,$[Ni(CN)_4]^{2-}$ BF_3, BCl_3, Ferrocene, CO_2, NaCl, Benzene, Cyclohexane (Chair and boat from) CH_3Cl etc., Special Point Groups: Oh, Td, Ih, character tables, chirality of molecules

Books recommended

1. Cotton F.A. "Chemical Applications of Groups Theory" Interscience Publishers (1963).
2. Lowell Hall H. "Group Theory and Symmetry in Chemistry" McGraw Hill Book Company (1969).
3. Vincent A. "Molecular symmetry and Group Theory", John Wiley &sons, London, (1977).
4. Thermal analysis by T.Daniels.

<u>Specialization Paper-VIII: Organometallics and Catalysis Code: CHEM-644.5</u>
Credit Hours: 3+0 Marks: 100

Course Objectives

The objectives of this course is to impart theoretical knowledge about the bonding and structure of organometallic compounds, their types and their uses as catalysts.

Course Outcomes

After this course the students will be able to know about the bonding and structure of transition metals based organometallic compounds and their uses as in the field of catalysis.

Contents

Organometallic Compounds

Definition and classification of organometallic compounds, mechanistic steps in organometallic, sigma bonded organometallic compounds (Metal alkyls and Grignard reagents). Synthesis, properties and nature of bonding in pi complexes such as η2-η7, organometallic compounds in cn2-bonded olefin, n3-allylic, n4-cyclopentadienyl, n6-organometallic compounds) and characterization of organometallic compounds with the help of IR, NMR, mass spectrometry etc. Experimental techniques in organometallic chemistry, Transition metal Organometallics.

Catalysis

History and types of catalysis, Catalytic cycle, Factors affecting catalysis, poisoning of catalyst, Mode of action, Organic synthesis via transition metal complexes (Hydroformylation, olefin hydrogenation, polymerization of ethene and oxidation of ethene to acetaldehyde), Ziegler-Natta catalyst, Wilkinson's catalyst, Advantages and Disadvantages of various catalysts, importance of catalysis.

Books Recommended

1. M. Bochmann. Organometallic-1. Oxford University press (1994).
2. M. Bochmann. Organometallic-2. Oxford University press (1994).
3. Yamamoto. Organotransition metal chemistry. John wiley & sons, USA (1986).
4. P. Pawell. Principles of organometallic chemistry. 2nd edition, Chapman and Hall, New York (1988).

Environmental Chemistry-II **Code: CHEM-645.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry especially related to various energy resources, use of fuels and their consequences on atmospheric air and water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of various energy resources, different fuels and the consequences of their uses on the environment.

Course Contents

Energy Sources

Fossil Fuels

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, and environmental problems associated with petroleum,

Soils and Mineral Resources

Estimating reserves of mineral resources of earth, extraction of metal-general principles, iron, steel, aluminum, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Other Sources

Nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

Practicals

1. Determination of nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
2. Determination of caffeine in tea leaves by HPLC.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-II /Research Thesis/ Review Article CHEM-646.5
Credit Hours: 0+3 Marks: 100

Special Practicals

1. Estimation of oxalic acid and H_2SO_4 in a mixture.
2. Separation of metal ions by paper chromatography and their identification with the help of locating agents and comparison of Rf values.
3. Analysis of water for TDS, TSS, PH Determination, Hardness determination and removal, Total Chloride content, total Phosphate contents.
4. Determination of %age composition of a mixture containing H_3BO_3 and CH_3COOH.
5. Preparation of Hexa aqua Chromium (III) Chloride.

Organic Chemistry

M.Sc. 1st –Year, Semester –I

<u>Course Title: Organic Chemistry-I</u> **<u>Code: CHEM-512.6</u>**

Credit Hours: 3+1 **Marks: 100**

Course Objectives

Objective of this course is to introduce to students the basic concepts of organic chemistry, acids-bases and introductory chromatography.

Course Outcomes

After completing this course, the students will have acquired knowledge about important concepts required for understanding of organic chemistry.

Contents

Introduction to Organic Chemistry

Chemistry of carbon compounds; organic chemistry, a historical perspective.

Basic concepts in Organic Chemistry

The concept of hybridization leading to bond angles, bond lengths, bond energies and shape of organic molecules, formation and nature of σ and π bonding in organic molecules, VSEPR theory, polar covalent bonds and dipole moment, inductive and field effects, localized and delocalized chemical bonding, conjugation, resonance, aromaticity in benzenoid and non-benzenoid compounds, Huckle's rule, antiaromaticity, hyperconjugation, intra and inter-molecular hydrogen bonding.

Acids and bases

A brief overview of acids and bases, Lewis acids and bases, strength of acids and bases, concept of conjugate base, pKa and Ka values, Using pka values for determination of acidity and equilibrium, effect of structure on acidity and basicity.

A Brief Introduction to Chromatographic Methods

Introduction to basic theory of chromatography. Column, paper and thin layer chromatographic techniques, physical and chemical visualization methods, gas-liquid chromatography, HPLC (basic introduction).

Recommended Books

1. Wade, L.G, “Organic Chemistry”, 6th edition, Pearson Education Ltd, International.
2. Clayden, J., Greeves, N., Warren, S. and Wothers, P., “Organic Chemistry”, Oxford University Press, New York.
3. Loudon, G. M., “Organic Chemistry”, Oxford University Press, New York
4. Pavia, D. L., Lampman, G. M. and Kriz, G. S., “Introduction to Spectroscopy: A Guide for Students of Organic Chemistry”, Saunders Golden Sunburst Series, London.
5. Finar, I. L., “Organic Chemistry”, Vol. 1, Pearson Education, Delhi.
6. Carey, F. A., “Organic Chemistry”, McGraw-Hill, New York.
7. Ahluwalia, V. K. and Goyal, M., “A Text Book of Organic Chemistry”, Narosa Publishing House, New Delhi
8. March, J., “Advanced Organic Chemistry”, John Wiley & Sons, New York.
9. Bansal, R. K., “Organic Reaction Mechanisms”, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
10. Pine, S. H., “Organic Chemistry”, National Book Foundation, Islamabad.

Practicals

Laboratory Ethics and safety measures

Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations.

Basic Organic laboratory Techniques (Qualitative analysis):

1. Determination of physical constants of organic compounds
    a. Boiling points
    b. Melting points
    c. Molecular weights
2. Isolation and Purification techniques
    a. Filtration
    b. Recrystallization
    c. Sublimation
    d. Solvent extraction
    e. Distillation
        - At atmospheric pressure
        - Steam distillation

- Fractional distillation
- Vacuum distillation

f. Chromatographic techniques

- Paper chromatography
- TLC
- Column chromatography

Recommended Books

1. Clarke, H. T., "A Handbook of Organic Analysis-Qualitative and Quantitative", CBS Publishers & Distributors, New Delhi.
2. Mann, F. G. and Saunders, B. C., "Practical Organic Chemistry", Longman, London.
3. Vogel, A. I., "Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis", Longman, London.
4. Vishnoi, N. K., "Advanced Practical Organic Chemistry", Vikas Publishing House Pvt. Ltd., New Delhi.
5. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., "Vogel's Text Book of Practical Organic Chemistry", National Book Foundation, Islamabad.
6. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., "The Systematic Identification of Organic Compounds", John Wiley & Sons, New York.
7. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., "Vogel's Text Book of Quantitative Chemical Analysis", Pearson Education, New Delhi.

Organic Chemistry

M.Sc. 1st –Year, Semester –II

Course Title: Organic Chemistry-II **Code: CHEM-522.6**

Credit Hours: 3+1 **Marks: 100**

Course Objectives

Major objective of this course is to acquaint students with classification, nomenclature and characteristic reactions of the major classes of organic compounds.

Course Outcomes

Students will acquire knowledge about preparation as well as reactions of major functional groups which is helpful for further studying organic synthesis.

Course Contents

Classes and Nomenclature of Organic Compounds

Classification of organic compounds; development of systematic nomenclature of organic compounds; IUPAC nomenclature of hydrocarbons, heteroatom functional groups, mono and polycyclic compounds.

Functional Groups Chemistry

A detailed chemistry (methods of preparation, physical properties and chemical reactions) of the common functional groups i.e. aliphatic hydrocarbons – alkanes, alkenes, alkynes, benzene and other aromatic hydrocarbons, alkyl halides, amines, alcohols and phenols, ethers and epoxides, thiols and sulfides, carbonyl compounds – aldehydes and ketones; carboxylic acids and their derivatives – esters, amides, anhydride and acid halides.

Recommended Books

1. March, J., “Advanced Organic Chemistry”, John Wiley & Sons, New York.
2. Loudon, G. M., “Organic Chemistry”, Oxford University Press, New York.
3. Brown, W. H., “Introduction to Organic Chemistry”, Saunders College Publishing, Tokyo.
4. Pine, S. H., “Organic Chemistry”, National Book Foundation, Islamabad.
5. Mc. Murry, J., “Organic Chemistry”, Brooks/Cole Publishing Company, California.
6. Carey, F. A., “Organic Chemistry”, McGraw-Hill, New York.
7. Wade, L.G, “Organic Chemistry”, 6th edition, Pearson Education Ltd, International.

Practicals

Two/three step synthesis of organic compounds and isolation of organic compounds from natural sources

Synthesis of

1. Nitrobenzene from benzene and nitration mixture.
2. Dinitrobenzene from nitrobenzene (using the previous step).
3. Benzoin from banzaldehyde (Benzoin condensation).
4. Benzol from the crude benzoin (using the previous step).
5. Benzylic acid from benzoin (using the previous step).

Isolation of

1. Caffeine from tea leaves
2. Citric acid from lemon
3. Nicotine from tobacco leaves
4. Piperine from black pepper

Recommended Books

1. Vogel, A. I., "Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis", Longman, London.
2. Mendham, J., Denney, R. C., Barnes, J. D. and Thomas, M. J. K., "Vogel's Text Book of Quantitative Chemical Analysis", Pearson Education, New Delhi.
3. Clarke, H. T., "A Handbook of Organic Analysis-Qualitative and Quantitative", CBS Publishers & Distributors, New Delhi.
4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., "Vogel's Text Book of Practical Organic Chemistry", National Book Foundation, Islamabad.
5. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., "The Systematic Identification of Organic Compounds", John Wiley & Sons, New York.
6. Mann, F. G. and Saunders, B. C., "Practical Organic Chemistry", Longman, London.

Specialization Courses

Organic Chemistry

M.Sc. 2nd –Year, Semester –III

Specialization Paper-1: Chemistry of Natural Products **Code: CHEM-631.6**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objectives of this course include to let the students learn about major classes of natural products like alkaloids, steroids, terpenoids, flavonoids, antibiotics, their biological functions, their molecular structures, isolation, synthesis and biosynthetic pathways.

Course Outcomes

Students will acquire detailed knowledge about different classes of natural products, their structural types, medicinal uses, isolation from natural sources and about different methodologies used for their synthesis in laboratory.

Course Contents

Introduction to Natural Product: Primary and Secondary Metabolites, drug discoveries from Natural Products.

Alkaloids

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

Terpenoids

Introduction; classification; isolation; general methods for structure elucidation; discussion with particular reference to structure and synthesis of citral, and camphor.

Steroids

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

Flavonoids

Introduction; classification; isolation; general methods for structure elucidation; discussion with particular reference to structure and synthesis of quercetin, chrysin and catechin.

Antibiotics

Concept and definition, chemistry of penicllin, chloramphenicol and tetracyclene.

Books Recommended

1. Clayden, J., Greeves, N. Warren, S. and Worthers, P. Organic Chemistry, Oxford University (2001).
2. Mann, J., Davidson, R.S., Hobbs, J.B., Banthrope, D.V. and. Harborne, J.B, Natural Products, Longman Group Ltd., U.K.(1994).
3. Nakanishi, K. ,Goto, T., Ioto, S. Natori, S. Nozone, S. et.al., Natural Products, Vol. 1, Academic Press Inc, New York (1974).
4. Finar, I. L., Organic Chemistry, Stereochemistry and the Chemistry of Natural Products, Vol. 2, Pearson Education, Delhi (1975).
5. Shoppee, C. W., "Chemistry of the Steroids", Butterworths, London.
6. Hesse, M., "Alkaloid Chemistry", John Wiley & Sons, New York.
7. Fieser, L. F. and Fieser, M., "Steroids", Asia Publishing House, London.

Specialization Paper-II: Organic Spectroscopy-I **CHEM-632.6**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Major objective of this course is to acquaint students with fundamental concepts of UV-Visible spectroscopy, Infrared spectroscopy and Mass spectrometry as used by organic chemist for structure determination.

Course Outcomes

As result of taking this course, the students will acquire detailed knowledge about three fundamental spectroscopic techniques that are used for characterization of organic compounds.

Course Contents

Ultraviolet-Visible Spectroscopy

Introduction, Various electronic energy levels and electronic transitions (185-800 nm), Vacuum UV, Beer-Lambert law, chromophores, auxochromes, bathochromic and hypsochromic shifs, hypochromic and hyperchromic effect, effect of solvent on electronic transitions, calculation of λ^{max} value and factors influencing it, UV bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds, UV spectra of aromatic and heterocyclic compounds. Application of UV-spectroscopy to problems in organic chemistry.

Infrared spectroscopy

Introduction – basic principle, instrumentation and sample handling. Functional group, fingerprint region and far IR region. Absorbtion of infrared radiation and molecular vibration. Fundamental vibrations and overtones, stretching and bending vibrations, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds – aldehydes, ketones, carboxylic acids, esters, amides, anhydrides, lactones, lactams and conjugated carbonyl compounds. Effect of inter and intra – molecular hydrogen bonding and solvent on vibrational frequencies. Combination bands and Fermi resonance, FTIR of gaseous; solids and polymeric materials.

Mass spectrometry

Introduction, ion production, EI, CI, FD and FAB, factors affecting fragmentation, ion analysis and ion abundance, molecular ion peak, metastable peak, nitrogen rule, molecular ion determination, molecular formula from isotopic ratio data, isotope profile of halogen compounds, Mc Lafferty rearrangement and ortho effect, mass spectral fragmentation patterns hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, esters, amides, nitriles, amines and nitro compounds. Determination of molecular weight and molecular formula using mass spectrometry.

Books Recommended

1. Pavia, D. L., Lampman, G.M. and Kriz, G.S., Introduction to spectroscopy: a Guide for Students of Organic Chemistry, Thomson Learning, Australia (2001).
2. Silverstein, R. M. Webster F.X. and Kiemle, D.J. Spectrometeric Identification of Organic Compounds, John Wiley and Sons Inc., USA (2005).
3. Brown, D.W., Floyed, A.J. and Sainsury, M. Organic spectroscopy, 1. Wiley and Sons, Chichester (1998).
4. Willians, D. H. and Fleming, I. Spectroscopic methods in organic Chemistry, 4th ed., McGraw-Hill Book. Co., Lodon (1987).
5. Younas, M. Organic Spectroscopy, Ilmi Kitab Khana, Lahore (2004).
6. Kalsi, P.S. “Spectroscopy of Organic Compounds”, Wiley Eastern Ltd., New Delhi.
7. Lambert, J. B, Shurvell, H. F., Lightner, D. A. and Cooks, R. G., “Introduction to Organic Spectroscopy”, Macmillan Publishing Company, New York.
8. Williams D. H. and Fleming, I., “Spectroscopic Methods in Organic Chemistry”, Athlone Press, London.
9. Davis, R. and Freason, M., “Mass Spectrometry”, John Wiley & Sons, New York.

Specialization Paper-III: Stereochemistry **Code: CHEM-633.6**
Credit Hours: 3 +0 **Marks: 100**

Course Objectives

To let the students learn about 3-dimensional aspects of molecules and the role of 3 dimensional molecular structures on the physical properties of molecules, their reactivities and selective interactions with other chiral molecules.

Course Outcomes

After taking this course, the students are presumed to have learned about 3-dimensional nature of organic compounds and their role during reactions in organic synthesis.

Course Contents

Introduction, history and significance of stereochemistry. Drawing of 3-dimentional structures. Inter-conversion of Fischer, Newman, Sawhorse, and flying wedge formulae.

Concept of Conformational analysis in alkanes, cycloalkanes, substituted alkanes and decalins. Geometrical isomerism: Cis/Trans, E/Z conventions, determination of configuration, geometrical isomerism in cyclic compounds.

Optical isomerism: Structure and Symmetry, symmetry elements, Chirality and prochirality, enantiomers, and diastereomers, R/S nomenclature, racemates, racemization amd resolution of racemic mixture, epimerization, walden inversion, Axial and planar chirality, optical isomerism in allenes, biphenyls (atropisomerism), spiranes and hemispiranes, molecular overcrowding and cyclostereisomereism.

Dynamic stereochemistry; stereoselectivity and stereospeciticity; Nucleophilic addition: use of chiral substrates, chiral auxiliaries, reagents and catalysts; asymmetric conjugate addition, asymmetric Diels Alder reaction, hydroboration, catalytic hydrogenation (e.g. via chiral hydrazones and oxyzolines), dihydroxylation, epoxidation (sharpless).

Book Recommended

1. Eliel, E. L.; Wilen, S. H Doyle, M.P. and Michael, P. Basic Organic Stereochemistry, Willey Inter Science, New York (2003).
2. Kalsi, P. S. Sterochemistry and mechanism through Solved problems, new age international publishers, New Delhi, India (2001).
3. Mislow, K. Introduction to stereochemistry, W.A. Benjamin, New York (1966).
4. Morris, D.G. Stereochemistry, Royal Society of Chemistry, UK. (2001).

5. M. North. Principles and application of stereochemistry, Stanely Thornes: Cheltenham, UK (1998).
6. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.

Specialization Paper-IV: Organic Reactions Mechanisms Code: CHEM-634.6
Credit Hours: 3+0 Marks: 100

Course Objectives

Major objective of this course is to introduce the student the various methods used for determination of reaction mechanisms and the common mechanisms of substitutions, additions, elimination and some rearrangement reactions.

Course Outcomes

After completing this course, the students would have acquired fundamental knowledge about various methods used for determination of reaction mechanisms, mechanisms of major types of organic reactions which can be utilized to design new synthetic routes, development of new reactions methodologies as well as for establishing mechanism for new reactions.

Course Contents

Reaction Mechanism and Methods of their Determination

Types of reactions, structure and reactivity, electrophile and nucleophile, ambident electrophile and nucleophile, transition state and intermediate; Types of mechanisms, various methods of determination of reaction mechanism – kinetic, thermodynamic, stereochemical, spectroscopic, intermediate formation, isotope labelling etc.

Substitution reactions

(a) Electrophilic aliphatic substitution reaction: The SE^1 and SE^2 mechanisms, effect of substrates, leaving group and the solvent polarity on the reactivity.
(b) Electrophilic aromatic substitution reaction: Mechanism, effect of substituents on reactivity and orientation of electrophilic aromatic substitution reactions.
(c) Nucleophilic Substitution reaction: The SN^1, SN^2 and SN^i mechanisms, effect of substrate structure, attacking nucleophile, leaving group and reaction medium, ambedient nucleophile.

Addition and elimination reactions

(a) Addition to carbon –carbon multiple bonds, addition to carbon-heteroatom multiple bonds.
(b) The E1, E2, E^1cB mechanisms, orientation of double bond, reactivity effects of substrate structures, attacking base and the leaving group and the medium, pyrolytic elimination.

Rearrangements

Classification of molecular rearrangements: mechanism of intramolecular 1,2 shifts involving migration of a group from carbon to carbon, carbon to nitrogen and carbon to oxygen with some examples.

Books Recommended

1. March, J. Advanced Organic chemistry: Reaction, Mechanism and Structure, 5th ed., John Wiley, New York (2007).
2. Caruthers, W. Modern methods of organic Synthesis, 3rd ed., Cambridge University Press, Cambridge (1986).
3. Aansari, F.L., Quershi R. and Quershi, M.L. Electrocyclic Reactions, John Wiley and Sons (1999).
4. Norman, R.O.C. Principles of Organic Synthesis, 3rd ed., Chapman and Hall, London (1993).
5. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry Part A: Structure and Mechanisms", Kluwer Academic /Plenum Publishers, New York.
6. Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
7. McMurry, J., "Organic Chemistry", Brooks/Cole Publishing Company, California.
8. Solomons, T. W. G. and Fryhle, C. B., "Organic Chemistry", John Wiley & Sons, New York.

Course Title: Environmental Chemistry-I **Code: CHEM-635.4**
Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry, atmospheric and air pollution, water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of environmental pollution and their consequences as well as how to be able to overcome such problems.

Course Contents

The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmosphere photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulations, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen photochemicals smog, airborne load, control of automobile emissions.

Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophiction, detergents and phosphates, importance of micro-organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

Practicals

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of fluoride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. S. K. Banerji, Environmental chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental chemistry, Brooks, California

<u>Special Particles-I /Research Thesis/ Review Article</u> **<u>Code: CHEM-636.6</u>**

Credit Hours: 0+3 **Marks: 100**

Contents

1. Purification and drying of common organic solvents.
2. Setting up different apparatus for distillation and reactions.
3. Multistep synthesis of different types of organic compounds with a selection from any of the following categories
   a. Synthesis of different heterocyclic systems
   b. Different types of C-C bond formation
   c. Different types of C-heterotaom bond formation
4. Purification of synthesized compounds by different techniques.
5. Characterization and identification of synthesized/isolated by different spectroscopic methods

Recommended Books

1. Vogel, A. I., “Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis”, Longman, London.
2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., “Vogel’s Text Book of Practical Organic Chemistry”, National Book Foundation, Islamabad.
3. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., “The Systematic Identification of Organic Compounds”, John Wiley & Sons, New York.
4. Palleros, D. R., “Experimental Organic Chemistry”, John Wiley & Sons, New York.
5. Keese, R, Muller, R. K. and Toube, T. P., “Fundamentals of Preparative Organic Chemistry”, John Wiley & Sons, New York.
6. Newman, M. S., “An Advanced Organic Laboratory Course”, Macmillan, New York.
7. Mann, F. G. and Saunders, B. C., “Practical Organic Chemistry”, Longman, London.
8. Clarke, H. T., “A Handbook of Organic Analysis-Qualitative and Quantitative”, CBS Publishers & Distributors, New Delhi.

Specialization Courses

Organic Chemistry

M.Sc. 2nd–Year, Semester–IV

Specialization Paper-V: Chemistry of Heterocycles **Code: CHEM-641.6**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objective of this course is to introduce the students to heterocyclic compounds, their occurrence, nomenclature, synthesis and different types of reactions.

Course Outcomes

Students will acquire detailed knowledge about structural features of heterocyclic compounds, their uses, synthesis and reactivities which will be beneficial to students in future for designing new synthetic routes for these heterocycles and their analogues.

Course Contents

Introduction, significance and applications of heterocyclic compounds. General behavior, geometry and stereochemistry of heterocyclic compounds.

Nomenclature of heterocyclic compounds according to IUPAC, Hantzsch-Widmann-Pettersen system and SMILES. Saturated, Unsaturated and Aromatic Heterocycles, criteria of aromaticity, Tautomerism in small to large ring heterocycles, brief overview of structure, natural occurrence, physical properties, synthesis and reactivities of Furan, Thiophene, Pyrrole, Indole, Pyridine, benzofuran.

Recommended Books

1. R. K. Bansal, Hetrocyclic Chemistry, 4th ed., New Age international. Pvt. Ltd., India (2005).
2. T. Eicher and s. Hauptmann, The Chemistry of Heterocycles, George Thieme Verlag, New York (1995).
3. J. A. Joule, K. Mills, G.F. Smith, Hetrocyclic Chemistry, Stanely Thomes Publication Ltd.; (1998).
4. R. H. Acheson, An introduction to Chemistry of Heterocycles, John Wiley, New York (1987).
5. M. Samisburg, Heterocyclic Chemistry, Royal Society of Chemistry (2001)
6. H. Charles, Deputy and S. Orville, Chapman, Molecular reaction and photochemistry. Prentice Hall. New York.

Specialization Paper-VI: Oxidation Reduction **Code: CHEM-642.6**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objective of this course is to acquaint the students with different oxidation and reduction reactions that are powerful tools for different functional groups interconversions.

Course Outcomes

The students will learn in detail about different oxidation and reduction reactions, their mechanisms, different oxidizing and reducing agents, their relative reactivities and reagents for selectively oxidizing or reducing a particular r functional group in the presence of others.

Course Contents

Oxidation

Oxidation of alcohols, aldehydes and C=C & C-H bonds in hydrocarbons with chromium and manganese compounds; oxidation with Osmium tetroxide, formation of cis and trans diols, Oxidation with peracids and peroxides (oxidation of C=C, carbonyl compounds, amines, and sulphides); Oxidation with periodic acid, lead tetraacetate, mercuric acetate, and selenium dioxide), Swern oxidation and other methods of oxidation.

Reduction

Low and high pressure catalytic hydrogenation and dehydrogenation, catalysts, solvents and equipments for catalytic hydrogenation reductions, mechanism and stereochemistry, metal hydride reductions and related reactions, reagents for metal hydride reductions, modified reagents for metal hydride reductions, hydroboration and related mechanism, dissolving metal reduction and related mechanism, reactivities of various functional groups towards different methods of reductions and selective reductions.

Books Recommended

1. W. Carruthres I. Coldham. Modern methods of organic synthesis, Cambridge University press.
2. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
3. Hudlicky, Milos. "Reductions in Organic Chemistry", Ellis Horwood Limited, 1984.
4. Hudlicky, Milos. "Oxidations in Organic Chemistry", ACS monograph Series, No 186.
5. Norman, R.O.C. and. Coxon, J.M: Principles of organic synthesis, Blackie Academic and Professional, London.

Specialization Paper-VII: Named Organic reactions **Code: CHEM-643.6**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

To let the students learn about some important and well established named reactions that can be used to make C-C, C-N, C-O and other types of bonds important in organic synthesis.

Course Outcomes

The named organic reactions are well established reactions and they serve as powerful tools for making different types of bonds commonly encountered in organic molecules. This course will help the students in developing synthetic pathways.

Course Contents

Name Organic Reactions: Recent developments, mechanistic, stereochemical aspects and synthetic applications of various Name reactions: Aldol Condensation, Diels-alder reaction, Michael Addition, Robinson annulations, Knoevenagal Condensation, Clasien Condensation, Dickmann Condensation, Mannich Reaction, Wittig reaction, Peterson reaction, Heck Reaction, Suzuki reaction, Sonogashira coupling, Stille coupling, Birch reduction, Friedel Craft reaction, Husdiecker reaction and fischer indole synthesis, Bergmann,s cyclisation, Corey Kim oxidation, Cannizzaro reaction, Dakin oxidation, Kolbe Schmitt oxidation. Various rearrangement reactions like Wagner-Meerwein, Baker-Venkataraman, Hoffmann, Beckmann, Curtius, Benzil-Benzilic acid, Claisen, Favorskii.

Recommended Books

1. Mundy, B.P. Ellerd, M.G. Favalozo F.G. and Favalozo, Jr. Name Reactions and Reagents in Organic Synthesis, john Wiley, New York (2005).
2. Smith, M. B. and Marks, Advanced Organic Chemistry, Reactions, Mechanism and Structure, 5th ed., John Wiley, New York (2001).
3. R.O.S. Norman, Principles of organic synthesis, 3rd ed., Chapman-Hall, London (1993).
4. Gilchrist, T.L. and Rees, C. W., “Carbenes, Nitrenes and Arynes’ Nelson, London.
5. Clayden, J., Greeves, N., Warren, S. and Wothers, P., “Organic Chemistry”, Oxford University press New York.
6. Sykes, P. “A guide book to Mechanism in organic Chemistry” Longmann, London.
7. Carry, F. A. and Sundberg, R.J., “Advanced Organic Chemistry” Part A:” Structure and Mechanisms” oxford university press.

8. Bruchner, R., Advance Organic Chemistry-Reaction Mechanism" Harcourt Science and Technology company, New York.

Specialization Paper-VIII: Organic Spectroscopy-II Code: CHEM-644.6

Credit Hours: 3+0 Marks: 100

Course Objectives

This course is complementary to Organic spectroscopy-I and objective of this course is to let the students learn in detail about H^1 and C^{13}-NMR spectroscopy.

Course Outcomes

After completing this course and Organic spectroscopy-I, the students will be able to interpret the structures of simple organic molecules from their IR, MS and NMR spectra.

Course Contents

H^1 and C^{13}-Nuclear Magnetic Resonance spectroscopy

Introduction, basic principle, instrumentation and sample handling. CW- and FT-NMR spectrometer, Chemical shift and factors affecting chemical shift, chemical shifts equivalence and magnetic equivalence, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides), shielding, deshielding and anisotropic effect, mechanism, spin-spin splitting and coupling constant, factors affecting coupling constant; AX, AX_3, A_2X_3, AMX, ABX, AB_2, A_2B_2 systems, influence of stereochemical factors on chemical shift of protons.

Structure elucidation of organic compounds by joint interpretation of UV, IR, MS and NMR.

Recommended Books

1. Hesse, M. Meier H. and Zeeh, B. Spectroscopic methods in organic Chemistry, Georg Thieme Verlag, Stuttgart, Germany (1997).
2. Pavia, D.L. Lampan G. M. and Kirz, G.S., Introduction to spectroscopy, Brooks/Cole Thomson Learning, USAS (2001).
3. Silverstein, R.M. Webster, F.X. and Kiemle, Spectroscopic identification of organic compounds, John Wiley and Sons Inc., USA (2005).
4. Harwood, L.M. and. Claridge, T.D.W introduction to Organic spectroscopy, Oxford University Press Inc., New York (1997).

5. Friebolin, H., Basic one and two dimensional NMR spectroscopy, 4th ed., Wiley VCH, New York (2005).
6. Macomber, R.S., NMR Spectroscopy: Basic Principles and Applications, Harcourt Brace Jovanovich Publishers, San Diego (1998).
7. Younas, M., Organic Spectroscopy, Ilmi kitab Khana, Lahore (2001).

Environmental Chemistry-II **Code: CHEM-645.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry especially related to various energy resources, use of fuels and their consequences on atmospheric air and water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of various energy resources different fuels and the consequences of their uses on the environment.

Course Contents

Energy Sources

Fossil Fuels

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, and environmental problems associated with petroleum,

Soils and Mineral Resources

Estimating reserves of mineral resources of earth, extraction of metal-general principles, iron, steel, aluminium, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Other Sources

Nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

Practicals

1. Determination of nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
2. Determination of caffeine in tea leaves by HPLC.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-II/Research project/Review-article **Code: CHEM-646.6**

Credit Hours: 0+3 **Marks: 100**

Contents

1. Purification and drying of common organic solvents.
2. Setting up different apparatus for distillation and reactions.
3. Multistep synthesis of different types of organic compounds with a selection from any of the following categories
   a. Synthesis involving any name reaction
   b. Synthesis of poly-functional aliphatic and aromatic compounds
4. Identification of various classes of natural products.
5. Isolation and purification of various classes of natural products.
6. Determination of melting points of the isolated compounds.
7. Characterization and identification of synthesized/isolated by different spectroscopic methods

Recommended Books

1. Vogel, A. I., "Elementary Practical Organic Chemistry Part 3: Quantitative Organic Analysis", Longman, London.
2. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., "Vogel's Text Book of Practical Organic Chemistry", National Book Foundation, Islamabad.

3. Shriner, R. L., Hermann, C. K. F., Morrill, T. C., Curtin, D. Y. and Fuson, R. C., “The Systematic Identification of Organic Compounds”, John Wiley & Sons, New York.
4. Palleros, D. R., “Experimental Organic Chemistry”, John Wiley & Sons, New York.
5. Keese, R, Muller, R. K. and Toube, T. P., “Fundamentals of Preparative Organic Chemistry”, John Wiley & Sons, New York.
6. Newman, M. S., “An Advanced Organic Laboratory Course”, Macmillan, New York.
7. Mann, F. G. and Saunders, B. C., “Practical Organic Chemistry”, Longman, London.
8. Clarke, H. T., “A Handbook of Organic Analysis-Qualitative and Quantitative”, CBS Publishers & distributors, New Delhi.

Physical Chemistry

M.Sc. 1st –Year, Semester –I

Course Title: Mathematics for Chemists **Code: CHEM-515**

Credit Hours: 2+0 **Marks: 100**

Course Contents

Large and small numbers, exponents and radicals.

Functions and their graphs.

Trigonometric functions, graphs of logarithmic and trigonometric functions.

Differential calculus; rules for differentiations, graphical significance of differentiation, successive differentiation, partial differentiation, solution of the problems of differential calculus found in the physical chemistry text book.

Integral calculus; theory, rules, integration between limits, integration by partial fractions, solution of the problems of integral calculus found in physical chemistry text book.

Infinite series, Maclaurin series, Taylor series, Fourier series

Recommended Books

1. D.M.Hirst, Mathematics for chemists, Macmillan, London
2. J. F. Frank Ayrus, Theory and Problems of differential and integral calculus, Schuam: Outline series, McGraw Hill, Singapore.
3. J. Marsden and A. Weinstein, Calculus, the Benjamin/Cummings Pub. Co.
4. P. G. Francis, Mathematics for Chemistry, Chapman and Hall, London.

Course Title: Physical Chemistry-I **Code: CHEM-513.7**
Credit Hours: 3+1 **Marks: 100**

Course Objectives

Objective of this course is to refresh some important aspects of states of matter, atomic structure and chemical kinetics.

Course Outcomes

After taking this refreshing course, the students will be able to grasp the concepts and knowledge that will be furnished in semester II.

Course Contents

Kinetic Molecular Theory of Gases

Concept of gases and gas laws, General gas equation, Value of gas constant and its dependence on the unit of pressure and volume, Kinetic molecular theory (KMT) assumption & KM equation, Binary collisions & molecular velocities, Maxwell's Boltzmann's law of molecular velocities. Calculation of molecular velocities, Maxwell Boltzmann's law of energy distribution.

Atomic Structure

Nature of light, atomic spectra, the wave nature of particle, wave nature of particles, wave mechanics and the Schrodinger equation, a one dimensional illustration of the Schrodinger equation, a particle in one dimensional square potential well. A three dimensional illustration of the Schrödinger equation, the cubic potential well problem, the use of angular momentum to impose quantum restrictions.

Chemical Kinetics

Rate of Chemical reaction & rate law, integrated rate laws of 1^{st}- & 2^{nd}-order reactions with same and different initial concentrations of reactants. Effect of temperature on the reaction rate. Lindemann's theory of unimolecular reactions. Bimolecular collision theory.

Practicals

1. Kinetics of saponification of ethyl acetate.
2. Study of the adsorption isotherms of acetic acid-charcoal system.
3. To determine the heat of neutralization of a strong acid with a strong base.
4. To find the viscosity of the given liquid at room temperature by viscometer.
5. Determination of Refractive Index of binary mixture by Refractometry method.
6. Determination of the wavelength of maximum absorption of potassium permanganate.
7. To verify Beer Lamberts law.

Recommended Books

1. Alberty, R. A., Robert J.S. and Moungi G. B. "Physical Chemistry". 4th ed, John Wiley and Sons (2004).
2. Ball, D W., "Physical Chemistry" 1st ed., Brooks/Cole Co. Inc. (2003).
3. Engel, Thomas and .Reid p., "Thermodynamics, Statistical Thermodynamics and Kinetics" 1st ed., Benjamin Cummings (2006).
4. James K. and Wothers, P., "Why Chemical Reactions Happen". Oxford University Press (2003).
5. Smith, E. Brain, "Basic Chemical Thermodynamics" 5th ed., Imperial College Press (2004).
6. Stephen B. R., Rice S. A. and Roses J., "Physical Chemistry"2nd ed., Oxford University Press (2000).
7. Jurg W., "Basic Chemical Thermodynamics" W. A. Banjamin (1969).
8. Chorkendorff, I. and Niemantsverdriet, J.W. "Concept of Modern Catalysis and Kinetics" 1st ed., John Wiley and Sons (2003).
9. Espenson, J. H. "Chemical Kinetics and Reaction Mechanism" 2nd ed., McGraw Hill (2002).
10. Berry R. S., Stuart A.R., and Roses J. "Physical and Chemical Kinetics" 2nd ed.,Oxford University Press (2000).
11. Helpern Arthur M., "Experimental Physical Chemistry: A Laboratory Textbook" 2nd ed., Prentice Hall (1997).
12. Bassette J., Denney C., Jeffery G. H. and Mendham J. "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society. 4th ed. (1978).
13. Daniel, F., "Experimental Physical Chemistry" McGraw Hill (1962).
14. Shoemaker, D., "Experimental Physical Chemistry" McGraw Hill (1989)

Physical Chemistry

M.Sc. 1st –Year, Semester –II

Course Title: Physical Chemistry-II **Code: CHEM-523.7**

Credit Hours: 3+1 **Marks: 100**

Course Objectives

Objective of this course is to introduce some important aspects of chemical thermodynamics, equilibrium and solution chemistry.

Course Outcomes

After taking this course, the students will be able to understand concepts relevant to of chemical thermodynamics, equilibrium and solution chemistry.

Course Contents

Chemical Thermodynamics

1^{st} law of thermodynamics, Pressure-volume work & enthalpy of a system, heat capacity of gas at constant volume & constant pressure, 2^{nd} law of thermodynamics & entropy, Free energy Change, dependence of free energy on temperature and volume. Relation of free energy with equilibrium constant, Clausius-Clapeyron's equation. Partial molar quantities & Chemical potential.

Chemical Equilibrium

Types of equilibrium, Characteristic of chemical equilibrium, Law of mass action, Le-chatelier's principle, Equilibrium constant and the effect of variable e.g temperature, concentration and pressure on equilibrium constant ,Relationship between Kc, Kp, Kx and Kn, Temperature and chemical equilibrium-The Vant Hoff equation.

Solution Chemistry

Ideal & non ideal solution, Solubility of gases and Henry's law, Heat, Entropy and Free energy of mixing of ideal solution, colligative properties and lowering of vapour pressure, elevation in boiling point, depression in freezing point, osmotic pressure and their applications in determination of molecular masses. Salt hydrolysis and determination of hydrolysis constant (K), Statistical thermodynamics of ideal solution.

Practicals

1. Determination of the wavelength of maximum absorption of potassium permanganate.
2. To verify Beer Lamberts law.
3. Conductance measurement of different samples.
4. Conductometric titrations.
5. Potentiometric titrations.
6. Buffer solution and pH measurement.
7. Measurement of standard e.m.f of a cell.
8. Determination of equilibrium constant from emf measurement.
9. Molecular weight determination by cryoscopic method.
10. Molecular weight determination by ebullioscopic method.

Recommended Books

1. Albert R.A., Robert J.S. and Moungi G.B. "Physical Chemistry". 4 ed., John Wiley and Sons (2004).
2. Ball D.W. "Physical Chemistry" 1 ed., Brooks/Cole Co. Inc. (2003).
3. Bassetts J., Denney C., Jeffery G.H. and Mendham J. "Vogel's Textbook of Quantitative
4. Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society. 4th ed. (1978).
5. Hatch R.C. "Experimental Chemistry" van Nostrand Reinhold Company (1972).

Specialization Courses

Physical Chemistry

M.Sc. 2nd –Year, Semester –III

Specialization Paper-I: Quantum Chemistry **Code: CHEM-631.7**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objective of this course is to let the students understand the basis of spectroscopic techniques and other quantized processes by learning the concepts in the field of quantum chemistry.

Course Outcomes

At the end of this course, the students are expected to have acquired knowledge of the field of quantum chemistry which will help them understand courses relevant to spectroscopy.

Course Contents

Limitation of classical mechanics, wave and particle nature of matter, de-Broglie's equation, Heisenberg's uncertainty principle, concept of quantization of energy, Operators and their properties. Types of operators, Linear operator, Commutator operator, Vector operator, Laplacian operator, Hemaltonian operator, Hermition operator, Angular momentum. Postulates of quantum chemistry, Observable, Eigen function and Eigen values, general wave equation, Schrödinger wave equation (Time dependent + Time independent). Free particle, Particle in one dimensional box, three dimensional box,, Simple harmonic oscillator, Treatment of simple harmonic oscillator, Selection rules for simple harmonic oscillator, comparison between general wave equation and Schrödinger wave equation, Complex number, diatomic rigid rotor, Treatment of rigid rotor, Selection rules of rigid rotor. Valence bond and molecular orbital theories.

Books Recommended

1. Micheal D.F. "Elements of Quantum Mechanics" Oxford University Press (2005).
2. Griffiths, David J., "Introduction to Quantum Mechanics" 2 ed., Prentice Hall (2004).
3. Hayward, David O., "Quantum Mechanics for Chemists" 1 ed., John Wiley (2003).
4. House, James E., "Fundamentals of Quantum Mechanics" 2 ed., Elsevier-Academic Press

Specialization Paper-II: Electrochemistry and Photochemistry **Code: Chem-632.7**
Credit Hours: 3+0 **Marks: 100**

Course Objectives

Objective of this course is to let the students understand the concepts in the field of electrochemistry and photochemistry.

Course Outcomes

At the end of this course, the students are expected to have acquired knowledge of the field of electrochemistry and photochemistry.

Course Contents

Electrochemistry

An introduction to electrochemistry, Ohm's law, conductance, molar conductance and equivalent conductance, Kohlraush's law of independent migration of ion, Activity and activity coefficient, Debye-Huckel Theory, Electrochemical cells, Voltaic cell, Electrolytic cell, Cell notation, Types of electrochemical cell (Concentration cell & Redox cell), Types of electrodes, Standard Electrode, SHE, Calomel electrode, Ag-AgCl electrode & Amalgam electrode. Chemical reactions and Electrode potential, Nernst's equation and its application, electrochemical series and its application.

Photochemistry

Scope of photochemistry. Photochemical reactions and their quantum yields, Energy transfer in photochemical reaction. Kinetics of photochemical reaction (Absorption of light), Laws of absorption of radiation, Laws of photochemistry. Einstein's law of photochemical equivalence. Radioative and nonradioative process (fluorescence, phosphorescence, internal conversion, intersystem crossing, quenching process),. Flash photolysis. Techniques in photochemistry.

Books Recommended

1. Calvert J.G. and Pitts J.N. "Photochemistry" John Wiley, New York (1966).
2. Albert R.A., Robert J.S. Moungi G.B. "Physical Chemistry". 4 ed.John Wiley & Sons (2004).
3. Alberty R. "Physical Chemistry" 17th ed., John Wiley and Sons (1987).
4. Atkins, P.W. "Physical Chemistry" 6th ed., W.H. Freeman and Co. New York (1998).
5. Laidler K.J., John H.M. and Bryan C.S. "Physical Chemistry" 4th ed., Houghton Mifflin Publishing Company Inc.(2003).
6. Ball D.W. "Physical Chemistry" 1 ed., Brooks/Cole Co. Inc. (2003).
7. Bockris J.O.M. and Reddy A.K.N. "Modern Electrochemistry" Vol-I and II, 4th ed. Plenum Press, London (2003).
8. Muhammad M. and Amjad M. "Principles of Electrode Kinetics" Rooha Printers, Lahore

<u>Specialization Paper-III: Polymer and Colloidal Chemistry</u> **<u>CHEM-633.7</u>**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

The major objective of this course is to let the students learn about the different classes of polymers, the chemical nature, structures and physical properties of polymers. Emphasis will also be given to the some concepts of colloidal chemistry.

Course Outcomes

After completing this course the students would have acquired knowledge about the polymers, their different classes, chemical nature, structures and physical properties as well as some concepts of colloidal chemistry.

Course Contents

Polymer Chemistry

Introduction to Polymers, Types of polymers i.e. Natural and synthetic Polymers, Types of polymerizations i.e. Addition polymerization, step-growth polymerization, Ionic polymerization, Copolymerization, Emulsion Polymerization, Physical aspects of polymers, Molecular Weight of Polymers: Number average and Weight average molecular weight, Distribution, Degree of polymerization, methods of determination of molecular weight (viscosity, osmometry, light scattering method, Diffusion, Sedimentation, Optical rotation method), Kinetics of polymerization, Physical properties of polymers (Crystallinity, Plasticity, Elasticity).

Colloidal Chemistry

Introduction of colloids and its classification, Preparation, purification and properties of colloidal solution, Stability of colloidal dispersion, surface active agents, micelle formation and cleaning action, applications of colloidal solution. Emulsion its types, factors affecting emulsion stability, properties of emulsions its applications.

Recommended Books

1. Hiemenz P.C. “Polymer Chemistry: The Basic Concepts” Marcel Dekker (1984).
2. Stevens M.P. “Polymer Chemistry: An Introduction” Oxford University Press (1999).
3. Allcock H.R. and Lampe F.W. “Contemporary Polymer Chemistry” Prentice-Hall (1990).
4. Rudin “The Element of Polymer Science and Engineering” Academic Press (1990).
5. Sperling L.H. “Introduction to Physical Polymer Science” Wiley Interscience (1992).
6. Boyd R.H. and Phillips P.J. “The Science of Polymer Molecules” Cambridge (1993).
7. Malcolm P.S. “Polymer Chemistry” Oxford University Press (2005).
8. Ravue, “Principles of Polymer Chemistry” 2 ed. Plenum Publishers (2000).

Specialization Paper-IV: Nuclear Chemistry   Code: CHEM-634.7

Credit Hours: 3+0   Marks: 100

Course Objectives

The major objective of this course is to let the students learn about the fundamentals of nuclear chemistry and other relevant concepts.

Course Outcomes

After completing this course the students would have acquired knowledge about radiochemistry, radioactivity, radioisotopes, properties & function of nuclear radiation, the chemistry of radio isotopes, nuclear reactors and nuclear reactions and their applications.

Course Contents

Fundamentals of Nuclear Chemistry

Elemental particles, isotopes, isobars, isotones, Atomic nucleus, Nuclides, Nuclear forces, Nuclear stability (Neutron-Proton ratio, Magic number, Mass defect and nuclear binding energy), nuclear models (shell + liquid drop model).

Radioactivity

Natural radioactivity, Nuclear Reaction Cross Section, Detection and measurement of radioactivity, Modes of decay, Kinetics of radioactive decay, Activity of radioactive substance (Calculation of half-life, Calculation of sample left after T time, Average life, Radioactive equilibrium), Transmutation and artificial radioactivity, Application of Radioactivity (Use of radioisotope as tracer, uses of radioisotopes in reaction mechanism, and Radioactive dating), Group displacement law, Radioactive Disintegration series, Nuclear reactions and nuclear energy (Fission reaction, Fusion reaction), Nuclear Reactors, Atomic bomb, Hydrogen bomb.

Books Recommended

1. Albert R.A., Robert J.S. and Moungi G.B. “Physical Chemistry”. 4 ed., John Wiley and Sons (2004).
2. Ball D.W. “Physical Chemistry” 1 ed., Brooks/Cole Co. Inc. (2003).
3. Vertes A. “Basics of Nuclear Science” Kluwer Academic Publisher London (2003).
4. Friedlander G. and Kennedy J.W. “Nuclear and Radiochemistry” 3 ed., Wiley, New York (1981).

Course Title: Environmental Chemistry-I **Code: CHEM-635.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry, atmospheric and air pollution, water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of environmental pollution and their consequences as well as how to be able to overcome such problems.

Course Contents

The atmosphere and air pollution

Structure and properties of the atmosphere, temperature inversion and air pollution, atmosphere photochemistry, possible depletion of stratospheric ozone, natural vs polluted air, particulate matter, analysis and control of particulations, sulphur oxides, effects of sulphur dioxides and particulates, other industrial air pollutants, carbon monoxide, oxides of nitrogen photochemicals smog, airborne load, control of automobile emissions.

Water and water treatment

Unique physical and chemical properties of water, criteria of water quality, natural water-eutrophiction, detergents and phosphates, importance of micro-organisms in water purification, primary and secondary treatment of water, advanced waste water treatment, removal of nitrogen and phosphorus, sources of industrial water pollution, heavy metals and mercury.

The green revolution

Pest control, pesticides, toxicity of pesticides, pest management.

Practicals

1. Determination of phenol contents in a given sample by spectrophotometric method.
2. Determination of lead in polluted water sample by spectrophotometric method.
3. Determination of fluoride in water sample by spectrophotometric method.
4. Determination of organic matter in the given sample by spectrophotometric method.
5. Determination of sulphide in the given sample by spectrophotometric method.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. S. K. Banerji, Environmental chemistry, Tata Publisher, Delhi.
5. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Course Title: Special Practical-I/Research Project/Review-article CHEM-636.7
Credit Hours: 0+3 Marks: 100

Special Practicals

Specific experiments may be set making use of the following instruments depending upon their availability. Special experiments may also be designed for which a specimen list of instruments is given below. For the innovative designing of experiments the Journal of Chemical Education may be consulted.

1. Determination of partial molar quantities.
2. Determination of free energy changes, standard free energies.
3. Verification of Kohlrausch law.
4. Study of temperature dependence of electrode potentials.
5. Determination of heat of solution, ionic reactions and other experiments from thermochemistry.
6. Determination of molecular weight of a polymer by viscosity method.
7. Precipitation value of electrolytes.
8. Measurement of cyclic voltammogram of an organic compound and its interpretation.
9. Determination of dipole moment of an organic liquid.

Books Recommended

1. Braun R.D. and Walters F. “Application of Chemical Analysis” (1982).
2. David P. “Experiments in Physical Chemistry” 5 ed. (1989).
3. James A.M. and Prichard F.E. “Practical Physical Chemistry” 3 ed. Longman (1974).
4. Shoemaker D.P., Garland C.W. and Nibler J.W. “Experiment IN Physical Chemistry” McGraw Hills, New York (1989).
5. Shoemaker C.W., Nibler G.J.W. and Christian G.D. “Analytical Chemistry” 6 ed. (2004).
6. James A.M. and Prichard F.E. “Practical Physical Chemistry” 3 ed. Longman (1974).
7. Mowry S. and Ogren P.J., J. Chemical Education, **76**(7) (1999).

Specialization Courses

Physical Chemistry

M.Sc. 2nd –Year, Semester –IV

Specialization Paper-V: Molecular Spectroscopy **Code: CHEM-641.7**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

To furnish a detailed knowledge of different molecular spectroscopic techniques and their applications.

Course Outcomes

After completing this course, the students are expected to have acquired a detailed understanding off the different molecular spectroscopic techniques.

Course Contents

Molecular Spectroscopy

Electromagnetic radiation, its interaction with matter, Absorption/emission of radiation, different spectral regions.

Microwave Spectroscopy

Rotational motion of molecules and their classification, moment of inertia, rigid and non-rigid rotor, quantum equations, selection rules, Spectra, Energy level diagrams, Bond length determination for Linear and symmetric top molecules.

Infra-red Spectroscopy

Vibrational motion of molecule, Degree of freedom, Harmonic and inharmonic oscillator, Their quantum equations, Selection rules, Spectra and energy level diagram for linear and symmetric top molecules, bond length determination, Born oppenheimer approximation.

Rotational-Vibration Spectra

Vibrating rotor, Harmonic and inharmonic, Quantum equations, Selection rules, Energy level diagram for linear and symmetric top molecule

Electronic Spectra

Introduction to electronic spectroscopy, Electronic transitions, Vibrational fine structure of electronic spectra, Rotational fine structure of electronic spectra, Frank-Condon's principle.

Introduction to symmetry of molecules & Group Theory

Books Recommended

1. Whiffen D. H. "Spectroscopy" Longmans Green and Co.: London, (1966).
2. Barrow G. "Molecular Spectroscopy" McGraw Hill (1962).
3. Becker E. D. "High Resolution NMR; Theory & Chemical Application", New York, Academic Press (1980).
4. Graybal J.D. "Molecular Spectroscopy", New York, McGraw-Hill (1988).

Specialization Paper-VI: Statistical Thermodynamics **Code: CHEM-642.7**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

The major objective of this course is to introduce some concepts of statistical thermodynamics e.g. the concept of probability, partition functions, various thermodynamic functions like, enthalpy, entropy, Gibbs free energy etc. to the students.

Course Outcomes

After successful completion of this course, the students would have acquired knowledge of various concepts of thermodynamics and thermodynamic functions.

Course Contents

Statistical Thermodynamics

Probability concepts. Partition functions. The relationship of partition function to the various thermodynamic functions. (translational energy, vibrational energy, rotational energy, entropy, heat, enthalpy, pressure, Gibbs free energy, entropy of mixing of gasses, heat capacity), Translational, vibrational and rotational partition function and equilibrium constant. Relationship between entropy and probability. Theories of heat capacities of solids i.e. The Einstein model and The Debye model.

Books Recommended

1. Gasser R.P.H. and Richards W.G. "Entropy and Energy Levels" Oxford University Press (1974).
2. Wayatt P.A.H. "The Molecular Basis of Entropy and Chemical Equilibrium" Royal Institute of Chemistry London (1971).

3. Smith E.B. “Basic Chemical Thermodynamics” 4 ed. Oxford University Press (1990).
4. Seddon J.M. and Gale J.D. “Thermodynamics and Statistical Mechanics” Royal Soc Chem, UK (2002).
5. Aston J.G. and Fritz J.J. “Thermodynamics and Statistical Thermodynamics” JohnWiley, New York (1987).

Specialization Paper-VII: Surface Chemistry and Catalysis Code: CHEM-643.7

Credit Hours: 3+0 Marks: 100

Course Objectives

The major objective of this course is to introduce some concepts of surface chemistry e.g. adsorption and their types, factors that affect adsorption, various adsorption isotherms etc. and catalysis.

Course Outcomes

After successful completion of this course, the students would have acquired knowledge of different concepts related to surface chemistry and their applications in the field of catalysis.

Course Contents

Surface Chemistry

Adsorption, types of adsorption, Factors effecting adsorption of gases on solid surface, Comparison between physiosorption and Chemisorption, Characteristic of adsorption. Adsorption isotherm, Freundlich adsorption isotherm, Langmuir adsorption isotherm, Langmuir adsorption isotherm applied to adsorption with dissociation, B.E.T adsorption isotherm, surface area determination using BET isotherm, Gas adsorption isotherm or Henry equation, Surface active and surface inactive substances & Gibbs adsorption isotherm, Adsorption from solution at liquid surfaces. Adsorption from solution on solid surface, factor effecting adsorption from solution at liquid surface, applications of adsorption.

Catalysis

Homogeneous & Heterogeneous catalysis, Application of heterogeneous catalysis, Enzyme catalysis, Mechanism of enzyme catalysis (Key-lock model & Michaelis–Menten kinetics).

Books Recommended

1. Segal H. “Enzyme Kinetics” John Wiley New York (1975).
2. Schlutz A.R. “Enzyme Kinetics” (1964) Cambridge University Press England

Specialization Paper-VIII: Chemical Kinetics **Code: CHEM-644.7**

Credit Hours: 3+0 **Marks: 100**

Course Objectives

Main objectives of this course is to let the student understand the principles of chemical kinetics and their applications for different kinds of reactions.

Course Outcomes

After completing this course, the students would have acquired a detailed knowledge of the kinetics, their role in determination of reactions mechanisms and would understand the kinetics of different types of reactions.

Course Contents

Kinetics of 3rd order reaction and its different cases, Methods of determination of order of chemical reaction, Correlation between physical properties and concentration. Theory of absolute reaction rate (Transition state theory), Comparison of collision and absolute reaction theories, Steady state approximation.

Kinetics of reversible/opposing reactions, parallel reactions, consecutive reactions & chain Reaction (H_2 + Br_2, HBr). Effects of salt on reaction in solution (Primary & secondary salt effect), Thermodynamic formulation of reaction rates. Calculation of entropy and enthalpy changes. Thermal decomposition of nitrogen pentoxide.

Recommended Books

1. Albery J., Electrode Kinetics, Clarendon, Oxford (1975).
2. Espenson, J. H. Chemical Kinetics and Reaction Mechanism 2 ed., McGraw Hill London (2002).
3. Espenson J.H. “Chemical Kinetics and Reaction Mechanisms” 2 ed. McGraw Hill, New York (1995).
4. Frost A.A. and Pearson R.G. “Kinetic and Mechanism” 2 ed. John Wiley and Sons Inc, New York (1961).
5. Laidler K.J. “Chemical Kinetics” 3 ed. Pearson Education Company, New York (1987).

Environmental Chemistry-II **Code: Chem-645.4**

Credit Hours: 2+1 **Marks: 100**

Course Objectives

To acquaint the students with fundamental principles of environmental chemistry especially related to various energy resources, use of fuels and their consequences on atmospheric air and water pollution and water purification.

Course Outcomes

After taking this course, the students will have a sound knowledge of various energy resources, different fuels and the consequences of their uses on the environment.

Course Contents

Energy Sources

Fossil Fuels

Origin and development of coal: Origin and reserves of petroleum and natural gas, composition and classification of petroleum, refining, and environmental problems associated with petroleum,

Soils and Mineral Resources

Estimating reserves of mineral resources of earth, extraction of metal-general principles, iron, steel, aluminum, copper and other metals, sulphur and nitrogen. Organic matter in soil, soil nutrients, ion exchange in soils, solid pH and nutrients availability.

Other Sources

Nuclear fission reactors, solar energy, power synthesis, tidal and geothermal energy, synthetic chemical fuels, the H economy, electrochemical energy conversion, conservation of free energy, the energy balance of the earth.

Practicals

1. Determination of nicotinamide in acid and cigarette smoke by HPLC using reverse phase chromatography.
2. Determination of caffeine in tea leaves by HPLC.

Books Recommended

1. Anil Kumar, Environmental chemistry, Wiley Eastern, New Delhi
2. J. W. Moore & E. A. Moore, Environmental chemistry, Academic Press, New York.
3. S. K. Banerji, Environmental chemistry, Prentice Hall, Delhi.
4. Staneley E. Manahan, Environmental chemistry, Brooks, California.

Special Practicals-II/Research project/Review-article Code: CHEM-646.7

Credit Hours: 0+3 Marks: 100

Specific experiments may be set making use of the following instruments depending upon their availability. Special experiments may also be designed for which a specimen list of instruments is given below. For the innovative designing of experiments the Journal of Chemical Education may be consulted.

1. Evaluation of pKa value an indicator by spectrometric method.
2. Sugar analysis and inversion studies by polarimetry.
3. Study of isotherms and experiments of surface chemistry.
4. Kinetics of fading of phenolphthalein in alkaline solution.
5. Study of the effect of pH on the rate constant of the reaction between iodide and persulphate ions.
6. Kinetics of autocatalytic reaction between permanganate and oxalate ions.
7. Determination of energy of activation of the reaction between similar chargers of ions.
8. Kinetics of the reaction between methyl orange and peroxodisulphate ions in presence of bromide ions.

Books Recommended

1. Braun R.D. and Walters F. "Application of Chemical Analysis" (1982). th
2. David P. "Experiments in Physical Chemistry" 5 ed. (1989). rd
3. James A.M. and Prichard F.E. "Practical Physical Chemistry" 3 ed. Longman (1974).
4. Shoemaker D.P., Garland C.W. and Nibler J.W. "Experiment IN Physical Chemistry" McGraw Hills, New York (1989).
5. Shoemaker C.W., Nibler G.J.W. and Christian G.D. "Analytical Chemistry" 6 ed. (2004).
6. James A.M. and Prichard F.E. "Practical Physical Chemistry" 3 ed. Longman (1974).
7. Mowry S. and Ogren P.J., J. Chemical Education, **76**(7) (1999).