DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

B.Sc. (Hons.) Chemistry
(Program ID-5)

(As per Choice Based Credit System)

1st TO 6th SEMESTER

Examinations 2015–2016 Session Onwards

Syllabi Applicable For Admissions in 2015

Total minimum credits required for B.Sc (Hons.)-Chemistry are 140

Scheme of Courses B.Sc (Hons.) Chemistry (Program ID- 5)
Semester-1

S No.	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	CHE111	Inorganic Chemistry-I	Core	4	0	0	4
2	CHE112	Inorganic Chemistry Lab-I	Core	0	0	4	2
3	CHE113	Physical Chemistry-I	Core	4	0	0	4
4	CHE114	Physical Chemistry Lab-I	Core	0	0	4	2
5	SGS107	Human Values and General Studies	AECC	4	0	0	4
6	Generic Elective-I		GE				6
7	Generic Elective-II		GE				4
	Total						26

GE (Generic Elective-I) (Choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	PHY153A	Optics and Lasers	4	0	0	4
	PHY154	Optics Lab	0	0	3	2
2	BTY243	Biotechnology and Human Welfare	4	0	0	4
	BTY244	Biotechnology and Human Welfare Lab	0	0	3	2
3	BCH 524	Principles of Biochemistry	4	0	0	4
	BCH 525	Principles of Biochemistry Lab	0	0	3	2

GE (Generic Elective-II) (Choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	MTH 160A	Mathematics for Chemists-I	4	0	0	4
2	MIC111	Introduction to Microbiology	4	0	0	4

Course Title: Inorganic Chemistry-I

Course Code: CHE111

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

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Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A

Atomic Structure: (14 Lectures)

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 o f *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams.
Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

PART B

Periodicity of Elements: (16 Lectures)

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.
(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's

electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

PART C

Chemical Bonding: (26 Lectures)

(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and itslimitations. 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, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pair of electrons, multiple bonding (σ and π bond approach) 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.

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

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

PART D

Oxidation-Reduction: (4 Lectures)

Redox equations, Standard Electrode Potential and its application to inorganic reactions.

Principles involved in volumetric analysis to be carried out in class.

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E. and Mc Daniel, D.H. *Concepts & Models of Inorganic Chemistry*, Oxford, 1970
3. Atkins, P.W. and Paula, J. *Physical Chemistry*, Oxford Press, 2006.
4. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications 1962.

Course Title: Inorganic Chemistry Lab -I

L	T	P	Credits	Marks	Pass marks
0	0	4	2	50	20

Course Code: CHE112

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 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 (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS

Course Title: Physical Chemistry-I

Course Code: CHE113

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A

Gaseous state: **(18 Lectures)**

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,σfromη;variationcalculation of viscosityof 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 for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and 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.

PART B

Liquid state: **(6 Lectures)**

Qualitative treatment of the structure of the liquid state; Radial distribution function; 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.

Qualitative discussion of structure of water.

PART C

Solid state: **(16 Lectures)**

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. Defects in crystals. Glasses and liquid crystals.

PART D

Ionic equilibria: **(20 Lectures)**

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-, di-and triprotic acids (exact treatment).

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

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.Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Reference Books:

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

Course Title: Physical Chemistry Lab-I

L	T	P	Credits	Marks	Pass marks
0	0	4	2	50	20

Course Code: CHE114

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

1. **Surface tension measurements.**
    a. Determine the surface tension by (i) drop number (ii) drop weight method.
    b. Study the variation of surface tension of detergent solutions with concentration.
2. **Viscosity measurement using Ostwald's viscometer**.
    a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
    b. Study the variation of viscosity of sucrose solution with the concentration ofsolute.
3. **Indexing of a given powder diffraction pattern of a cubic crystalline system.**
4. **pH metry**
    a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
    b. Preparation of buffer solutions of different pH
        i. Sodium acetate-acetic acid
        ii. Ammonium chloride-ammonium hydroxide
    c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
    d. Determination of dissociation constant of a weak acid.

Reference Books

1. Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi, 2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York, 2003.
3. Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York, 2003.

Course Title: Human Values and General Studies

Course Code: SGS107

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Time: 04 Hours

Course Objectives

a) To sensitize students about the role and importance of human values and ethics in personal, social and professional life.
b) To enable students to understand and appreciate ethical concerns relevant to modern lives.
c) To prepare a foundation for appearing in various competitive examinations
d) To sensitize the students about the current issues and events of national and international importance
e) To provide opportunity to the students to study inter disciplinary subjects like Geography, Science, Economy, Polity, History, International Relations etc.

Part - A

Human Values

1. **Concept of Human Values:** Meaning, Types and Importance of Values. **2 Hrs**
2. **Value Education :** Basic guidelines for value education **2 Hrs**
3. **Value crisis and its redressal** **1 Hrs**

Being Good and Responsible

1. Self Exploration and Self Evaluation **2 Hrs**
2. Acquiring Core Values for Self Development **2 Hrs**
3. Living in Harmony with Self, Family and Society **3 Hrs**
4. Values enshrined in the Constitution: Liberty, Equality **3 Hrs**
5. Fraternity and Fundamental Duties. **3 Hrs**

Part - B

Value – based living

1. Vedic values of life **2 Hrs**
2. *Karma Yoga* and *Jnana Yoga* **2 Hrs**

3. *Ashta Marga* and *Tri-Ratna* **2 Hrs**

Ethical Living:

1. Personal Ethics **2 Hrs**
2. Professional Ethics **3 Hrs**
3. Ethics in Education **2 Hrs**

Part-C

General Geography

World Geography **3 Hrs**

The Universe, The Solar System, The Earth, Atmosphere, The World we live in, Countries rich in Minerals, Wonders of the World, Biggest and Smallest.

Indian Geography **3 Hrs**

Location, Area and Dimensions, Physical Presence, Indian States and Union Territories, Important sites and Monuments, Largest-Longest and Highest in India.

General History **3 Hrs**

Glimpses of India History, Ancient Indian, Medieval India, Modern India, Various Phases of Indian National Movement, Prominent Personalities, Glimpses of Punjab history with special reference to period of Sikh Gurus

Glimpses of World History **3 Hrs**

Important Events of World History, Revolutions and Wars of Independence, Political Philosophies like Nazism, Fascism, Communism, Capitalism, Liberalism etc.

Indian Polity: Constitution of India **3 Hrs**

Important Provisions, Basic Structure, Union Government, Union Legislature and Executive, State Government: State Legislature and Executive, Indian Judiciary, The Election Commission, Panachayati Raj System, RTI etc.

General Economy **3 Hrs**

The process of liberalization, privatization, globalization and Major World Issues, Indian Economy, Indian Financial System, Major Economic Issues, Economic Terminology.

Part-D

General Science **3 Hrs**

General appreciation and understandings of science including the matters of everyday observation and experience, Inventions and Discoveries

Sports and Recreation **3 Hrs**

The World of Sports and recreation, Who's Who is sports, Major Events, Awards and Honours. Famous personalities, Festivals, Arts and Artists

Current Affairs **3 Hrs**

National and International Issues and Events in News, Governments Schemes and Policy Decisions

Miscellaneous Information

Who is who **2 Hrs**

Books and Authors, Persons in News, Awards and Honours, Abbreviations and Sports

References:

1. Tripathi,A. N.*Human Values*,New Age International Publishers, New Delhi, Third Edition, 2009
2. Surbiramanian, R. *Professional Ethics*,Oxford University Press, New Delhi, 2013.
3. Anand, R. *Human Values and Professional Ethics*,Satya Prakashan, New Delhi, 2012
4. Bhalla, S.; Prakashan, S. *Human Values and Professional Ethics*, New Delhi, 2012.
5. Soryan, R. *Human Values and Professional Ethics*, Dhanpat Rai & Co. Pvt. Ltd., First Edition, 2010.
6. Jayshree, S.; Raghavan B. S., *Human Values and Professional Ethics,*S. Chand & Co. Ltd. 2007.
7. Singh, Y.; Garg, A. *Human Values and Professional Ethics*, Aitbs publishers, 2011.
8. Vrinder Kumar, *Human Values and Professional Ethics*,Kalyani Publishers, Ludhiana, 2013.
9. Gaur, R.;Sangal, R.; Bagaria,G. P.Human Values and Professional Ethics, Excel Books, New Delhi 2010.
10. Osula, B.; Upadhyay, S.*Values and Ethics,* Asian Books Pvt. Ltd., 2011.
11. Radhakrishnan, S.; *Indian Philosophy,* George Allen & Unwin Ltd., New York: Humanities Press INC, 1929.
12. Dwivedi, A. N. *Essentials of Hinduism, Jainism and Buddhism,* Books Today, New Delhi – 1979

13. Bhan, S. *Dayanand : His life and work,*DAVCMC, New Delhi – 2001.
14. Dwivedi, K. D.*Esence of Vedas,*Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
15. Chaubey, B. B. *Vedic Concepts,*Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
16. Aggarwal, R. S. *Advance Objective General Knowledge*, S. Chand Publisher (2013)
17. Sen, S.*Concise General Knowledge Manual 2013,* Unique Publishers,2013
18. Verma, R. P.*Encyclopedia of General Knowledge and General Awareness* Penguin Books Ltd (2010)
19. Thorpe, E.; Thorpe, S.*General Knowledge Manual 2013-14,* The Pearson, Delhi.
20. Mohanty, M.*General Knowledge Manual 2013-14,* Macmillan Publishers India Ltd., Delhi.
21. *India 2013,* Government of India (Ministry of Information Broadcasting), Publication Division, 2013.
22. Methew, M. *Manorama Year Book 2013-14,*Malayalam Manorama Publishers, Kottayam, 2013.
23. *Spectrum's Handbook of General Studies – 2013-14,* Spectrum Books (P) Ltd., New Delhi

CURRENT AFFAIRS

Magazines

Economic and Political Weekly, Yojna, the Week, India Today, Frontline, Spectrum.

Competition Success Review, Competition Master, Civil Services Chronicle, Current Affairs, World Atlas Book

Newspapers

The Hindu, Times of India, The Hindustan Times, The Tribune

Course Title: Optics and Lasers

Course Code: PHY153A

Time: 04 Hours

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

AIM: The aim and objective of the course on **Optics and Lasers** for the students of B.Sc. (Hons) Chemistry is to enable them to understand the different phenomenon exhibited by the light as well as the basics of the laser light.

PART A

Interference **(12 Lectures)**

Young's double slit experiment, Coherent Source, Theory of interference fringes, Types of interference, Fresnel's biprism, thickness of thin transparent sheet, Interference in thin films, Newton's rings and their application, Michelson Interferometer, Application of thin film interference; Anti reflection coatings; dielectric mirrors; interference filters; Holography.

PART B

Diffraction **(12 Lectures)**

Difference between Fresnel and Franunhoffer diffraction, Franunhoffer diffraction at a single slit and its discussion, Fraunhoffer diffraction at double slit, missing orders in a double slit, Diffraction of N slits and its discussion, Diffraction grating, Missing orders, dispersive power, Rayleigh Criterion for resolving power, resolving power of a diffraction grating.

PART C

Polarization **(11 Lectures)**

Polarised light and its production; polarisers and analyzers; anisotropic crystals; Polarization by transmission and reflection, Malus Law, Brewster's Law, Polarization by refraction, anisotropic crystals, Theory of double refraction, Elliptically and circularly polarized light, Quarter wave and half wave plates, Production and detection of polarized light, Optical activity, specific rotation. Half shade polarimeter; LCD's.

PART D

Lasers **(10 Lectures)**

Attenuation of light in an optical medium; thermal equilibrium; interaction of light with matter; Einstein relations; light amplification; population inversion; active medium, pumping; metastable states; principle pumping schemes; optical resonant cavity; axial modes; gain curve and laser operating frequencies, transverse modes; types of lasers; Q switching; laser beam characteristics and applications.

Reference Books:

1. Subramanayam, N.; Lal, B. and Avadhamulu; M. N. *Textbook of Optics.* New Delhi: S. Chand & Company, 2006.
2. Jenkins, F.A.; White, H.E. *Fundamentals of Optics.* USA: McGrawHill Publication,
3. Ghatak,A. *Optics.* New Delhi:Tata McGraw Hill Publication, 2008.

Course Title: Optics Lab
Course Code: PHY 154

Time: 03 Hours

L	T	P	Credits	Marks	Pass marks
0	0	3	2	50	20

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipments.

(60hrs)

Note:

- Students are expected to perform at least sixteen experiments out of following list.
- The examination for both the courses will be of 3hours duration.
- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

List of Experiments:

Experimental skills: General Precautions for measurements and handling of equipment, representation of measurements, Fitting of given data to a straight line, and Error analysis, Significant figures and interpretation of results

List of Experiments: Students are expected to perform at least eight experiments out of following list.

1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine the Dispersive Power of the Material of a given Prism using Mercury Light.
3. To determine the Resolving Power of a Prism.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine the Thickness of a Thin Paper by measuring the Width of the Interference Fringes produced by a Wedge Shaped Film.
7. To determination Wavelength of Sodium Light using Michelson's Interferometer.
8. To determine the wavelength of Laser light using Diffraction of Single Slit.
9. To determine the wavelength of (1) Sodium and (2) Mercury Light using Plane Diffraction Grating.
10. To determine the Dispersive Power of a Plane Diffraction Grating.
11. To determine the Resolving Power of a Plane Diffraction Grating.
12. To determine the (1) Wavelength and (2) Angular Spread of HeNe Laser using Plane Diffraction Grating.
13. To study the wavelength of spectral lines of sodium light using plane transmission grating.
14. To study the specific rotation of sugar solution Laurents half shade polarimeter method
15. To study the numerical aperture and propagation losses using HeNe laser Optical fibre set up.
16. To compare the focal length of two lenses by Nodal slide method.

Course Title: Biotechnology and Human Welfare

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Course Code: BTY243
Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Biotechnology and Human Welfare. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Biotechnology and Human Welfare. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (20 Lectures)

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

PART B (15 Lectures)

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

PART C (15 Lectures)

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

PART D (10 Lectures)

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

Reference Books:

1. Sateesh M. K.*Bioethics and Biosafety*, I. K. International Pvt Ltd., 2010
2. Sree Krishna V. *Bioethics and Biosafety in Biotechnology*, New age international Publishers, 2007.

Course Title: Biotechnology and Human Welfare Lab

L	T	P	Credits	Marks	Pass marks
0	0	3	2	50	20

Course Code: BTY244
Time: 03 Hours

Course Objectives:

This course is intended to learn the basic concepts of Biotechnology and Human Welfare Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Biotechnology and Human Welfare Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

Reference Books:

1. Sateesh M. K.*Bioethics and Biosafety*, I. K. International Pvt Ltd., 2010.
2. Sree, K. V. *Bioethics and Biosafety in Biotechnology*, New age international Publishers, 2007.

Course Title: Principles of Biochemistry
Paper Code: BCH 524

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Course Objective: The course is intended for under graduate course students. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their biochemistry.

PART A (15 Lectures)

Introduction to Biochemistry

Water as a biological solvent. Weak acids and bases. pH and buffers. Henderson-Hasselbalch equation. Physiological buffers. Fitness of the aqueous environment for living organisms.

Carbohydrates

Structure of monosaccharides. Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides. Glycoproteins.

Proteins

Introduction to proteins. Classification based on solubility, shape, composition and functions. Amino acids: common structural features, stereoisomerism and RS system of designating optical isomers. Classification and structures of standard amino acids as zwitterion in aqueous solutions. Physical and chemical properties of amino acids. Titration of amino acids. Separation of amino acids. Essential amino acids.

Structure of peptide bond. Solid-phase synthesis of peptides. Peptide sequencing. Chemical and enzymatic cleavage of polypeptide chains and separation of peptides. Levels of structure in protein architecture. denaturation and renaturation of proteins. Behaviour of proteins in solutions. Salting in and salting out of proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins.

PART B (15 Lectures)

Nucleic Acids

Nature of genetic material. Evidence that DNA is the genetic material. Composition of DNA and RNA. Generalized structural plan and Nomenclature of nucleic acids. DNA double helix. Structure and roles of different types of RNA. Size of DNA in prokaryotes and eukaryotes. Central dogma of molecular biology. Concepts of gene, genome and chromosome.

Porphyrins

Porphyrin nucleus and classification of porphyrins. Important metalloporphyrins occurring in nature. Detection of porphyrins. Bile pigments – chemical nature and physiological significance.

Lipids

Definition and classification of lipids. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids, prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats – hydrolysis, saponification value, rancidity of fats, Reichert-Meissel Number and reaction of glycerol. Biological significance of fats. Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens), sphingomyelins, glycolipids – cerebrosides, gangliosides. Properties and functions of phospholipids, isoprenoids and sterols.

PART C (15 Lectures)

Introduction to Metabolism

General features of metabolism, experimental approaches to study metabolism – intact organisms, bacterial mutants, tissue slices, radioisotopes.

Carbohydrate Metabolism

Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentations. Reactions and energetics of TCA cycle. Gluconeogenesis, glycogenesis and glycogenolysis. Reactions and physiological significance of pentose phosphate pathway. Regulation of glycolysis and TCA cycle. Photosynthesis – a brief review.

Electron Transport Chain and Oxidative Phosphorylation

Structure of mitochondria. Sequence of electron carriers. Sites of ATP production. Inhibitors of electron transport chain. Chemiosmotic hypothesis. Inhibitors and uncouplers of oxidative phosphorylation. Transport of reducing potentials into mitochondria.

PART D (15 Lectures)

Lipid Metabolism

Introduction. Hydrolysis of triacylglycerols. Transport of fatty acids into mitochondria. β-oxidation of saturated fatty acids. ATP yield from fatty acid oxidation. Biosynthesis of saturated and

unsaturated fatty acids. Metabolism of ketone bodies. Oxidation of unsaturated and odd chain fatty acids. Biosynthesis of triglycerides and important phospholipids, glycolipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism.

Amino Acid Metabolism

General reactions of amino acid metabolism – transamination, oxidative deamination and decarboxylation. Urea cycle. Degradation and biosynthesis of amino acids. Glycogenic and ketogenic amino acids.

Nucleotide Metabolism

Sources of atoms in the purine and pyrimidine nucleotides. Biosynthesis and degradation of purines and pyrimidines. Regulation of purine and pyrimidine biosynthesis.

Porphyrin Metabolism

Biosynthesis and degradation of porphyrins. Production of bile pigments.

Recommended Books:

1. Nelson, D.L. & Cox, M.M., *Lehninger Principles of Biochemistry*, 5th Edition, WH Freeman & Company, New York, 2008.

2. Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R. H. *Outlines of Biochemistry*, 5th edition, John Wiley & Sons Inc, 1987.

3. Voet, D. &Voet, J. G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004.

4. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006.

Course Title: Principles of Biochemistry Laboratory
Paper Code: BCH 525

L	T	P	Credits	Marks	Pass marks
0	0	3	2	50	20

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNS/o-Toluidine/Enzymatic method
2. Estimation of proteins by Biuret method
3. Quantitative estimation of cholesterol in the blood
4. Estimation of alkaline and acid phosphatases
5. Estimation of blood glucose.
6. Estimation of cholesterol
7. Sugar Fermentation in Microorganisms.
8. Estimation of Glucose 6-P.
9. Estimation of Urea.
10. Estimation of Uric acid.
11. Estimation of Creatinine.

Course Title: Mathematics for Chemists-I
Course Code: MTH 160A
Time: 04 Hours

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Course Objective: This course familiarizes the students with trigonometry, permutations and combinations, the theory of matrices which are used in solving equations in mechanics and other streams used in Mathematics, Physics etc. The objective is to provide basic understanding of the geometry of two and three dimensions.

PART A (14Lectures)

Trigonometry:
T- Ratios, addition and subtraction formulae, multiple angles, sub-multiple angles, trigonometric equations, inverse trigonometrical functions (proofs of articles are not required).

PART B (14Lectures)

Algebra: Fundamental principle of counting, Permutation and Combination with simple applications. Principle of mathematical induction, statement of Binomial Theorem and its applications.

PART C (12 Lectures)

Determinants and Matrices:
Introduction to matrix, Different kinds of matrices, Addition, Multiplication, Symmetric and Skew symmetric matrix, Transpose of matrix. Determinant of matrix, properties of determinant, product of two determinant of third order. Adjoint and Inverse of matrix, Rank of matrices, Condition of Consistency of system of linear equations, Eigen vectors and Eigen values using matrices, Cayley's Hamilton Theorem (without proof).

PART D (16 Lectures)

Co-ordinate Geometry:
Polar & Cartesian co-ordinates in plane, different forms of straight lines. Angle between two Straight lines. Conditions of parallelism and perpendicularity. Standard equations of circle, Parabola, ellipse and Hyperbola (without proof) and simple problems.
Solid Geometry: Sphere, Cone, Cylinder

Reference Books:

1. Mathematics, *A Text book for Class XI and XII (Parts I & II*). New Delhi: NCERT 2003.
2. Jain, R K, and K Iyengar S. R.*Advanced Engineering Mathematics*, New Delhi: Narosa Publishing House, 2003.
3. Thomas, George B. and Finney Ross L. *Calculus and Analytic Geometry*. New Delhi Addison Wesley, 1995
4. Narayan, S. *A text book of Matrices*. New Delhi: S Chand & co Ltd, 2004

Course Title: Introduction to Microbiology
Course Code: MIC111
Time: 04 Hours

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

PART A **(15 Lectures)**

History of Development of Microbiology

Development of microbiology as a discipline. Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming

Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman

Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

PART B **(40 Lectures)**

Diversity of Microbial World

A. Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

B. General characteristics of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

• **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

• **Fungi**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• **Protozoa**

General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

PART C (5 Lectures)

An overview of Scope of Microbiology

Recommended Books:

1. Tortora, G. J., Funke, B. R. and Case, C. L. *Microbiology: An Introduction*. 9th edition. Pearson Education. 2008. Print

2. Madigan, M. T., Martinko, J. M., Dunlap, P. V. and Clark, D. P. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2014.

3. Cappucino, J. and Sherman, N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print

4. Wiley, J. M., Sherwood, L. M. and Woolverton, C. J. *Prescott's Microbiology*. 9th Edition. McGraw Hill International. 2013. Print

5. Atlas, R. M. *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers. 1997. Print

6. Pelczar, M. J. Chan ECS and Krieg NR. *Microbiology*. 5th edition. McGraw Hill Book Company. 1993. Print

7. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., and Painter, P. R. *General Microbiology*. 5th edition. McMillan. 2005. Print

Scheme of Courses B.Sc (Hons.) Chemistry (Program ID- 5)
Semester-2

S No.	Paper Code	Course Title	Course Type	L	T	P	Cr
1	CHE115	Organic Chemistry-I	Core	4	0	0	4
2	CHE116	Organic Chemistry Lab-I	Core	0	0	4	2
3	CHE117	Physical Chemistry-II	Core	4	0	0	4
4	CHE118	Physical Chemistry Lab-II	Core	0	0	4	2
5	EVS100	Environmental studies	AECC	4	0	0	4
6	ENG151A	Basic Communication Skills	AECC	3	0	0	2
7	ENG152	Basic Communication Skills Lab	AECC	0	0	2	2
8		Generic Elective-III	GE				6
	Total						26

GE (Generic Elective-III) (Choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	PHY155A	Modern Physics	4	0	0	4
	PHY156	Modern Physics Lab	0	0	3	2
2	BCH401	Gene Organization, Expression and Regulation	4	0	0	4
	BCH402	Gene Organization, Expression and Regulation Lab	0	0	3	2

Course Title: Organic Chemistry-I
Course Code: CHE115

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (6 Lectures)

Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules,Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects,hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

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

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

PART B (18 Lectures)

Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism 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 resolution. Relative and absolute configuration: D/L and R/S designations.

PART C (24 Lectures)

Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ AntiMarkownikoff 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 formcarbonyl compounds, Alkylation of terminal alkynes.

C. Cycloalkanes and Conformational Analysis

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

PART D (12 Lectures)

Aromatic Hydrocarbons

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

Reference Books:

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

Course Title: Organic Chemistry Lab-I

Course Code: CHE116

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

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 above compounds and 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)

Reference Books

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

Course Title: Physical Chemistry-II

Course Code: CHE117

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A

Chemical Thermodynamics: (36 Lectures)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

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*, *U* and *H* 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 of molecules andions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

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

Third Law: Statement of third law, concept of residual entropy, calculation of absoluteentropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Freeenergy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

PART B

Systems of Variable Composition: (8 Lectures)

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.

PART C

Chemical Equilibrium: (8 Lectures)

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p ,K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

PART D

Solutions and Colligative Properties: (8 Lectures)

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) 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.

Reference Books

1. Peter, A. & Paula, J. de. *Physical Chemistry 9thEd.,* Oxford University Press, 2011.
2. Castellan, G. W. *Physical Chemistry 4thEd.,* Narosa 2004.
3. Engel, T. & Reid, P. *Physical Chemistry 3rdEd.,* Prentice-Hall, 2012.
4. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi, 2004.
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.*Commonly Asked Questions in Thermodynamics.* CRC Press: NY, 2011.
6. Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010.
7. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.

Course Title: Physical Chemistry Lab-II

Course Code: CHE118

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Thermochemistry

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(c) Calculation of the enthalpy of ionization of ethanoic acid.
(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
(e) Determination of basicity/proticity of a polyprotic 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 copper sulphate.
(g) Study of the solubilityΔ of benzoic acid in water and determination of H.

Reference Books

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

Course Title: Environmental Studies

Course Code: EVS100

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objective: This course aims at understanding the students in aspects of environmental problems, its potential impacts on global ecosystem and its inhabitants, solutions for these problems as well as environmental ethics which they should adopt to attain sustainable development.

PART A

The multidisciplinary nature of environmental studies (2 Hours)

Definition, scope and importance, Need for public awareness

Natural Resources: Renewable and non-renewable resources: (8 Hours)

Natural resources and associated problems.

(a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

(b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

(c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

(d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

(e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

(f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Ecosystem: (4 Hours)

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession

- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

PART B

Biodiversity and its conservation **4 Hours**

- Introduction – Definition: Genetic, Species and Ecosystem Diversity
- Bio-geographical classification of India
- Value of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, global and national efforts.

Environmental Pollution **8Hours**

- Definition, causes, effects and control measures of:

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear pollution

- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

PART C

Social Issues and the Environment **7 Hours**

- Population growth, variation among nations, Population explosion – Family Welfare Programmes.
- Environment and human health,
- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Laws: The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and control of Pollution) Act 1974; The Wildlife Protection Act, 1972; Forest Conservation Act, 1980.
- Issues involved in enforcement of environmental legislation
- Public Awareness

PART D

Human Population and Environment5 Hours

- Population Growth and Variations among Nations
- Population Explosion
- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

Field Work **5 Hours**

- Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-Pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

Suggested Readings:

1. Odum, EP. *Basic Ecology*. Japan: Halt Saundurs, 1983.
2. Botkin, DB, and Kodler EA. *Environmental Studies: The Earth as a living planet.* New York:John Wiley and Sons Inc., 2000.

3. Singh, JS, Singh, SP, and Gupta SR. Ecology, *Environment and Resource Conservation.* New Delhi: Anamaya Publishers, 2006.
4. De, AK. *Environmental Chemistry*. New Delhi: Wiley Eastern Ltd., 1990.
5. Sharma, PD. *Ecology and Environment*. Meerut Rastogi Publications, 2004

Course Title: Basic Communication Skills

Course Code: ENG151A

Time: 03 Hours

L	T	P	Credits	Marks	Pass Marks
3	0	0	2	50	20

Course Objective:

- To enhance students' vocabulary and comprehensive skills through prescribed texts.
- To hone students' writing skills.

Learning Outcomes: Students will be able to improve their writing skills as well as will enrich their word power.

60 Hours

Unit – A Applied Grammar (Socio-Cultural Context)

1. Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection 5 hours
2. Tenses (Rules and Usages in Socio-cultural contexts) 6 hour
3. Modals: Can, Could, May, Might, Will, Would, Shall, Should, Must, Ought to 5hours
4. Passives 5 hours
5. Reported/Reporting Speech 5 hour

Unit – B Reading (Communicative Approach to be Followed)

1. J M Synge: Riders to the Sea (One Act Play) 7 hours
2. Anton Chekhov : Joy (Short Story) 5 hours
3. Swami Vivekanand : The Secret of Work (Prose) 7 hours

Unit – C Writing

1. Paragraph and Essay Writing 5Hours
2. *Letter Writing: Formal and Informal* 5 hours
3. Notice and Email 5hours

References:

a. Books

1. Kumar, Sanjay and PushpLata. *Communication Skills*. India: OUP, 2012. Print.
2. Vandana, R. Singh. *The Written Word* by. New Delhi: Oxford University Press, 2008. Print.

b. Websites

1. www.youtube.com (to download videos for panel discussions). Web.
2. www.letterwritingguide.com. Web.
3. www.teach-nology.com.Web.
4. www.englishforeveryone.org.Web.
5. www.dailywritingtips.com.Web.
6. www.englishwsheets.com.Web.
7. www.mindtools.com.Web.

Course Title: Basic Communication Skills Lab

Course Code: ENG 152

Time: 02 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	2	2	50	20

Course Objective:

- To improve fluency in speaking English.
- To promote interactive skills through Group Discussions and role plays.

Learning Outcome: Students will get exposure to speaking through the above mentioned interactive exercises. In addition, they will develop a technical understanding of language learning software, which will further improve their communicative skills.

***Unit* – A Speaking/Listening**

1. Movie-Clippings 10 hours
2. Role Plays 10 hours
3. Group Discussions 10 hours

References Books:

1. Gangal, J. K. *A Practical Course In Spoken English.* India: Phi Private Limited, 2012. Print.
2. Kumar, Sanjay and PushpLata. *Communication Skills*. India: OUP, 2012. Print.

Websites

1. www.youtube.com (to download videos for panel discussions).Web.
2. www.englishforeveryone.org.Web.
3. www.talkenglish.com.Web.
4. www.mindtools.com.Web.

Course Title: MODERN PHYSICS

Course Code: PHY155A
Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

The aim and objective of the course on Modern Physics for the student of B.Sc. (Hons.) Chemistry is to equip them with the knowledge of wave particle duality, quantum mechanics and atomic nucleus and radioactivity

PART A

Wave Particle Duality (10 Lectures)

Quantum theory of light, Xrays and their diffraction, Compton effect, pair production, Wave Properties of Particles;de Broglie waves, waves of probability, the wave equation, phase and group velocities, particle diffraction, uncertainty principle and its applications.

PART B

Quantum Mechanics (11 Lectures)

Difference between classical and quantum mechanics, wave function and wave equations. Schrodinger's equation, time dependent and steady state forms, Expectation values, particle in a box, reflection and transmission by a barrier, tunnel effect, harmonic oscillator.

PART C

Quantum Theory of Hydrogen Atom (12 Lectures)

Schrodinger's equation for the hydrogen atom, separation of variables, quantum numbers, principal quantum number, orbital quantum number,
Magnetic quantum number, electron probability density, radiative transitions, selection rules. Zeeman Effect, Anomalous Zeeman effect, X-ray Spectra.

PART D

Atomic Nucleus and Radioactivity (12 Lectures)

Nonexistence of electrons in the nucleus, The neutron, stable nuclei, nuclear sizes and shapes, binding energy, liquid drop model, shell model, meson theory of nuclear forces Radioactivity; Radioactive decay, Half-life, radioactive dating, radioactive series, alpha decay and its theory, beta decay, gammadecay, radiation hazards and radiation units.

Books:

1. Beiser, A.*Concepts of Modem Physics*: McGraw Hill, 1987.
2. Ghatak and Loknatham. *Quantum Mechanics*:(Springer), 2004.
3. Kuhn, H. *Atomic Spectra*:. (Longman Green). 1969.
4. Hyde, K. *Basic ideas and Concepts in Nuclear Physics*: (Institute of Physics), 2004.

Course Title: Modern Physics Lab
Course Code: PHY156
Time: 03 Hours

L	T	P	Credits	Marks	Pass marks
0	0	3	2	50	20

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment.

Note:

- Students are expected to perform at least eighteen experiments out of following list.
- The examination for both the courses will be of 3hours duration.
- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

List of Experiments:

Experimental skills: General Precautions for measurements and handling of equipment, representation of measurements, Fitting of given data to a straight line, and Error analysis, Significant figures and interpretation of results

1. Determination of Planck's constant using photocell.
2. Study of Solar Cell characteristics
3. To find half-life period of a given radioactive substance using GM counter
4. Study of C.R.O. as display and measuring device, Study of Sinewave, square wave signals (half wave and full wave rectification)
5. Determination of ionization potential of mercury.
6. Study of excitations of a given atom by Franck Hertz set up.
7. To determine charge to mass ratio (e/m) of an electron by Thomson method.
8. Study of Arc emission spectrum of given samples (Fe and Cu).
9. To determine the heat capacity of given materials.
10. To find conductivity of given semiconductor crystal using four probe method.
11. To determine the Hall coefficient and mobility of given semiconductors.
12. To determine the operating plateau and dead time of a given G.M. Counter.
13. To find the coefficient of thermal conductivity of a bad conductor by Lee’s method.
14. To find the ionization potential of mercury using gas filled diode.
15. To determine the thermionic work function of tungsten using directly heated diode.
16. To determine the speed of light in air.
17. To study the various laws of thermal radiation.
18. To demonstrate diaparaferro magnetism in an inhomogeneous magnetic field.
19. To measure the wave lengths of Balmar series of visible emission line from hydrogen.
20. To determine the electronic charge by Millikan oil drop method.

Course Title: Gene Organization, Expression and Regulation

L	T	P	Credits	Marks	Pass marks
4	0	0	4	100	40

Paper Code: BCH401

Course Objectives: This course introduces students to the biochemistry underlying the genetic machinery of the cell.

Unit A (15 hours)

Structure of genes and chromosomes No. of Hours : 8

Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA.

Replication of genomes No. of Hours : 12

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and telomeres in linear chromosomes. Replication of RNA genomes.

Unit B (15 hours)

Recombination of DNA No. of Hours : 4

Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

Gene mutations and repair No. of Hours : 6

Molecular basis of mutations, multiple repair systems, mismatch repair, base excision repair, nucleotide excision repair, direct repair and translesion DNA synthesis.

Transcription of genes No. of Hours : 10

General features of gene transcription, procaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription.

RNA processing No. of Hours : 4

Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing.

Protein synthesis No. of Hours : 10

Features of the genetic code, amino acylation of tRNAs, structure and assembly of ribosomes; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

Regulation of gene expression No. of Hours : 6

Regulation of transcription in prokaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation. Regulation of transcription in eukaryotes, regulatory sequences - enhancers, silencers response elements, nucleosome alterations, DNA-protein interactions and RNA interference.

Recommended books

1. Nelson DL & Cox M.M., Lehninger Principles of Biochemistry, 5th Edition, WH Freeman & Company, New York, 2008.

2. Voet D & Voet JG, Biochemistry, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004.

3. Murray, R.K., Granner, D.K. and Rodwell, V.W. Harper's Illustrated Biochemistry, 27th Edition, McGraw Hill Company Inc. Singapore, 2006.

Course Title: Gene Organization, Expression and Regulation Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Paper Code: BCH402

Experiments:

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A_{260}/A_{280} ratio to distinguish between them.

2. To study the viscosity of DNA solutions.

3. Isolation of chromosomal DNA from E. coli.

4. Isolation of total RNA from yeast cells.

Scheme of Courses B.Sc (Hons.) Chemistry (Program ID- 5)
Semester-3

S No.	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	CHE211	Inorganic Chemistry-II	Core	4	0	0	4
2	CHE212	Inorganic Chemistry Lab-II	Core	0	0	4	2
3	CHE213	Organic Chemistry-II	Core	4	0	0	4
4	CHE214	Organic Chemistry Lab-II	Core	0	0	4	2
5	CHE215	Physical Chemistry-III	Core	4	0	0	4
6	CHE216	Physical Chemistry Lab-III	Core	0	0	4	2
7	Generic Elective-IV		GE				4
8	SEC-I		SEC				2
	Total						24

GE (Generic Elective-IV) (Choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	MTH 260A	Mathematics for Chemists-II	4	0	0	4
2	EVS251	Ecology and Environment Management	4	0	0	4
3	CHE270	Nanotechnology	4	0	0	4

SEC (Skill Enhancement Course)-I (Choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE271	Analytical clinical biochemistry	2	0	0	2
2	CHE272	Chemical Technology & Society	2	0	0	2

Course Title: Inorganic Chemistry-II
Course Code: CHE211

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (6 Lectures)

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

PART B (8 Lectures)

Acids and Bases

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

PART C (30 Lectures)

Chemistry of *s* and *p* Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

PART D (16 Lectures)

Noble Gases:
Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers:
Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.

2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models ofInorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4thEd.*, Pearson, 2010.

6. Shriver & Atkins, *Inorganic Chemistry 5thEd.*

Course Title: Inorganic Chemistry Lab-II
Course Code: CHE212

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Cuprous Chloride, Cu_2Cl_2
(ii) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$
(iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Reference Books:

- Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS. 1978

Course Title: Organic Chemistry-II

Course Code: CHE213

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A

Chemistry of Halogenated Hydrocarbons: (16 Lectures)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

PART B

Alcohols, Phenols, Ethers and Epoxides: (16 Lectures)

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

PART C

Carbonyl Compounds: (**14 Lectures)**

Structure, reactivity and preparation;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements,α haloform reaction and Baeyer Villiger oxidation, - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, NaBH4, MPV, PDC and PGC);

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

PART D

Carboxylic Acids and their Derivatives: (14 Lectures)

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Sulphur containing compounds:

Preparation and reactions of thiols, thioethers and sulphonic acids.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.

Course Title: Organic Chemistry Lab-II

Course Code: CHE214

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:
   i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine)β and phenols (-naphthol, vanillin, salicylic acid) by any one method:
      a. Using conventional method.
      b. Using green approach
   ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) andβone of the following phenols (-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
   iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
   iv. Bromination of any one of the following:
      a. Acetanilide by conventional methods
      b. Acetanilide using green approach (Bromate-bromide method)
   v. Nitration of any one of the following:
      a. Acetanilide/nitrobenzene by conventional method
      b. Salicylic acid by green approach (using ceric ammonium nitrate).
   vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.
   vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.
   viii. Hydrolysis of amides and esters.
   ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
   x. *S*-Benzylisothiouronium salt of one each of water soluble and water insoluble acids(benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
   xi. Aldol condensation using either conventional or green method.
   xii. Benzil-Benzilic acid rearrangement.

Reference Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education, 2009.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.,* Pearson, 2012
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis,* University Press, 2000.
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: QualitativeAnalysis*, University Press, 2000.

Course Title: Physical chemistry-III

Course Code: CHE215

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A

Phase Equilibria: (28 Lectures)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications tofractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications.

PART B

Chemical Kinetics (18 Lectures)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

PART C

Catalysis: (8 Lectures)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

PART D

Surface chemistry: (6 Lectures)

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

Reference Books:

1. Peter Atkins & Julio De Paula, *Physical Chemistry 9thEd.*, Oxford University Press, 2010).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi, 2004.
4. Engel, T. & Reid, P. *Physical Chemistry 3rdEd.*, Prentice-Hall, 2012.
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY, (2011).
6. Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 2011.
7. Ball, D. W. *Physical Chemistry* Cengage India, 2012.
8. Mortimer, R. G. *Physical Chemistry 3rdEd.*, Elsevier: NOIDA, UP, 2009.
9. Levine, I. N. *Physical Chemistry 6thEd.*, Tata McGraw-Hill, 2011.
10. Metz, C. R. *Physical Chemistry 2ndEd.*, Tata McGraw-Hill, 2009.

Course Title: Physical Chemistry Lab-III

Course Code: CHE216

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
    a. simple eutectic and
    b. Congruently melting systems.
III. Distribution of acetic/ benzoic acid between water and cyclohexane.
IV. Study the equilibrium of at least one of the following reactions by the distribution method:
    (i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$
    (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow [Cu(NH_3)_n]^{2+}$
V. Study the kinetics of the following reactions.
    1. Initial rate method: Iodide-persulphate reaction
    2. Integrated rate method:
        a. Acid hydrolysis of methyl acetate with hydrochloric acid.
        b. Saponification of ethyl acetate.
    3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate.

VI. Adsorption

I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi, 2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York, 2003.
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York, 2003.

Course Title: Mathematics for Chemists-II

Course Code: MTH 260 A

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objective: This course is designed to introduce the fundamental concepts of continuity, differentiation and integration of functions of one variable. Its objective is to acquaint students with various applications of these topics relating to extreme value problems, problems of finding areas and distance travelled, moreover to describe connection between integral and differential calculus through Fundamental Theorem of Calculus.

PART-A (11 Lectures)

Function, Limit and Continuity:

Functions and graphs, Domain and Co-Domain, range, Inverse Functions, Exponential and Logarithmic Functions, limit of Functions, Algebraic Computations of limits, Continuity of Functions at a point, Continuity of Functions in interval.

PART -B (13 Lectures)

Differential of Explicit and Implicit functions:

An Introduction to the Derivative, Differentiation of standard Functions, Formulae on derivative of sum, difference, product and quotient of functions, chain rule, derivative of Trigonometric functions, Inverse Trigonometric functions, Exponential and Logarithmic Functions.

Differentiation of implicit functions, Derivative of functions expressed in parametric form, derivative of higher order**.**

PART-C (11 Lectures)

Applications of derivatives:

Increasing and decreasing functions, Sign of derivative, Maxima and Minima of a function of single variable. Rolle's, Lagrange and Cauchy mean values theorems and their applications, Taylor theoremand Maclaurian's theorem with Lagrange's form of remainder and applications of formal expansions of functions. (Proofs of theorems are not required).

PART-D (11 Lectures)

Integral Calculus:

Integration as inverse of differentiation, Indefinite Integral of standard forms, Methods of Substitution, Methods of fractions, Integration by parts, Definite Integral.

Reference Books:

1. Narayan, Shanti and Mittal P K .*Differential Calculus*. New Delhi: S Chand & Co Ltd, 2005.
2. Narayan, Shanti and Mittal P K. *Integral Calculus*, New Delhi: S Chand & Co Ltd, 2004.
3. Mathematics, *A Text book for Class XI and XII (Parts I & II*). New Delhi: NCERT 2003.

Course Title: Ecology and Environment Management

Course Code: EVS251
Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Ecology and Environment Management. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Ecology and Environment Management. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART-A (12 Lectures)

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope ofEcology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem.Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats.Cybernetics & Homeostasis. Biological control of chemical environment.

PART-B (20 Lectures)

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production &ecomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids,Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,Pcycles).

PART-C (18 Lectures)

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents,Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detectionsystems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup :Case studies

PART-D (10 Lectures)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment.Bioremediation, Waste disposal.

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond orterrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weinerdiversity index for the same community.
3. Principle of GPS (Global Positioning System).

4. Study of the life table and fecundity table, plotting of the three types of survivorshipcurves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH,chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

Reference Books:

1. Chapman, J.L., Reiss, M.J. 1999. *Ecology: Principles and applications* (2nd edition) CambridgeUniversity Press.
2. Divan Rosencraz, *Environmental laws and policies in India*, Oxford Publication.
3. Ghosh, S.K., Singh, R.*Social forestry and forest management. Global Vision Publishing House,* 2003
4. Joseph, B., *Environmental studies*, Tata Mc Graw Hill.
5. Michael Allabay, *Basics of environmental science*, Routledge Press.
6. Miller, G.T. 2002. *Sustaining the earth, an integrated approach*. (5thedition) Books/Cole,Thompson Learning, Inc.
7. Mohapatra *Textbook of environmental biotechnology IK publication*.
8. Rana SVS, *Environmental pollution – health and toxicology*, Narosa Publication
9. Sinha, S. *Handbook on Wildlife Law Enforsement* in India. TRAFFIC, India,2010.
10. Thakur, I. S., *Environmental Biotechnology*, I K Publication.

Course Name: Nanotechnology

Course Code: CHE270

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Nanotechnology. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Nanotechnology. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART-A (15 Lectures)

Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state and its variation with energy, Effect of crystal size on density of states and band gap. Electron confinement in one, two and two-dimensions, Nanostructures and its types, role of size, quantum confinement, surface to volume ratio, Size-dependent properties and applications, Single electron tunneling.

PART-B (15 Lectures)

Nucleation and growth of nanostructures: Homogenous and heterogeneous, Top down and bottom upapproaches, Chemical route: Chemical precipitation, Sol-gel, Microemulsions or reverse micelles, Solvothermal/hydrothermal, Electrochemical,Self-Assembly Monolayers (SAM), Physical routes - Inert gas condensation, Sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy, Chemical and Molecular vapour deposition methods, Lithography.

PART-C (15 Lectures)

X-ray diffraction (XRD), determination of particle size, study of texture and microstructure, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM) - Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM) Transmission Electron Microscopy (TEM), Optical characterization – UV-Visible, Photoluminescence, Vibrational spectroscopy, Magnetic resonance spectroscopy.

PART-D (15 Lectures)

Carbon: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C_{60}, alkali doped C_{60}; Various applications of nanotechnology in chemistry.

Reference Books:

1. Chow, G.M. and Gonsalves, K.E., *Nanotechnology - Molecularly Designed Materials*, American Chemical Society (1996).
2. Jain, K.P., Physics of Semiconductor Nanostructures, Narosa (1997).
3. Cao, G., *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, Imperial College Press (2004).
4. B. D. Cullity, *Elements of X –ray Diffraction,Prentice Hall*,3rd edition (2001).
5. R.F. Egerton, *Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM* F. Egerton, Springer (2005).
6. Nalwa,H.S.*Encyclopedia of Nanotechnology*, Springer (2012).
7. Bhusan, B. *Springer Handbook of Nanotechnology*, Springer, 3rd edition (2010).

Course Title: Analytical Clinical Biochemistry

Course Code: CHE271

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
2	0	0	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Analytical Clinical Biochemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Analytical Clinical Biochemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Review of concepts studied in the core course:
Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
Isolation and characterization of polysachharides.
Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins:α -helixβ and - pleated sheets, Isolation, characterization, denaturation of proteins.
Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site,Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.
Lipids: Classification. Biological importance of triglycerides and phosphoglycerides andcholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.
Lipoproteins.
Properties, functions and biochemical functions of steroid hormones.
Biochemistry of peptide hormones.
Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.
Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.
Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
Urine: Collection and preservation of samples. Formation of urine. Composition andestimation of

constituents of normal and pathological urine.

Practical

Identification and estimation of the following:
1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:

1. T.G. Cooper: *Tool of Biochemistry*.
2. Keith Wilson and John Walker: *Practical Biochemistry*.
3. Alan H Gowenlock: *Varley's Practical Clinical Biochemistry*.
4. Thomas M. Devlin: *Textbook of Biochemistry*.
5. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: *Biochemistry*.
6. G. P. Talwar and M Srivastava: *Textbook of Biochemistry and Human Biology*.
7. A.L. Lehninger: *Biochemistry*.
8. O. Mikes, R.A. *Chalmers*: *Laboratory Handbook of Chromatographic Methods*.

Course Title: Chemical Technology & Society

Course Code: CHE272

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
2	0	0	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Chemical Technology & Society. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Chemical Technology & Society. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Theory: 30 Lectures

Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Reference Book:

John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed.

Scheme of Courses B.Sc (Hons.) Chemistry (Program ID- 5)
Semester-4

S No.	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	CHE217	Inorganic Chemistry-III	Core	4	0	0	4
2	CHE218	Inorganic Chemistry Lab-III	Core	0	0	4	2
3	CHE219	Organic Chemistry-III	Core	4	0	0	4
4	CHE220	Organic Chemistry Lab-III	Core	0	0	4	2
5	CHE221	Physical Chemistry-IV	Core	4	0	0	4
6	CHE222	Physical Chemistry Lab-IV	Core	0	0	4	2
7	Generic Elective-V		GE				6
8	SEC-II		SEC				2
	Total						26

GE (Generic Elective-V) Choose one

S.No	Paper Code	Course Title	L	T	P	Cr.
1	PHY253A	Electricity, Magnetism and Electronics	4	0	0	4
	PHY254	Electricity, Magnetism and Electronics Lab	0	0	3	2
2	BCH403	Biochemical Correlations in Diseases	4	0	0	4
	BCH404	Biochemical Correlations in Diseases Lab	0	0	3	2

SEC (Skill Enhancement Course)-II (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE281	Fuel Chemistry	2	0	0	2
2	CHE282	Pharmaceutical Chemistry	2	0	0	2
3	CSA252	Computer for Chemists	2	0	0	2

Course Title: Inorganic Chemistry-III
Course Code: CHE217

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A

Coordination Chemistry: (26 Lectures)

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurementof CFSE10Dq in weakand strong fields, pairingo,t). energies, factors affecting the magnitude of 10 Dq (Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.
IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

PART B

Transition Elements: (18 Lectures)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

PART C

Lanthanoids and Actinoids: (6 Lectures)

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

PART D

Bioinorganic Chemistry: (10 Lectures)

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions

(Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.
Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Reference Books:

1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
2. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry*, Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry*. Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C., *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A., *Chemistry of the Elements*, Butterworth-Heinemann,1997.

Course Title: Inorganic Chemistry Lab-III

Course Code: CHE218

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Reference Book:

1. Vogel, A.I. *A text book of Quantitative Analysis*, ELBS 1986.

Course Title: Organic Chemistry-III
Course Code: CHE219

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (18 Lectures)

Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles and isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

PART B (8 Lectures)

Polynuclear Hydrocarbons

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.
(8 Lectures)

PART C (22 Lectures)

Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction

Derivatives of furan: Furfural and furoic acid.

PART D **(12 Lectures)**

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Terpenes

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral α and -terpineol.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry ofNatural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
5. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
6. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan,2010.

Course Title: Organic Chemistry Lab-III

Course Code: CHE220

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Reference Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.*, Pearson, 2012
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis,* University Press, 2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry:Qualitative Analysis,* University Press, 2000.

Course Title: Physical Chemistry-IV
Course Code: CHE221

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A **(20 Lectures)**

Conductance

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

PART B **(28 Lectures)**

Electrochemistry

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining

(i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox,

precipitation).

PART C (12 Lectures)

Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

Reference Books:

1. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press, 2011.
2. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa, 2004.
3. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP, 2009.
4. Barrow, G. M., *Physical Chemistry 5th Ed.*, Tata McGraw Hill: New Delhi, 2006.
5. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall, 2012.
6. Rogers, D. W. *Concise Physical Chemistry* Wiley, 2010.
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.*, John Wiley & Sons, Inc. 2005.

Course Title: Physical Chemistry Lab-IV

Course Code: CHE222

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

Conductometry

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
    i. Strong acid vs. strong base
    ii. Weak acid vs. strong base
    iii. Mixture of strong acid and weak acid vs. strong base
    iv. Strong acid vs. weak base

Potentiometry

I Perform the following potentiometric titrations:
    i. Strong acid vs. strong base
    ii. Weak acid vs. strong base
    iii. Dibasic acid vs. strong base
    iv. Potassium dichromate vs. Mohr's salt

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi, 2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.;* McGraw-Hill: New York, 2003.
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York, 2003.

Course Title: Electricity Magnetism and Electronics
Course Code: PHY253A
Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Electricity Magnetism and Electronics. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Electricity Magnetism and Electronics. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A **(12 Lectures)**

Vector Analysis
Vectors and Vector properties, Components of Vectors, Unit Vectors, Product of Vectors.
Electric Charges and Field
Electric Charges, Conductors, Insulators and Induced Charges,Coulomb Law, Electric Field and Forces, Electric field Calculations, Electric field lines. ElectricDipoles.
Gauss law
Charges & Electric Flux and calculations, Gauss's Law, Electric Potential Energy and Potential Gradient.

PART B **(10 Lectures)**

Magnetism
Magnetism, magnetic field, Magnetic field lines and flux, motion of charges particle in Magnetic field, BioSavart law, Ampere law, Magnetic Materials, Faraday's Law, Maxwell equations
Dielectric: Dielectric and Gauss's Law in Dielectric.
Electromotive Force
Electromotive force & Circuits, Mutual Inductance, Self-Induction and Inductors

PART C **(12 Lectures)**

Conduction in Semiconductors Electrons and holes in semiconductor, carrier concentration, donor and acceptor impurities, charge densities, Fermi Level in semiconductors, diffusion, carrier lifetimes, continuity equation
Diode Characteristics
Qualitative theory of pn junction, pn diode, band structure of an open circuit diode, current components, qualitative theory of diode currents, VI Characteristics.

PART D **(11 Lectures)**

Transistors

Junction Transistors, Transistor current components, transistor as an amplifier, CB and CE configuration

Applications

Half Wave rectifier, ripple factor, full wave rectifier, filters, photoconductivity, Photodiode

REFERENCE BOOKS:

1. Sears's *University Physics with Modern Physics*, Hugh D Young and Roger A Freedman, 12thEdition Pearson Education, 2008.
2. *Fundamentals of |Physics*, Resnick&Hlleday, 8th Edition Wile
3. *Electronic Devices and Circuits*: J. Millman and C.C. Halkias Tata McGraw Hill, 1991

Course Title: Electricity Magnetism and Electronics Lab
Course Code: PHY 254
Time: 03 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	3	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of EM and Electronics Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of EM and Electronics Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

List of Experiments:

Experimental skills: General Precautions for measurements and handling of equipment, representation of measurements, Fitting of given data to a straight line, and Error analysis, Significant figures and interpretation of results

1. To verify the Thevenin, Norton, Superposition, and Maximum Power Transfer Theorem.
2. To measure the Input and Output Impedance of an Unknown Network and to convert it into Equivalent T and π Circuits.
3. To study (a) Halfwave Rectifier and (b) Fullwave Bridge Rectifier and investigate the effect of C, L and π filters.
4. To study the characteristics of pnjunction diode.
5. To study the Forward and Reverse characteristics of a Zener Diode and to study its use as a Voltage Regulator.
6. To study the Characteristics of a Photodiode.
7. To determine the Characteristics of pn junction of a Solar Cell.
8. To study the CE Characteristics of a Transistor.
9. To study the various Transistor Biasing Configurations.
10. To study the Frequency Response of Voltage Gain of aRCCoupled Amplifier.
11. To design an Oscillator of given specifications using Transistors.
12. To study the characteristics of Junction Field Effect Transistor.
13. To study the characteristic of Metal Oxide Semiconductor Field Effect Transistor.
14. To study the magnetic field produced by a current carrying solenoid using a pickupcoil/Hall sensor and to find the value of permeability of air.
15. To determine the frequency of A.C. mains using sonometer.
16. Determination of given inductance by Anderson's bridge.
17. To determine the value of an air capacitance by deSauty Method and to findpermittivity of air. Also, determine the dielectric constant of a liquid.
18. Study of R.C. circuit with a low frequency a.c. source.

19. Studies based on LCR Board: Impedance of LCR circuit and the phase and between voltage and current.
20. To measure low resistance by Kelvin’s double bridge/ Carey Foster’s bridge.
21. To study the basic ideas of equal a priori probability, law of two independent events, and probability distribution of identical particles in two compartments for a two option system using colored dice.

Course Title: Biochemical Correlations in Diseases

Paper Code: BCH403

L	T	P	Credits	Marks
4	0	0	4	100

Course Objectives: This course introduces students to the biochemistry underlying various diseases and the mechanisms of pathogenesis.

Unit A (15 hours)

Inborn errors of metabolism

Alkaptonuria, Phenylketonuria, Glycogen and Lipid storage diseases, SCID, Clotting disorders.

Nutritional deficiency based diseases

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindedness, Rickets, Osteomalacia, Osteoporosis, Wilson's disease.

Unit B (15 hours)

Lifestyle diseases

Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II. Inflammatory Bowel Disease (IBD).

Hormonal Imbalances

Outline of hormone action and imbalances leading to disease - precocious puberty, hyper and hypopituitarism. Hyper and hypothyroidism.

Unit C (15 hours)

Autoimmune diseases

Concepts in immune recognition - self and non self discrimination, organ specific autoimmune diseases – Hashimoto's thyroiditis, Grave's disease, myasthenia gravis;. Systemic diseases - SLE, rheumatoid arthritis; Diabetes Mellitus-I.

Diseases caused due to misfolded proteins

Alzheimer's, Huntington's disease, Kuru, Creutzfeldt-Jakob disease, Sickle cell anaemia, Thalessemia.

Unit D (15 hours)

Infectious diseases

Viral infection (polio, measles, mumps, influenza, HIV); Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera); Protozoan (Plasmodium and Trypanosoma) and parasitic infections. Vaccines against diseases. General strategies in the design and development of vaccines.

Reference Books

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7

3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.

4. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

Course Title: Biochemical Correlations in Diseases Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Paper Code: BCH404

Experiments:

1. Glucose tolerance test.

2. Lipid profile: triglycerides and total cholesterol.

3. Obesity parameters.

4. RBC counting and haemoglobin estimation.

5. Blood pressure measurements.

6. Bone density measurements (visit to a nearby clinic).

7. T4/TSH assays.

Course Title: Fuel Chemistry

Course Code: CHE281

Time: 02 Hours

L	T	P	Credits	Marks	Pass Marks
2	0	0	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Fuel Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Fuel chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

30 Lectures

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.
Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization ofcoal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting)Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference Books:

1. Stocchi, E. *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. Jain. P.C., Jain, M. *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.

3. Sharma, B.K. *Industrial Chemistry,* Goel Publishing House, Meerut.

Course Title: Pharmaceutical Chemistry

L	T	P	Credits	Marks	Pass Marks
2	0	0	2	50	20

Course Code: CHE282

Time: 02 Hours

Course Objectives:

This course is intended to learn the basic concepts of Pharmaceutical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Pharmaceutical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Theory: 30 Lectures

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Practicals

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

1. Patrick, G.L. *Introduction to Medicinal Chemistry, Oxford University* Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.

3. William O. Foye, Thomas L., Lemke, David A. William: *Principles of MedicinalChemistry*, B.I. Waverly Pvt. Ltd. New Delhi

Course Title: Computer for Chemists
Course Code: CSA252

L	T	P	Credits	Marks
2	0	0	2	50

Course Duration: 45 Hours

Course Objective: The objective of the course is to introduce students to the basic knowledge about the structure and functioning of computers, algorithm designing and implementing chemistry formulae's using C programming Concepts.

UNIT-A **15 Hours**

Introduction to Computers

- Basic Structure and Functioning of Computer with a PC
- Different Component of a Computer, Hardware and Software
- Binary Number and Arithmetic
- Introduction to Computer Language, Operating System
- Data Processing, Algorithms and Flow Charts.

Principle of Programming in C

- Data Types, Constants, Variables
- Arithmetic Operators, Unary Operators, Relational Operators,
- Logical Operators, Assignment and Conditional Operators, Library functions.

UNIT-B **10 Hours**

Data Input and Output

- Single Character Input, Single Character Output, Entering Input Data
- More About Scan Functions, Writing Output Data, More About Print Functions
- Gets and Puts Functions, Interactive Programming.

Control Structures

- Introduction, Decision Making with If – Statement, If Else and Nested If,
- While And Do-While, For Loop.
- Jump Statements: Break, Continue, goto, Switch Statement.

UNIT-C **12 Hours**

Functions

- Introduction To Functions, Function Declaration, Function Categories
- Standard Functions, Parameters And Parameter Passing, Pass – By Value/Reference
- Recursion, Global and Local Variables, Storage Classes.

Arrays

- Introduction to Arrays, Array Declaration, Single and Multidimensional Array, Memory Representation, Matrices, Strings, String Handling Functions.

UNIT-D **8 Hours**

Programming in Chemistry

- Development of Small Computer Code involving Simple Formulae in Chemistry
- How to run Standard Programs and Packages
- Execution of Linear Regression
- X-Y Plot, Numerical Integration and Differentiation
- Differential Equation Solution Programs

Reference Books

1. Computers and Common Sense, R. Hunt and J.Shelley, Prentice Hall
2. Computational Chemistry, A.C Norris
3. J.GeinBrookshear, Computer Science: An Overview, Addition-Wesley
4. Yashvant P Kanetkar, Let us C, BPB Publications, New Delhi, Seventh Edition.
5. E. Balagurusami, Programming in ANSI C, Tata McGraw Hill, Fourth Edition.
6. Byron S. Gottfried, Programming in C, McGraw Hills, Second Edition.

Scheme of Courses B.Sc (Hons.) Chemistry (Program ID- 5)
Semester-5

S No.	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	CHE311	Organic Chemistry-IV	Core	4	0	0	4
2	CHE312	Organic Chemistry Lab-IV	Core	0	0	4	2
3	CHE313	Physical Chemistry-V	Core	4	0	0	4
4	CHE314	Physical Chemistry lab-V	Core	0	0	4	2
5	Discipline Specific Elective-I		DSE-1				6
6	Discipline Specific Elective-II		DSE-2				6
	Total						24

DSE (Discipline Specific Electives)-I (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE371	Analytical Methods in Chemistry	4	0	0	4
	CHE372	Analytical Methods in Chemistry Lab	0	0	4	2
2	CHE373	Novel Inorganic Solids	4	0	0	4
	CHE374	Novel Inorganic Solids lab	0	0	4	2

DSE (Discipline Specific Electives)-II (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE375	Polymer Chemistry	4	0	0	4
	CHE376	Polymer Chemistry lab	0	0	4	2
2	CHE377	Research Methodology for Chemistry	5	1	0	6
3	CHE378	Molecular Modelling & Drug Design	4	0	0	4
	CHE379	Molecular Modelling & Drug Design Lab	0	0	4	2

Course Title: Organic Chemistry-IV

Course Code: CHE311

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (9 Lectures)

Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides;
Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

PART B (24 Lectures)

Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification.
α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

PART C (15 Lectures)

Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules).
Introduction to metabolism (catabolism, anabolism).
ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD^+, FAD.
Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.
Overview of catabolic pathways of fat and protein.
Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

PART D (12 Lectures)

Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Reference Books:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. VIth Edition. W.H. Freeman and Co., 2006
2. Nelson, D.L., Cox, M.M. and Lehninger, A.L. *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co., 2009
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. *Harper's Illustrated Biochemistry*. XXVIII edition. Lange Medical Books/ McGraw-Hill., 2009

Course Title: Organic Chemistry Lab-IV

Course Code: CHE312

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Reference Books:

1. *Manual of Biochemistry Workshop*, 2012, Department of Chemistry, University of Delhi.
2. Arthur, I. V. *Quantitative Organic Analysis*, Pearson.

Course Title: Physical Chemistry-V

Course Code: CHE313

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (24 Lectures)

Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2,

H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

PART B (24 Lectures)

Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

PART C (12 Lectures)

Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Reference Books:

1. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi, 2006.
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill, 2001.
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA, 2004.
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press, 2005.
5. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press, 2015.

Course Title: Physical Chemistry Lab-V

Course Code: CHE314

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Time: 04 Hours
Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

0 Lectures

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration
II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
III. Study the kinetics of iodination of propanone in acidic medium.
IV. Determine the amount of iron present in a sample using 1,10-phenathroline.
V. Determine the dissociation constant of an indicator (phenolphthalein).
VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide
VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi 2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in PhysicalChemistry 8th Ed.;* McGraw-Hill: New York 2003.
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York 2003.

Course Title: Analytical Methods in Chemistry

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Code: CHE371

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Analytical Methods in Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Analytical Methods in Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (5 Lectures)

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

PART B (25 Lectures)

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution,geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation(choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

PART C (15 Lectures)

Thermal methods of analysis:
Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:
Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values.

PART D (15 Lectures)

Separation techniques:
Solvent extraction: Classification, principle and efficiency of the technique.
Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.
Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.
Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.
Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.
Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiralchromatographic techniques using chiral columns (GC and HPLC).
Role of computers in instrumental methods of analysis.

Reference Books:

1. Vogel, Arthur I: *A Test book of Quantitative Inorganic Analysis* (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry – Methods of separation*.

Course Title: Analytical Methods in Chemistry Lab

Course Code: CHE372

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Analytical Methods in Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Analytical Methods in Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

I. Separation Techniques

1. Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

(i) To separate a mixture of Ni^{2+}& Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. Analysis of soil:

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.

3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books:

1. Vogel, Arthur I: *A Text book of Quantitative Inorganic Analysis* (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: *Exploring Chemical Analysis, Ed. New York*, W.H. Freeman, 2001.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry – Methods of separation*

Course Title: Novel Inorganic Solids

Course Code: CHE373

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Novel Inorganic Solids. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Novel Inorganic Solids. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A **(10 Lectures)**

Synthesis and modification of inorganic solids:
Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

PART B **(20 Lectures)**

Inorganic solids of technological importance:
Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.
Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals.

Nanomaterials:
Overview of nanostructures and nanomaterials: classification.
Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.

PART C **(10 Lectures)**

Introduction to engineering materials for mechanical construction:
Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

PART D **(20 Lectures)**

Composite materials:

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applicationsof composites.

Speciality polymers:

Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

Reference Books:

1. Shriver & Atkins. *Inorganic Chemistry*, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*.
3. Frank J. Ovens, *Introduction to Nanotechnology*

Course Title: Novel Inorganic Solids Lab

Course Code: CHE374

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Novel Inorganic Solids Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Novel Inorganic Solids Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

1. Determination of cation exchange method
2. Determination of total difference of solids.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of silver and gold metal nanoparticles.

Reference Book:

1. Fahan, *Materials Chemistry*, Springer, 2004.

Course Title: Polymer Chemistry

Course Code: CHE375

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Polymer Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Polymer Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (12 Lectures)

Introduction and history of polymeric materials:
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.
Functionality and its importance:
Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

PART B (14Lectures)

Kinetics of Polymerization:
Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.
Crystallization and crystallinity:
Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.
Nature and structure of polymers-Structure Property relationships.

PART C (16 Lectures)

Determination of molecular weight of polymers (M_n,M_w, etc) by end group analysis,viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.
Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLFequation, Factors affecting glass transition temperature (Tg).

PART D (18 Lectures)

Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamicsof polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and relatedpolymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Reference Books:

1. *Seymour's Polymer Chemistry*, Marcel Dekker, Inc.
2. G. Odian: *Principles of Polymerization*, John Wiley.
3. F.W. Billmeyer: *Text Book of Polymer Science*, John Wiley.
4. P. Ghosh: *Polymer Science & Technology*, Tata Mcgraw-Hill.
5. R.W. Lenz: *Organic Chemistry of Synthetic High Polymers*.

Course Title: Polymer Chemistry lab

Course Code: CHE376

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Polymer Chemistry lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Polymer Chemistry lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

1. **Polymer synthesis**

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
    a. Purification of monomer
    b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
2. Preparation of nylon 66/6

1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
    a. Preparation of IPC
    b. Purification of IPC
    c. Interfacial polymerization
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
    (b) Polyacrylamide-aq.$NaNO_2$ solution(Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.

5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Reference Books:

1. Malcohm P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed.
2. Harry R. Allcock, Frederick W. Lampe and James E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall, 2003.
3. Fred W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience, 1984.
4. Joel R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall, 2003.
5. Petr Munk and Tejraj M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons, 2002.
6. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons, 2005.
7. Malcolm P. Stevens, *Polymer Chemistry: An Introduction*, 3rd ed. Oxford University Press, 2005.
8. Seymour/ Carraher's *Polymer Chemistry*, 9th ed. by Charles E. Carraher, Jr., 2013.

Course Title: Research Methodology for Chemistry

Course Code: CHE377

Time: 05 Hours

L	T	P	Credits	Marks	Pass Marks
5	1	0	6	150	60

Course Objectives:

This course is intended to learn the basic concepts of Research Methodology for Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Research Methodology for Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (20 Lectures)

Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journalabbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index,Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups andcommunities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web.Internet resources for chemistry. Finding and citing published information.

PART B (20 Lectures)

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

PART C (12 Lectures)

Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working

with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

PART D (23 Lectures)

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and theiruse.Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests.Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A., *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow, 2011.
2. Hibbert, D. B. & Gooding, J. J. *Data analysis for chemistry*. Oxford University Press.2006
3. Topping, J. *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.1984
4. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman, Chapters 3-5, 2007.
5. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific dataanalysis.* Cambridge Univ. Press, 487 pages, 2001.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
7. OSU safety manual 1.01.

Course Title: Molecular Modelling and drug design

Course Code: CHE378

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Molecular Modelling and drug design for Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Molecular Modelling and drug design for Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A **(10 Lectures)**

Introduction to Molecular Modelling:

Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

PART B **(14 Lectures)**

Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

PART C **(12 Lectures)**

Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

PART C **(24 Lectures)**

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

Structure Prediction and Drug Design:

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design,

Drug Discovery – Chemoinformatics – QSAR.

Reference Books:

1. Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
2. Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
3. Gupta, S. P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

Course Title: Molecular Modelling and drug design Lab
Course Code: CHE379

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Molecular Modelling and drug design lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Molecular Modelling and drug design lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

i. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecularσbondsorbitalsandethene,of ethyne,etha benzene andπbondspyriine.
ii. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene.
iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
iv. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
v. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).
vi. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
vii. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
ix. (a) Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Reference Books:

1. Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
2. Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
3. Gupta, S. P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

Scheme of Courses B.Sc (Hons.) Chemistry (Program ID- 5)
Semester-6

S No.	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	CHE315	Inorganic Chemistry-IV	Core	4	0	0	4
2	CHE316	Inorganic Chemistry-IV Lab	Core	0	0	4	2
3	CHE317	Organic Chemistry-V	Core	4	0	0	4
4	CHE318	Organic Chemistry-V Lab	Core	0	0	4	2
5	Generic Elective-VI		GE				6
6	Discipline Specific Elective-III		DSE-3				6
7	Discipline Specific Elective-IV		DSE-4				6
	Total						30

GE (Generic Elective-VI) (Choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	PHY353	Mechanics and Waves	4	0	0	4
	PHY354	Mechanics and Waves Lab	0	0	3	2
2	CHE330	Physical and Chemical Aspects of Biological chemistry	4	0	0	4
	CHE331	Physical and Chemical Aspects of Biological chemistry Lab	0	0	3	2

DSE (Discipline Specific Electives)-III (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE381	Green Chemistry	4	0	0	4
	CHE382	Green Chemistry Lab	0	0	4	2
2	CHE383	Applications of Computers in Chemistry	4	0	0	4
	CHE384	Applications of Computers in Chemistry lab	0	0	4	2

DSE (Discipline Specific Electives)-IV (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE385	Instrumental Methods of Analysis	4	0	0	4
	CHE386	Instrumental Methods of Analysis lab	0	0	4	2
2	CHE387	Industrial Chemicals & Environment	4	0	0	4
	CHE388	Industrial Chemicals & Environment lab	0	0	4	2

Course Title: Inorganic Chemistry-IV

Course Code: CHE315

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (10 Lectures)

Theoretical Principles in Qualitative Analysis (H_2S Scheme)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

PART B (22 Lectures)

Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behavior of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium inpolymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

PART C **(18 Lectures)**

Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

PART D **(10 Lectures)**

Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

Reference Books:

Recommended Texts:

1. Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972
2. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, 1996-03-07.
3. Cotton, F.A. G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India,
4. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.,* Harper Collins 1993, Pearson,2006.
5. Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005
6. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry3rd Ed.*, John Wiley and Sons, NY, 1994.
7. Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements*, *Elsevier 2nd Ed*, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
8. Lee, J.D. *Concise Inorganic Chemistry 5th Ed.,* John Wiley and sons, 2008.
9. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
10. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
11. Basolo, F. & Person, R. *Mechanisms of Inorganic Reactions: Study of MetalComplexes in Solution 2nd Ed.*, John Wiley & Sons Inc; NY.
12. Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
13. Miessler, G. L. & Donald, A. Tarr, *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
14. Collman, James P. et al. *Principles and Applications of Organotransition MetalChemistry*. Mill Valley, CA: University Science Books, 1987.
15. Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals*. *j* New York, NY: John Wiley, 2000.
16. Spessard, Gary O., &Gary L. Miessler. *Organometallic Chemistry*. Upper Saddle River, NJ: Prentice-Hall, 1996.

Course Title: Inorganic Chemistry Lab-IV

Course Code: CHE316

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:
CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}
Mixtures should preferably contain one interfering anion, **or** insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3)**or** combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^- , NO_3^- and I^-.
Spot tests should be done whenever possible.

i. Measurement of 10 Dq by spectrophotometric method
ii. Verification of spectrochemical series.
iii. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
iv. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Findλ the $_{max}$ of the complex.
v. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Reference Books

1. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla.
2. Marr & Rockett *Inorganic Preparations.*

Course Title: Organic Chemistry-V

Course Code: CHE317

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (24 Lectures)

Organic Spectroscopy

General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules λmaxforcalculationforα,βtheunsaturatedfollowingaldehydes,systems: ketones,
carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds.

Applications of IR, UV and NMR for identification of simple organic molecules.

PART B (16 Lectures)

Carbohydrates

Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

Disaccharides – Structure elucidation of maltose, lactose and sucrose.

Polysaccharides – Elementary treatment of starch, cellulose and glycogen.

PART C (8 Lectures

Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

PART D (12 Lectures)

Polymers

Introduction and classification including di-block, tri-block and amphiphilic polymers; Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.

Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.

Reference Books:

1. Kalsi, P. S. *Textbook of Organic Chemistry 1stEd.*, New Age International (P) Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
4. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.
5. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry ofNatural Products*), Dorling Kindersley (India) Pvt. Ltd. Pearson Education.
6. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan 2010.
9. Kemp, W. *Organic Spectroscopy*, Palgrave

Course Title: Organic Chemistry Lab-V

Course Code: CHE318

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
5. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

Reference Books:

1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson, 2012.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education, 2009
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.*, Pearson, 2012
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis*, University Press, 2000.
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry:Qualitative Analysis*, University Press, 2000.

Course Title: Mechanics and Waves

Course Code: PHY 353

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Mechanics and Waves. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Mechanics and Waves. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (11 Lectures)

LAWS OF MOTION

Inertial reference frame, Newton's laws of motion, motion in uniform field, components of velocity and acceleration in different coordinate systems, uniformly rotating frame, fictitious force, Coriolis force and its applications.

PART B (11 Lectures)

CENTRAL FORCES

Conservative and Non-conservative forces, Two particle central force problem, reduced mass, equation of motion, conservation of linear and angular momenta, conservation of energy, Nature of motion under central force and differential equation of motion under central force, Kepler's laws.

PART C (11 Lectures)

SIMPLE HARMONIC MOTION

Simple harmonic motion, differential equation of S.H. M. and its solution, velocity and acceleration of S.H.M., Energy of a simple harmonic oscillator, examples of simple harmonic motion, similarities between electrical and mechanical oscillators.

PART D (12 Lectures)

WAVE MOTION

Type of waves, the wave equation and its solution, Characteristic impedance of a string, Impedance matching, Reflection and transmission of energy, Reflected and transmitted energy coefficients, Standing waves on a string of fixed length, Energy of a vibrating string. Wave and group velocity their measurements.

B**ooks:**

1. E.M. Purcell *Berkeley Physics Course* (Vol. 1), *Mechanics*, (Ed), McGrawHill Publication.

2. Feymman, R. P.; Lighton, R. B.; Sands,M.; *The Feymman Lectures in Physics* (Vol. 1), BI Publications, Delhi
3. Puri,S.P. *Fundamentals of Vibration and Waves*, Tata McGraw Hill Company, New Delhi.
4. Arora, C.L. and Hemne,P.S. *Physics for degree students*, S. Chand Company, New Delhi 2010.
5. Tayal, D.C. *Mechanics* Himalayan Publishing House, Mumbai, 2013.
6. Srivastava,P.K. "*Mechanics*" (New Age International).

Course Title: Mechanics and Waves Laboratory

Course Code: PHY 354

Time: 03 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	3	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Mechanics and Waves Laboratory. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Mechanics and Waves Laboratory. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

(60 hrs.)

List of Experiments:

Experimental skills: General Precautions for measurements and handling of equipment, representation of measurements, Fitting of given data to a straight line, and Error analysis, Significant figures and interpretation of results

1. Use of Verniercallipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Lightmeter, dry and wet thermometer, TDS/conductivity meter and other measuring instruments based on applications of the experiments. Use of Plumb line and Spirit level.
2. To analyse the given experimental Data by using the least squares curve fitting and the knowledge of straight line fitting of the experimental data. Also determine the standard deviation and their use in expressing the experimental results. (Note: To achieve these objectives on a sample data of some experiment to be decided by the teacher concerned.)
3. To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine:
   (i) Radius of gyration of bar about an axis through its C.G. and perpendicular to its length.
   (ii) The value of g in the laboratory.
4. Determination of acceleration due to gravity ‘g’ by Kater’s pendulum method.
5. To study moment of inertia of a flywheel.
6. Determination of height (of inaccessible structure) using sextant.
7. To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar.
8. To study one dimensional collision using two hanging spheres of different materials.
9. To study the magnetic field produced by a current carrying solenoid using a pickupcoil/Hall sensor and to find the value of permeability of air.
10. To determine the frequency of A.C. mains using sonometer.

11. To study C.R.O. as display and measuring device by recording sines and square waves, output from a rectifier, verification (qualitative) of law of electromagnetic induction and frequency of A.C. mains.
12. To measure thermo e.m.f. of a thermocouple as a function of temperature and find inversion temperature.
13. Determination of given inductance by Anderson's bridge.
14. To determine the value of an air capacitance by deSauty Method and to findpermittivity of air. Also, determine the dielectric constant of a liquid.
15. Study of R.C. circuit with a low frequency a.c. source.
16. Studies based on LCR Board: Impedance of LCR circuit and the phase and between voltage and current.
17. To measure low resistance by Kelvin’s double bridge/ Carey Foster’s bridge.

17. To study the basic ideas of equal a priori probability, law of two independent events, and probability distribution of identical particles in two compartments for a two option system using coloured dice

Course Title: Physical and Chemical Aspects of Biological Chemistry

Course Code: CHE330

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Physical and Chemical Aspects of Biological Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical and Chemical Aspects of Biological Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (14 Lectures)

Chemical Bond:

Concepts of Atoms and Molecules,

Chemical Bonds and their importance in structure of biomolecules: Ionic Bonds ,Covalent bond. Dipole moment and molecular structure. Weak chemical forces-hydrogen bond, inter and intramolecular hydrogen bonds, effects of hydrogen bonding, Van der Waals forces. Electrophiles and Nucleophiles.

PART B (14 Lectures)

Water, Acid ,Base and Chemical reaction:

Water as a biological solvent, physical and chemical properties of water, importance of water for living organisms.

Properties of Acid and Base. Shapes of titration curves of strong and weak acids and bases. Meaning of ka and pka values.

Chemical reactions: Chemical equation-oxidation reduction reaction-redox potential and its role in biological reaction

PART C (14 Lectures)

pH, Buffer and Physiological Buffers:

Concept of pH and pOH, numerical problems of pH, methods to determine pH, pH meters-types of electrodes , principle and working of pH meter.

Buffers, buffer capacity and factors affecting buffering capacity, Henderson– Hesselbalch equation, simple numerical problems involving application of this equation.Physiological Buffers: Types and importance.

PART D (16 Lectures)

Osmosis, Viscosity, Diffusion, Adsorption and solution:

Basic principles and importance of Osmosis, Viscosity, Diffusion and Adsorption in lifesciences.

Mole concept, Normal, Molar, Molal and Percent Solutions. Numerical problems. Stock, Working solutions .preparation of w/v, v/v and dilute solutions. Concepts of Density and specific gravity.

Reference Books:

1) Frifelder, D.; Freeman, W.H.and Co.,*Physical biochemistry* by.
2) Vanholde, K.E.*Physical biochemistry,* Practice Hall Inc. New Jersey.
3) Cooper,*Tools of biochemistry*.
4) Eric Conn., P.K.Stumpf.*Outlines of biochemistry,* John Wiley and Sons.
5) Nelson, David & Cox., *Lehninger'sPrinciples of Biochemistry*, Macmillan NY.
6) Donald, V., Judith V. and Charlotte P.*Fundamentals of Biochemistry* by John Willey and Sons.
7) Stryer, L.; Freeman, W.H.and Co*Biochemistry*.
8) Fisher, J. Arnold,J.R.P. *Instant Notes in Chemistry for Biologists*.
9) Atkins J,*Chemical Principles*, *the quest for insight*

Course Title: Physical and Chemical Aspects of Biological chemistry lab

Course Code: CHE331

L	T	P	Credits	Marks	Pass Marks
0	0	3	2	50	20

Time: 03 Hours

Course Objectives:

This course is intended to learn the basic concepts of Physical and Chemical Aspects of Biological chemistry lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical and Chemical Aspects of Biological chemistry lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

1. Introduction to Basic Instruments used in Biochemistry laboratory- Microscope, Balance, Vortex mixer, Magnetic stirrer, Refrigerator, Water Distillation system, Water bath , Incubator , Hot air Oven.
2. Use, importance and cleaning of different types of glassware and auto pipettes and their calibration.
3. Principle and Use of pH meter.
4. Measuring and adjusting pH of given sample.
5. Preparation of different types of buffer solutions.
6. Preparation and Numerical problems on Normal Solutions.
7. Preparation and Numerical problems on Molar Solutions.
8. Preparation and Numerical problems on percent solutions and dilutions.

Reference Books:

1) K.Wilson and Walker*Principles and techniques of practical biochemistry*, Cambridge University press.
2) Upadhyay and Nath*Biophysical biochemistry*.
3) Eric Conn., Stumpf. P.K.*Outlines of biochemistry* John Wiley and Sons.
4) Lubert S., Freeman W.H.and Co.*Biochemistry*.
5) Thimmaiah,S.R.*Standard methods of biochemical analysis*, Kalyani Publishers Delhi, India.
6) Irwin H. Segel*Biochemical Calculations*.

Course Title: Green Chemistry

Course Code: CHE381

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Green Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Green chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (4 Lectures)

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

PART B (24 Lectures)

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

PART C (24 Lectures)

Examples of Green Synthesis/ Reactions

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium

iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.

2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).

Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

3. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

4. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

PART D (8 Lectures)

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; on covalent derivatization; Green chemistry in sustainable development.

Reference Books:

1. V.K. Ahluwalia & M.R. Kidwai: *New Trends in Green Chemistry*, Anamalaya Publishers 2005.
2. P.T. Anastas & J.K. Warner: *Oxford Green Chemistry- Theory and Practical*, University Press 1998.
3. A.S. Matlack: *Introduction to Green Chemistry*, Marcel Dekker, 2001.
4. M.C. Cann & M.E. Connely: *Real-World cases in Green Chemistry*, American Chemical Society, Washington, 2000.
5. M.A. Ryan & M. Tinnesand, *Introduction to Green Chemistry*, American Chemical Society, Washington, 2002.

Course Title: Green Chemistry Lab

Course Code: CHE382

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Applications of Computers in Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Applications of Computers in Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

1. Safer starting materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

- Effect of concentration on clock reaction
- Effect of temperature on clock reaction. (if possible)

2. Using renewable resources

Preparation of biodiesel from vegetable oil.

3.Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH^- → propene + trimethylpropene + water

(II) 1-propanol $\xrightarrow{H_2SO_4/}$ propene + water

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

Alternative Green solvents

5. Diels Alder reaction in water

Reaction between furan and maleic acid in water and at room temperature rather than in benzene

and reflux.
6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice.
7. Mechanochemical solvent free synthesis of azomethines
8. Co-crystal controlled solid state synthesis (C^2S^3) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.

Alternative sources of energy
9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press, 1998.
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment*. American Chemical Society, Washington DC, 2002.
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington D, 2002.
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93-81141-55-7, 2013.
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society, 2008.
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society, 2008.
7. Pavia, D. L. Lamponan, G. H. & Kriz, G.S. *W B Introduction to organic laboratory*.

Course Title: Applications of Computers in Chemistry

Course Code: CHE383

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Applications of Computers in Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Applications of Computers in Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Theory: 60 Lectures

Basics:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Numerical methods:

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterativemethod, Newton-Raphson method, Binary bisection and Regula-Falsi.

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probabilitydistributions and mean values.

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.

Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideasof molecular mechanics and practical MO methods.

Reference Books:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman, Chapters 3-5, 2007.
2. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press, 487 pages, 2001.
3. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. 1985.
4. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* JaicoPublishing House: Delhi, 1996.

Course Title: Applications of Computers in Chemistry Lab

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Code: CHE384

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Applications of Computers in Chemistry Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Applications of Computers in Chemistry Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

60 Lectures

Computer programs based on numerical methods forRoots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).

1. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
2. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.
3. Matrix operations. Application of Gauss-Siedel method in colourimetry.
4. Simple exercises using molecular visualization software.

Reference Books:

1. McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008).
2. Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier, 2005.
3. Steiner, E. *The Chemical Maths Book* Oxford University Press, 1996.
4. Yates, P. *Chemical Calculations*. 2nd Ed. CRC Press, 2007.
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman Chapters 3-5, 2007.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*,Cambridge Univ. Press 487 pages, 2001.
7. Noggle, J. H. *Physical Chemistry on a Microcomputer*. Little Brown & Co. 1985.
8. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* JaicoPublishing House: Delhi, 1996.

Course Title: Instrumental Methods of Chemical Analysis

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Code: CHE385

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Instrumental Methods of Chemical Analysis. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic Instrumental Methods of Chemical Analysis. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (20 Lectures)

Introduction to spectroscopic methods of analysis:
Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Molecular spectroscopy:
Infrared spectroscopy:
Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.
UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitationsources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

PART B (16 Lectures)

Separation techniques
Chromatography: Gas chromatography, liquid chromatography, supercritical fluids,Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple

vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques
Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemicalionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

PART C (12 Lectures)

Elemental analysis:
Mass spectrometry (electrical discharges).
Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence.excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).
NMR spectroscopy: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.

PART D (12 Lectures)

Electroanalytical Methods: Potentiometry & Voltammetry
Radiochemical Methods
X-ray analysis and electron spectroscopy (surface analysis)

Reference books:

1. Douglas A. Skoog, F. James, H., Stanley, C. (ISBN 0-495-01201-7)*Principles of Instrumental Analysis* - 6th Edition.
2. Willard, Merritt, Dean, Settle*Instrumental Methods of Analysis*, 7th ed,
3. P.W. Atkins: *Physical Chemistry*.
4. G.W. Castellan: *Physical Chemistry*.
5. C.N. Banwell: *Fundamentals of Molecular Spectroscopy*.
6. Brian Smith: *Infrared Spectral Interpretations: A Systematic Approach*.
7. W.J. Moore: *Physical Chemistry*.

Course Title: Instrumental Methods of Chemical Analysis Lab

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Code: CHE386

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Instrumental Methods of Chemical Analysis Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Instrumental Methods of Chemical Analysis Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
12. Determination of Caffeine in Beverages by HPLC
13. Potentiometric Titration of a Chloride-Iodide Mixture
14. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
15. Nuclear Magnetic Resonance
16. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
17. Use of “presumptive tests” for anthrax or cocaine
18. Collection, preservation, and control of blood evidence being used for DNA testing
19. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
20. Use of sequencing for the analysis of mitochondrial DNA
21. Laboratory analysis to confirm anthrax or cocaine
22. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
23. Detection of illegal drugs or steroids in athletes
24. Detection of pollutants or illegal dumping

25. Fibre analysis

Reference Books:

1. Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7) *Principles of Instrumental Analysis - 6th Edition* by
2. Willard, Merritt, Dean, Settle*Instrumental Methods of Analysis*, 7th ed,

Course Title: Industrial Chemicals and Environment

Course Code: CHE387

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Industrial Chemicals and Environment. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Industrial Chemicals and Environment. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

PART A (14 Lectures)

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of thefollowing gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling thefollowing chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

PART B (30 Lectures)

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2 , CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources andnature of

water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiarytreatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

PART C (10 Lectures)

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

PART D (6 Lectures)

Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, *Environmental Chemistry*, CRC Press, 2005.
8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole, 2006.
9. A. Mishra, *Environmental Studies. Selective and Scientific Books*, New Delhi, 2005.

Course Title: Industrial Chemicals and Environment Lab

L	T	P	Credits	Marks	Pass Marks
0	0	4	2	50	20

Course Code: CHE388

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Industrial Chemicals and Environment Lab. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Industrial Chemicals and Environment Lab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi