FACULTY OF SCIENCES
DEPARTMENT OF CHEMISTRY

B.Sc. (Hons.) Chemistry

w.e.f. July 2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its Scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

HUMANITIES AND SCIENCES DEPARTMENT

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

B.Sc. (Hons.) Chemistry

Chemistry is one of the branches of science dealing with the structure and behavior of nature with molecular perspective to understand scientific reasoning. The course includes many concepts, such as Nano chemistry, supramolecular chemistry, quantum chemistry, biological chemistry etc. Chemistry is fast moving from being a descriptive field to an exact science, a transition that will increasingly require input from all branches of science.

Apart from chemistry, students will also be able to learn Physics, Mathematics and other subjects in this course. In addition, the well-equipped teaching and research laboratories will facilitate the students to develop experimental, analytical and conceptual skills and build their interest in the field of research.

The program and the curriculum are ideally designed for academic as well as research growth.

PROGRAM OBJECTIVES

- Producing graduates who are well grounded in the fundamentals of Chemistry and acquisition of the necessary skills, in order to use their knowledge in Chemistry in a wide range of practical application.
- Help to become creative chemist to become successful in a wide range of professions where logical approach is required.
- To create general understanding about different chemical interactions to build a solid foundation in the subject.
- Bachelor of Science in chemistry gives multiple career options for the students to their interest.
- To familiarize the student with different instruments like U.V. spectrophotometer, refractometer, pH meter polarometer

It also promotes research and creative activities of students by providing exposure to the realm of physical science and technical expertise. The B.Sc. (Hons.) programme in chemistry is designed to provide a thorough basic knowledge in Chemistry at the under graduate level. Apart from the general topics in Chemistry, many of the new topics included in the syllabus keeps the students abreast with the latest developments taking place in the field. Also the experiments chosen for each practical course is such that they bring out the concept of application of the theory in a practical situation. It also helps in creative thinking and self-learning.

PROGRAM OUTCOMES

After completion of the program, the students will:

- Have sufficient understanding of the basic concepts in chemical processes.
- Be able to learn computer Science/Mathematics/Chemistry/Electronics as an elective subject apart from Chemistry as a major subject.
- Be able to communicate effectively by oral, computing and graphical means.
- Become successful professionals by demonstrating logical and analytical thinking abilities.
- Enable to describe and apply the basic principles of chemistry and to carry out practical techniques important in chemical analysis.
- Provide a systematic understanding of core chemistry concepts, principles and theories along with their applications.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

STRUCTURE AND SYLLABI OF B.Sc. (Hons.) CHEMISTRY (6 SEMESTER COURSE)

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BCH 101	Inorganic Chemistry - I	4	0	0	25	75	100	4	DCC
BCH 102	Physical Chemistry - I	4	0	0	25	75	100	4	DCC
BCH 103	Inorganic Chemistry – I (Lab)	0	0	4	15	35	50	2	DCC
BCH 104	Physical Chemistry - I (Lab)	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BENG 101	English	2	0	0	25	75	100	2	AEC
Open Elective Course (OEC-I) * - Select 1-paper & respective Lab(if any) of the following 4-disciplines									
OMTH 101	Calculus/	5	1	0	25	75	100	6	OEC
OCSC 101	Introduction to Programming	4	0	0	25	75	100	4	OEC
OPHY 101	Electricity & Magnetism	4	0	0	25	75	100	4	OEC
OCSC 102	Introduction to Programming (Lab)	0	0	4	15	35	50	2	OEC
OPHY 102	Electricity & Magnetism (Lab)	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC)**- Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**20**	

*** OEC- student has to choose one subject out of four disciplines and will be continue from Sem-I to Sem-IV.**

**The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university. (Instructions to students overleaf)
L – Lecture; T - Tutorial; P - Practical

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BCH 201	Organic Chemistry - I	4	0	0	25	75	100	4	DCC
BCH 202	Physical Chemistry - II	4	0	0	25	75	100	4	DCC
BCH 203	Organic Chemistry – I Lab	0	0	4	15	35	50	2	DCC
BCH 204	Physical Chemistry – II Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BEVS 101	Environmental Science	2	0	0	25	75	100	2	AEC
Open Elective Course (OEC-2) - Select 1- paper & respective Lab(if any) of the following disciplines									
OMTH 201	Linear Algebra	5	1	0	25	75	100	6	OEC
OCSC 201	Introduction to Database System	4	0	0	25	75	100	4	OEC
OPHY 201	Mechanics	4	0	0	25	75	100	4	OEC
OCSC 202	Introduction to Database System (Lab)	0	0	4	15	35	50	2	OEC
OPHY 202	Mechanics (Lab)	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Mandatory Audit Course (MAC)									
XXX	Audit Course#	2	0	0	25	75	100	0	AUD
Total Credits								**20**	

As per the list provided by University site

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BCH 301	Inorganic Chemistry - II	4	0	0	25	75	100	4	DCC
BCH 302	Organic Chemistry - II	4	0	0	25	75	100	4	DCC
BCH 303	Physical Chemistry - III	4	0	0	25	75	100	4	DCC
BCH 304	Inorganic Chemistry – II Lab	0	0	4	15	35	50	2	DCC
BCH 305	Organic Chemistry – II Lab	0	0	4	15	35	50	2	DCC
BCH 306	Inorganic Chemistry – II Lab	0	0	4	15	35	50	2	DCC
Skill Enhancement Course (SEC) – Select 1-paper out of the following									
SECC 01	Basic Analytical Chemistry	2	0	0	25	75	100	2	SEC
SECC 02	Green Chemistry	2	0	0	25	75	100	2	SEC
SECC 03	Pharmaceutical chemistry	2	0	0	25	75	100	2	SEC
SECC 04	Pesticide Chemistry	2	0	0	25	75	100	2	SEC
SECC 05	Fuel Chemistry	2	0	0	25	75	100	2	SEC
Open Elective Course (OEC-3) - Select 1- paper & respective Lab(if any) of the following disciplines									
OMTH 301	Differential Equations	5	1	0	25	75	100	6	OEC
OCSC 301	Computer Networks & Internet Technology	4	0	0	25	75	100	4	OEC
OPHY 301	Waves & Optics	4	0	0	25	75	100	4	OEC
OCSC 302	Computer Networks & Internet Technology (Lab)	0	0	4	15	35	50	2	OEC

OPHY 302	Waves & Optics (Lab)	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**26**	

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BCH 401	Inorganic Chemistry - III	4	0	0	25	75	100	4	DCC
BCH 402	Organic Chemistry - III	4	0	0	25	75	100	4	DCC
BCH 403	Physical Chemistry - IV	4	0	0	25	75	100	4	DCC
BCH 404	Inorganic Chemistry – III Lab	0	0	4	15	35	50	2	DCC
BCH 405	Organic Chemistry – III Lab	0	0	4	15	35	50	2	DCC
BCH 406	Physical Chemistry – IV Lab	0	0	4	15	35	50	2	DCC
Skill Enhancement Course (SEC) – Select 1-paper out of the following (not opted in Sem-III)									
SECC 01	Basic Analytical Chemistry	2	0	0	25	75	100	2	SEC
SECC 02	Green Chemistry	2	0	0	25	75	100	2	SEC
SECC 03	Pharmaceutical chemistry	2	0	0	25	75	100	2	SEC
SECC 04	Pesticide Chemistry	2	0	0	25	75	100	2	SEC
SECC 05	Fuel Chemistry	2	0	0	25	75	100	2	SEC
Open Elective Course (OEC-3) – Select 1- paper & respective Lab(if any) of the following disciplines									
OMTH 401	Numerical Methods	5	1	0	25	100	100	6	OEC
OCSC 401	Information Security	4	0	0	25	75	100	4	OEC
OPHY 401	Thermal Physics & Statistical Mechanics	4	0	0	25	75	100	4	OEC
OCSC 402	Information Security (Lab)	0	0	4	15	35	50	2	OEC
OPHY 402	Thermal Physics & Statistical Mechanics (Lab)	0	0	4	15	35	50	2	OEC

Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**26**	

SEMESTER V

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BCH 501	Organic Chemistry - IV	4	0	0	25	75	100	4	DCC
BCH 502	Physical Chemistry - V	4	0	0	25	75	100	4	DCC
BCH 503	Organic Chemistry – IV Lab	0	0	4	15	35	50	2	DCC
BCH 504	Physical Chemistry – V Lab	0	0	4	15	35	50	2	DCC
Discipline Elective Course (DEC) select any 2-papers & respective labs out of the following 3-papers									
DECC 501	Analytical Chemistry	4	1	0	25	75	100	4	DEC
DECC 502	Polymer Chemistry	4	0	0	25	75	100	4	DEC
DECC 503	Cement Chemistry	4	0	0	25	75	100	4	DEC
DECC 504	Analytical Chemistry Lab	0	0	2	15	35	50	2	DEC
DECC 505	Polymer Chemistry Lab	0	0	2	15	35	50	2	DEC
DECC 506	Cement Chemistry Lab								
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**24**	

SEMESTER VI

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory 2-Papers									
BCH 601	Inorganic Chemistry - IV	4	0	0	25	75	100	4	DCC
BCH 602	Organic Chemistry - V	4	0	0	25	75	100	4	DCC
BCH 603	Inorganic Chemistry – IV Lab	0	0	4	15	35	50	2	DCC
BCH 604	Organic Chemistry – V Lab	0	0	4	15	35	50	2	DCC
Discipline Elective Course (DEC) – Select any 2-papers & respective lab (if any) out of the following 3-papers									
DECC 501	Medicinal Chemistry	4	0	0	25	75	100	4	DEC
DECC 502	Molecular Modeling & Drug Design	4	0	0	25	75	100	4	DEC
DECC 503	Research Methodology for Chemistry	5	1	0	25	75	100	6	DEC
DECC 504	Medicinal Chemistry	0	0	2	15	35	50	2	DEC
DECC 505	Molecular Modeling & Drug Design	0	0	2	15	35	50	2	DEC
Total Credits								**24**	

Grand Total Credits: 144/146 [140 + 4/6 (for MOOC Course)]

NOTE: 1. Discipline Elective Course (DEC) papers may be added or deleted as per UGC guidelines.
2. Skill Enhancement Course (SEC) papers may be added or deleted as per UGC guidelines.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme	Duration
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 25% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

Grading Scheme

*Percentage	Grade	Grade Points	Category
≥90	O	10	Outstanding
≥ 80 to < 90	A+	9	Excellent
≥ 70 to < 80	A	8	Very Good
≥ 60 to < 70	B+	7	Good
≥ 50 to < 60	B	6	Above average
≥ 45 to < 50	C	5	Average
≥ 40 to < 45	P	4	Pass
< 40	F	0	Fail
	AB	0	Absent

***Lower limit included, upper limit excluded**

The multiplication factor for CGPA is 10

1. Automatic Rounding
2. Average difference between actual percentage and CGPA percentage ± 2.5%
3. Worst case difference between actual percentage and CGPA percentage ± 5% if somebody in all the 8 semesters in all the exams (around 75 in numbers) consistently scores at the bottom of the range, say 55 of 55-65 which is a very remote possibility.

SEMESTER I

Syllabus of B.Sc. (H) Chemistry

Semester I

Paper: Inorganic Chemistry - I
Paper Code: BCH 101

No. of Credits: 4
L: 4, T: 0
Theory: 60 Lectures

Sessional: 25
Theory Exam: 75
Total: 100

COURSE OBJECTIVE
The objective of the course is to make the students understand the basic concept of atom and atomic structure, periodic properties of elements and chemical bonding.

Atomic Structure: Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance.

Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau principle and its limitations. **(14 Lectures)**

Periodicity of Elements: Brief discussion of the following properties of the elements, with reference to *s* & *p*-block and the trends shown:

1. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
2. Atomic and ionic radii.
3. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods.
4. Electron gain entahlpy and trends in groups and periods.
5. Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. **(16 Lectures)**

Chemical Bonding:

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I_3^-, BrF_2^+, PCl_6^-, ICl_2^- ICl_4^- and SO_4^{2-}, Multiple bonding and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. **(30 Lectures)**

Referred Books:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Course Outcomes: After the completion of the course, students will be able to,

- Learn basic concept of atom and its structure in detail.
- Arrangement of electrons in atom.
- Concept of s, p, d and f orbitals and their shape using.
- Understand nature of chemical bonding and concept of molecular orbitals.

Paper: Inorganic Chemistry – I Lab
Paper Code: BCH-103

No. of Credits: 2 **Internal: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
60 Periods **Total: 50**

(A) Titrimetric Analysis

(i) Calibration and use of apparatus
(ii) Preparation of solutions of titrants of different Molarity/Normality

(B) Acid-Base Titrations

Principles of acid-base titrations to be discussed.

(i) Estimation of sodium carbonate using standardized HCl.
(ii) Estimation of carbonate and hydroxide present together in a mixture.
(iii) Estimation of carbonate and bicarbonate present together in a mixture.
(iv) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

Principles of oxidation-reduction titrations (electrode potentials) to be discussed.

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator (diphenylamine, N-phenylanthranilic acid) and discussion of external indicator.

Referred Books:

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

Paper: Physical Chemistry - I

Paper Code: BCH-102

No. of Credits: 4
L: 4, T: 0
Theory: 60 Lectures

Sessional: 25
Theory Exam: 75
Total: 100

COURSE OBJECTIVE

The objective of the course is to make the students understand the different states of matter and various laws governing the properties of solid, liquid and gaseous state. Emphasis will also be on the basic concept of ionic equilibrium and its applications.

Gaseous state: Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states. **(18 Lectures)**

Liquid state: Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. **(6 Lectures)**

Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

(16 Lectures)

Ionic equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. **(20 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Learn the states of matter in detail.
- Laws governing the solid, liquid and gaseous state.
- Have a deep understanding methods to study the solid, liquid and gaseous state.
- Concept of ionic equilibria and its applications.

Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

Paper: Physical Chemistry – I (Lab)

Paper Code: BCH-104

No. of Credits: 2 **Internal: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
60 Periods **Total: 50**

1. Surface tension measurements using stalagmometer.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension with different concentration of detergent solutions. Determine CMC.

2. Viscosity measurement using Ostwald's viscometer.

a. Determination of co-efficient of viscosity of an unknown aqueous solution.

b. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar of PVA.

c. Study the variation of viscosity with different concentration of sugar solutions.

3. Solid State:

a. Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. pH metry:

a. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH values (i). Sodium acetate-acetic acid (ii). Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.

d. Determination of dissociation constant of a weak acid.

Any other experiment carried out in the class.

Reference Books

• Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

• Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

• Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

SEMESTER II

Semester II

Paper: Organic Chemistry - I
Paper Code: BCH-201

No. of Credits: 4 **Sessional: 25**
L: 4, T: 0 **Theory Exam: 75**
Theory: 60 Lectures **Total: 100**

COURSE OBJECTIVE
The objective of the course is to have an understanding the structure and bonding in organic chemistry, electronic displacements, stereochemistry and chemistry of aliphatic and aromatic hydrocarbons.

Recapitulation of basics of Organic Chemistry

Hybridization, Shapes of molecules

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation Dipole moment; Hydrogen bonding (Applications to be discussed with relevant topics)

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Types, shape and relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

(6 Lectures)

Stereochemistry:

Fischer,Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans , syn-anti and E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations.

(18 Lectures)

Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

General methods of prepareation , physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

General methods of preparation, physical and chemical properties of alkenes and alkynes, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

C. Cycloalkanes and Conformational Analysis

Conformational analysis of alkanes: Relative stability and Energy diagrams. Types of cycloalkanes and their relative stability, Baeyer strain theory : Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ; Relative stability of mono substituted cycloalkanes.

(24 Lectures)

Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups. **(12 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic concepts of organic chemistry.
- Understand the basics of reaction mechanism.
- Stereochemistry and optical isomerism in organic compounds.
- Understand the chemistry of aliphatic and aromatic hydrocarbons.

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

Paper: Organic Chemistry – I (Lab)

Paper Code: BCH-203

No. of Credits: 4 **Internal: 15**
L: 4, T: 0 **External Exam: 35**
60 Periods **Total: 50**

1. Checking the calibration of the thermometer

2. Purification of organic compounds by crystallization using the following solvents:
   a.Water
   b.Alcohol
   c.Alcohol-Water

3. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
   a.Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

   b.Separation of a mixture of two sugars by ascending paper chromatography

   c.Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

7. Detection of extra elements
8. Organic Preparations
   (i) Bromination of acetanilide / aniline / phenol
   (ii) Nitration of nitrobenzene / toluene.

Reference Books:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

Paper: Physical Chemistry - II

Paper Code: BCH-202

No. of Credits: 4 **Sessional: 25**
L: 4, T: 0 **Theory Exam: 75**
Theory: 60 Lectures **Total: 100**

COURSE OBJECTIVE

The objective of the course is to have an understanding concept of thermodynamics in chemistry, system of variable composition, chemical equilibrium, solutions and colligative properties.

Chemical Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems.

First law: Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state. **(36 Lectures)**

Systems of Variable Composition: Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases. **(8 Lectures)**

Chemical Equilibrium: Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle, Quantitatively)). Free energy of mixing and spontaneity. equilibrium between ideal gases and a pure condensed phase. **(8 Lectures)**

Solutions and Colligative Properties: Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to

derive relations between the four colligative properties [(i) relative lowering of vapour pressure, elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution. **(8 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Understand the basic concept of chemical thermodynamics and the laws governing.
- Learn the basics of systems of variable compositions.
- Learn the concept of chemical equilibrium.
- Learn solution and colligative properties.

Reference Books

• Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
• Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
• Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
• McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).

• Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
• Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010). • Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

Paper: Physical Chemistry - II (Lab)

Paper Code: BCH-204

No. of Credits: 2
L: 0, T: 0, P: 4
60 Periods

Internal: 15
External Exam: 35
Total: 50

(a) Determination of heat capacity of a calorimeter for different volumes using (i) change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution of sulphuric acid or enthalpy of neutralization), and (ii) heat gained equal to heat lost by cold water and hot water respectively

(b) etermination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Determination of the enthalpy of ionization of ethanoic acid.

(d) Determination of integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity of a diprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of salt.

(g) Study of the solubility of benzoic acid in water and determination of ΔH.

Any other experiment carried out in the class.

Reference Books

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).
