DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

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

(As per Choice Based Credit System)

1st TO 6th SEMESTER

2022–2023

2022-2023

The Bachelor of Science in Chemistry lays the groundwork for various fields of study. Its principal objective is to cultivate a thorough understanding of essential principles and concepts in chemistry. The updated curriculum is meticulously structured on a discipline-based approach, ensuring that it remains manageable while also meeting international standards.

PROGRAM EDUCATION OBJECTIVES (PEO)

PEO-1 To provide the students an in-depth understanding of the basic concepts of chemical sciences.

PEO-2 To develop student skill in problems solving, critical thinking and analytical reasoning.

PEO-3 To pursue higher studies, research and analysis in various disciplines of chemistry.

PEO-4 To attain entrepreneurship and self-empowerment in the area of chemical sciences.

PEO-5 To Provide a contemporary grounding in professional responsibility and ability to find solutions in a global, economic, environmental, and societal context.

Programme Outcomes

PO1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3. Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

Program Specific Outcomes (PSO)

PSO-1 The students will understand the existence of matter in the universe as solids, liquids, and gases which are composed of molecules, atoms and sub atomic particles.

PSO-2 Students will learn to estimate inorganic salt mixtures and organic compounds both qualitatively and quantitatively using the classical methods of analysis in practical classes.

PSO-3 Students will grasp the mechanisms of different types of reactions both organic and inorganic and will try to predict the products of unknown reactions.

PSO-4 Students will learn to synthesize the chemical compounds by maneuvering the addition of reagents under optimum reaction conditions.

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	CHE111A	Inorganic Chemistry-I	Core	4	0	0	4
2	CHE112A	Inorganic Chemistry Lab-I	Core	0	0	4	2
3	CHE113A	Physical Chemistry-I	Core	4	0	0	4
4	CHE114A	Physical Chemistry Lab-I	Core	0	0	4	2
5	SGS107	Human Values and General Studies	AECC	4	0	0	4
	NCC	NCC					2
6	Generic Elective-I		GE				6
7	Generic Elective-II		GE				4
8	NCC		Core				
	Total						26

GE (Generic Elective-I) (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	ZOO154	Zoology Diversity	4	0	0	4
	ZOO155	Zoology Diversity Lab	0	0	3	2
3	BTY121	Cell Biology	4	0	0	4
	BTY122	Cell Biology 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
3	BOT131	Plant Diversity	4	0	0	4

Course Title: Inorganic Chemistry-I

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

Course Code: CHE111A

Total Lectures: 60

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.

Course Outcomes

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

CO-1 Utilize the knowledge in quantum mechanics.
CO-2 Understand and utilize the knowledge of the periodic table and periodic properties
CO-3 Understand the concept of theories of covalent bonds Perceive the importance of structures and geometries of molecules using Radius Ratio Rules, VSEPR and MO theory
CO-4 Understand the concept of lattice energy using Born-Landé and Kapustinskii expression, rationalize the conductivity of metals, semiconductors and insulators based on the Band theory, understand the importance and application of chemical bonds, weak chemical forces and their effects,

UNIT I

Atomic Structure: (15 Lectures)

Bohr's theory and it's limitations, the nature of light, Bohr's theory of the atomic spectrum of hydrogen atom.
Wave mechanics: The wave-nature of electrons, The uncertainty principle and its significance, de Broglie equation, The Schrodinger wave equation, significance of ψ and ψ^2.

Quantum numbers and their significance. The radial part of the wave function and the radial distribution function Shapes of *s*, *p*, *d* and *f* orbitals, The angular part of the wave function. Sign of wave functions.
Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, The aufbau principle and its limitations, Variation of orbital energy with atomic number.

UNIT II

Periodicity of Elements: (15 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 and ionic radii.
(c) Ionization energy, Successive ionization energies and factors affecting ionization energy. Applications of ionization energy.
(d) Electron affinity, trends of electron gain enthalpy.
(e) Electronegativity, Pauling's/ Allred Rachow's/ and Mulliken's electronegativity scales. Variation of electronegativity with bond order, the inert-pair effect.

UNIT III

Covalent bond: (15 Lectures)

Lewis structures, Valence Bond theory (Heitler-London approach). Hybridization of atomic orbitals, 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; heteronuclear diatomic Molecules HF, CO and NO. Formal charge, Valence shell electron pair repulsion theory (VSEPR) and shapes of molecules, Limitations of the VSEPR model.
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.

UNIT IV

Ionic, Metallic bonding and weak chemical forces: (15 Lectures)

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of spheres, Cubic and hexagonal close-packing. The unit cell, Lattice energy: Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application.

Bonding in metals and semiconductors: Qualitative idea of band theories for Semiconductors and insulators, Types of Semiconductors, Defects in solid state lattices, Schottky defect, Frenkel defect
Weak Chemical Forces: vander Waals forces, Dipole moments, dipole-dipole interactions, dipole-induced dipole forces. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force on the melting and boiling points, solubility energetics of dissolution

process.

Reference Books:

1. Concise Inorganic Chemistry (4th Edition) By J. D. Lee.
2. Shriver and Atkins' Inorganic Chemistry, 5th Edition.
3. Pearson - Inorganic Chemistry, 5/E - Catherine Housecroft
4. Pfennig, Brian William-Principles of inorganic chemistry-Wiley (2015)
5. Principles of Inorganic Chemistry by B.R. Puri, L.R. Sharma, K.C. Kalia

Course Title: Inorganic Chemistry Lab -I

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

Course Code: CHE112A

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.

Course Outcomes

CO1 The course will help them to understand the difference between qualitative and quantitative analysis.

CO2 They will use titration as a skill for quantitative analysis.

CO3 Students will perform the test for qualitative estimation of various acid and basic radicals.

1. Qualitative Analysis:
Semi micro analysis of salt mixtures containing two acidic and two basic radicals.

2. Quantitative Analysis:
Calibration and use of apparatus, Preparation of solutions of different Molarity/Normality of titrants.

(A) Acid-Base Titrations
(i) Estimation of carbonate and bicarbonate present together in a mixture.
(ii) Estimation of free alkali present in different soaps/detergents.
(B) Oxidation-Reduction Titrimetry
(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Svehla G., Vogel's Qualitative Inorganic Analysis (revised); 7th edition, Pubs: Orient Longman,1996.
2. Bassett, J., Denney, R. C., Jeffery, G. H., Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised); 4th edition, Pubs: Orient Longman, 1978.

Course Title: Physical Chemistry-I

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

Course Code: CHE113A

Total Lectures: 60

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.

Course Outcomes

CO1	The learners will be able to differentiate different States of Matter on the basis of their properties.
CO2	The learners will be able to understand the utility of the matter taught.
CO3	Students will be able to apply the concept practically
CO4	The learners will be able to solve numerical problems based on the driven formulas.
CO5	The learners will be able to think analytically and relate the learned concepts with their surroundings

UNIT I

Gaseous state: **(15 Lectures)**

Kinetic molecular model of a gas: Postulates of kinetic theory of gases, Derivations of gas laws; Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable); effect of temperature on distribution of molecular velocities; Expansivity and compressibility; Derivation for expression for average, root mean square and most probable velocity, collision frequency; collision diameter; mean free path, relation between mean free path and

coefficient of viscosity, calculation of mean free path with temperature and pressure. Degrees of freedom, law of equipartition of energy, heat capacities of an ideal gas

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, Clausius, Redlich-Kwong,); virial equation of state; Calculation of Boyle temperature. PV isotherms of real gases, and their comparison with vander Waals isotherms, continuity of states, critical constant; relation between critical constants and vander Waals constants, law of corresponding states.

UNIT II

Liquid state: (7 Lectures)

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension, viscosity and their determination. Young-Laplace equation, Effect of addition of various solutes on surface tension and viscosity; Explanation of cleansing action of detergents; Effect of Temperature and pressure on viscosity of liquids; Reynolds number, Refraction and optical activity.

Liquid crystals: Difference between liquid crystal, solid and liquid; classification, structure of nematic and cholestric phases; thermography.

UNIT III

Solid state: (8 Lectures)

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, 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, various defects in crystals.

UNIT IV

Ionic equilibria: (15 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

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; Multi stage equilibria in polyelectrolyte systems

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry 9th Ed*., Oxford University Press, 2010.
2. Ball, D. W. *Physical Chemistry* Thomson Press, India, 2013.
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa, 2004.
4. K.J. Laidler. *Physical Chemistry*, Houghton Mifflin; 2nd edition, 2006
5. K.L. Kapoor, Vol-1, Publisher: Laxmi Publications; Fourth edition (2011)

Course Title: Physical Chemistry Lab-I

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

Course Code: CHE114A

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.

Course Outcomes

CO1	The learners will be able to measure the physical properties of liquids.
CO2	The learners will be able to analyse the behaviour of different liquids.
CO3	The learners will be able to identify the gap between theoretical and experimentation.
CO4	The learners will be able to think analytically and relate the learned concepts with their surroundings

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 of solute.
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 Chemistry 8th 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

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

Course Code: SGS107

Total Lectures: 60

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 interdisciplinary subjects like Geography, Science, Economy, Polity, History, International Relations etc.

UNIT I

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**

UNIT II

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**

UNIT III

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.

UNIT IV

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: MODERN PHYSICS

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

Course Code: PHY155A
Total Lectures: 60

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

Course Outcomes (CO)
CO1: Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter
CO2: Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, probability density and the normalization techniques, skill development on problem solving e.g. one dimensional rigid box, tunneling through potential barrier, step potential, rectangular barrier.
CO3: Understand the quantum theory of non-relativistic Hydrogen atom and effect of magnetic field on spectral lines to understand Zeeman Effect respectively.
CO4: Knowledge about properties of atomic nucleus, liquid drop model and nuclear shell model and radioactivity, radioactive decays like alpha, beta, gamma decay.

UNIT I

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.

UNIT II

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.

UNIT III

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.

UNIT IV

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

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

Course Code: PHY156

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 3 hours duration.
- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Correlate between theory and experimental results, directly see the proof of principles and theories through practical knowledge
2	Use of specific measurement instruments and experimental apparatuses used in the modern physics lab, including necessary precautions
3	Apply basic quantum physics to find out Planck's constant, measurement of Ionization Potentieal, measurement of e/m ration by Milliken Oil drop method etc.
4	Find out the conductivity and type of semiconductor using Four probe method and Hall experimental respectively.

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: Mathematics for Chemists-I
Course Code: MTH 160A

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

Total Lectures: 60

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.

Course Outcomes (COs): After successfully completing this course the students will be able to
CO1: understand the basic concept of trigonometric functions and their formulae.
CO2: use the fundamental concepts of permutation and combination, principle of mathematical induction and binomial theorem on different problems in chemistry.
CO3: recall the concepts of matrices and its application to solve the system of linear equations.
CO4: understand the properties of coordinate geometry for idea of location, graph and distance between two lines and discuss definition of sphere, cone and cylinder.

UNIT I (14 Lectures)

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

UNIT II (14 Lectures)

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

UNIT III (16 Lectures)

Determinants and Matrices:
Introduction to matrix, Different kinds of matrices, Addition, Multiplication, Symmetric andSkew 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).

UNIT IV (16 Lectures)

Co-ordinate Geometry:
Polar & Cartesian co-ordinates in plane, different forms of straight lines. Angle between twoStraight 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

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	CHE115A	Organic Chemistry-I	Core	4	0	0	4
2	CHE116A	Organic Chemistry Lab-I	Core	0	0	4	2
3	CHE117A	Physical Chemistry-II	Core	4	0	0	4
4	CHE118A	Physical Chemistry Lab-II	Core	0	0	4	2
5	EVS100	Environmental studies	AECC	4	0	0	4
6	ENG151B	Basic Communication Skills	AECC	3	0	0	3
7	ENG152A	Basic Communication Skills Lab	AECC	0	0	2	1
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	PHY153A	Optics and Lasers	4	0	0	4
	PHY154	Optics Lab	0	0	3	2
2	BTY123	Fundamentals of Cell Biology	4	0	0	4
	BTY124	Fundamentals of Cell Biology	0	0	3	2

Course Title: Organic Chemistry-I

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

Course Code: CHE115A

Total Lectures: 60
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.

Course Outcomes

CO1: To Understand the nature of bonding and basic concepts of electron movement in small organic molecules.
CO2: To learn and formulate the free radical substitution and electrophilic addition reaction mechanisms.
CO3: To understand the physical and chemical properties of alkanes, alkenes and alkynes.
CO4: To understand the fundamental concepts of stereochemistry and apply it to different organic compounds.
CO5: To know the properties of aromatic compounds and their electrophilic aromatic substitution reactions.

UNIT I

Structure, Bonding and Mechanism of Organic Reactions: (15 Lectures)
Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, resonance, hyper conjugation, aromaticity, inductive and field effects, hydrogen bonding. Curved arrow notation, drawing electron movements with arrows half-headed and double-headedarrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates – carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species. Methods of

determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

Stereochemistry of Organic Compounds-I

Concept of isomerism. Types of isomerism. Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Difference between configuration and conformation. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Geometric isomerism – determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

UNIT II

Alkanes and Cycloalkanes: (15 Lectures)

Stereochemistry of Organic Compounds-II

Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative.

Alkanes and Cycloalkanes:

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes – nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings. The case of cyclopropane ring; banana bonds.

UNIT III

Alkenes, Cycloalkenes, Dienes (15 Lectures)

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rules, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes – mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$ Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. Methods of formation, conformation and Chemical reactions of cycloalkenes. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions– 1,2 and 1,4 additions, Diels-Alder reaction.

UNIT IV

Alkynes, Arenes and Aromaticity (15 Lectures)

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation, Hydrogenation and polymerization. Arenes and Aromaticity: Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus

and side chain. Structure of benzene: molecular formula and Kekule structure. Stabilityand carbon-carbon bond lengths of benzene, resonance structure, MO picture. Aromatic electrophilic substitution – general pattern of the mechanism, role of σ-and πcomplexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituent's, orientation and ortho/para ratio. Side chain reactions of benezene derivatives. Birch reduction. Methods of formation and chemical reactions of alkyl benzenes and biphenyl.

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.
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

Course Title: Organic Chemistry Lab-I

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

Course Code: CHE116A

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.

Course Outcomes

CO1: To Understand the importance of thermometer calibration and determine the melting or boiling points to check the purity of compounds.
CO2: To understand basic concept of purification of organic compounds through distillation, steam distillation and crystallization.
CO3: To apply the concept of decolourization of organic compounds using charcoal
CO4: Extraction of caffeine from tea leaves

1. Calibration of Thermometer
80-82^{o} (Naphthalene), 113-114^{o} **(**acetanilide**)**, 132.5-133^{o} (Urea), 100^{o} (distilled Water)
2. Determination of melting point
Naphthalene 80-82^{o}, Benzoic acid 121.5-122^{o}
Urea, 132.5-133^{o}, Succinic acid 184-185^{o}
Cinnamic acid 132.5-133^{o}, Salicylic acid 157-5-158^{o}
Acetanilide 113-5-114^{o}, m-Dinitrobenzene 90^{o}
p-Dichlorobenzene 52^{o}. Aspirin 135^{o}.
3. Determination of boiling points
Ethanol 78^{o}, Cyclohexane 81.4^{o}, Toluene 110.6^{o}
4. Mixed melting point determination
Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

5. Distillation

Simple distillation of ethanol-water and acetone-water mixtures using water condenser, Distillation of aniline using air condenser.

6. Crystallization

Concept of induction of crystallization

Phthalic acid from hot water (using fluted filter paper and stemless funnel), Acetanilide from boiling water, Naphthalene from ethanol, Benzoic acid from water.

7. Decolorisation and crystallization using charcoal

Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.

Crystallization and decolorisation of impure naphthalene (100g of naphthalene mixed with 0.3g of Congo Red using 1g decolorising carbon) from ethanol.

8. Sublimation

Camphor, Naphthalene, Phthalic acid and Succinic acid.

9. Extraction

Isolation of caffeine from tea leaves

10. Steam distillation

Purification of aniline/nitrobenzene by steam distillation.

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 Organic Chemistry,5th Ed.,* Pearson (2012)

Course Title: Physical Chemistry-II

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

Course Code: CHE117A

Total Lectures: 60

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.

Course Outcomes

CO1	To use defined thermodynamic terminology.
CO2	To Explain fundamental thermodynamic properties and chemical equilibrium
CO3	To describe the factors that favour the various thermodynamic processes
CO4	To Define and perform calculations for common concentration units molarity, molality and discuss the concepts of 4 colligative properties
CO5	To think analytically and relate the learned concepts with their surroundings

UNIT I

Chemical Thermodynamics: (36 Lectures)

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

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. Joule's law; Joule-Thomson coefficient and inversion temperature.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions 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.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

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

UNIT II

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; concept of fugacity and activity; method for determination of fugacity; variation of fugacity with temperature and pressure, fugacity of solids and liquids, Numerical.

UNIT III

Chemical Equilibrium: (8 Lectures)

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient; equilibrium constants and their quantitative dependence on temperature, pressure and concentration; Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier's principle (quantitative treatment).

UNIT IV

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 9th Ed.,* Oxford University Press, 2010.
2. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.
3. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall, 2014.

4. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi, 2004.
5. Maron S.H., Pretton C.F. (1965) Principles of Physical Chemistry, 4 Edition, Mac Millan Publishing Company, New York.
6. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.*Commonly Asked Questions in Thermodynamics.* CRC Press: NY, 2011.
7. Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2008.
8. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.

Course Title: Physical Chemistry Lab-II

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

Course Code: CHE118A

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.

Course Outcomes

CO1	The learners will be able to measure the thermodynamic properties of substance.
CO2	The learners will be able to analyse the behaviour of different types of heat flow
CO3	The learners will be able to understand the applications of Thermodynamics in basic sciences for deriving equations.
CO4	The learners will be able to think analytically and relate the learned concepts with their surroundings

Thermochemistry

(a) To determine the heat of solution of given salt.

(b) To Determine the Molecule Weight of given compound by Freezing Point Depression Method

(c) 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).

(d) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(e) Calculation of the enthalpy of ionization of ethanoic acid.

(f) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(g) 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.
(h) Determination of enthalpy of hydration of copper sulphate.
(i) Study of the solubility 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.

L	T	P	Credits	Marks
4	0	0	4	100

Course Title: Environmental Studies

Course Code: EVS100

Total Lectures: 60

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.

Course Outcomes (COs): After successfully completing this course the students will be able to
CO1: Understand the interconnected and interdisciplinary nature of environmental studies and develop critical thinking skills in relation to environmental affairs. Acquire knowledge about the depletion of the root cause of natural resources and their effective management.
CO2: **:** To aware about the biodiversity and its importance to mankind**.** Interpret and propose solutions to various environmental pollution, solid waste and disaster management.
CO3: Expand awareness of self in a global society and effectively engage diverse perspectives, values, and cultures, ranging from local to global, in dealing with environmental and social issues.
CO4: Awareness about effect of population increase on humans itself. Causes of spread of different diseases in society. How Indian government is supporting women and children that considered weakest section of society.
CO5:nil

UNIT I

Introduction to Environmental Studies

- Definition, components and types of Environment.
- Meaning of Environmental Studies and its Multidisciplinary nature;
- Scope and importance; Concept of sustainability and sustainable development.

6 hours

Natural Resources: Renewable and Non---Renewable Resources

- Land resources and land use change; Land degradation, soil erosion and desertification.

- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter---state).
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

8 hours

UNIT II

Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

2 hours

Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots

- India as a mega---biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In---situ and Ex---situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

8 hours

UNIT III

Environmental Pollution

Environmental Pollution: types, causes, effects and controls; Air, water, soil and noise pollution

- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

8 hours

Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

7 hours

UNIT IV

Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquake, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

6 hours

Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site---Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems---pond, river, Delhi Ridge, etc.

5 hours

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.

2. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36---37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29---64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.
14. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.

L	T	P	Credits	Marks
3	1	0	3	100

Course Title: Basic Communication Skills

Course Code: ENG151B

Total Lectures: 60

Course Objective:

- To enhance students' vocabulary and comprehension skills through the prescribed texts.
- To hone students' reading and writing skills.
- To teach the rules of English grammar descriptively.
- To make students aware about the socio-cultural aspect of English.

Learning Outcomes: Students will

- Have developed a wide vocabulary and be able to summarize ideas.
- Be able to read and analyze texts and display competence in written communication.
- Show a considerable understanding of English Grammar.
- Demonstrate sensitivity to cultural differences while communicating

Course Outcomes

- **CO1**: Students will be able to apply the concepts of grammar in socio-cultural context.
- **CO2**: Students will be able to perform basic writing tasks in order to enhance their communication skills.
- **CO3**: Students will recapitulate the concepts of Parts of Speech and Modals so as to improve communication.
- **CO4**: Students will be able to understand the relationship between Society and Language through reading and analyzing selected works.

<u>Unit – A</u>

1. **Applied Grammar (in Socio-Cultural Context)**
    - Tenses
    - Passives
    - Reported/Reporting Speech

Unit – B

1. **Reading (Communicative Approach to be Followed)**

    - Nissim Ezekiel : The Patriot (Poem)

(Sub-topic: Basic Introduction to Indianisms and Difference between Indian English & Standard English)

2. **Writing**

    - Paragraph Writing : Topic Sentence, Inductive logic, and Deductive logic
    - Essays: Narrative, Descriptive, Expository, and Persuasive
    - Notice: Format, Characteristics, and 5 W's,
    - Email: Structure, Characteristics of Effective Emails, and Advantages

Unit – C

1. **Applied Grammar (in Socio-Cultural Context)**

    - Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, and Interjection
    - Modals: Can, Could, May, Might, Will, Would, Shall, Should, and Must

Unit – D

1. **Reading (Communicative Approach to be Followed)**

    Alleen Pace Nilsen: Sexism in English (Prose)

    (Sub-topic: Relationship between Society & Language and Sexist Language)

2. **Writing**

    Letter Writing: Formal and Informal

Teaching Methodology:

a. **Grammar:** Grammar must be taught descriptively in socio-cultural context. The contextual teaching of grammar helps a learner understand the application of grammar rules in real life situations. The learner who learns grammar in isolation is unable to use the language fluently, whereas the learner who learns grammar in context uses the language confidently and fluently in real life situations.

b. **Literary Texts:** Communicative approach should be followed to teach the texts. Classroom activities guided by the communicative approach are characterised by trying to produce meaningful and real communication, at all levels. As a result there may be more emphasis on skills than systems, lessons are more learner-centred, and there may be use of authentic materials.

   Teachers can introduce the topic or theme of the text, pre-teach essential vocabulary items and use prediction tasks to arouse the interest and curiosity of students.

c. **Writing**: Some of the strategies that should be adopted are as follows:

   - Regularly assign brief writing exercises in your classes.
   - Provide guidance throughout the writing process, i.e. Pre-Writing, Drafting, Revising, Editing, and Publishing.
   - Give students opportunities to talk about their writing.
   - Encourage students to revise their work.

   Testing: The examinations will be conducted as per the norm of the university.

References:

a. Books

1. Eschholz, Paul and Rosa, Alfred (ed.), *Subject and Strategy*. NY: St. Martin's Press, 1978. Print.

2. Ezekiel, Nissim. *Collected Poems 1952-1988*. New Delhi: Oxford University Press, 1999. Print.

3. Hosler, Mary Margaret. *English Made Easy*. Delhi: McGraw, 2013. Print.
4. Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.
5. Mahanand, Anand. *English for Academic and Professional Skills*. Delhi: McGraw, 2013. Print.
6. Rani, D Sudha, TVS Reddy, D Ravi, and AS Jyotsna. *A Workbook on English Grammar and Composition*. Delhi: McGraw, 2016. Print.
7. Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2018. Print.
8. Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.
9. Tyagi, Kavita and Padma Misra. *Basic Technical Communication*. Delhi: PHI Learning, 2013. Print.

b. Websites

1. www.youtube.com (to watch standard videos)
2. http://learnenglish.britishcouncil.org/en
3. https://owl.english.purdue.edu/

Course Title: Basic Communication Skills Lab

L	T	P	Credits
0	0	2	1

Course Code: ENG152A

No. Of Lectures: 30

Course Objective:

- To improve the preparation and presentation competencies necessary for oral communication in a variety of contexts, as both a speaker and a listener.
- To improve pronunciation.
- To promote interactive skills through Group Discussions and role plays.

Learning Outcomes: Students will be able to:

- Develop proper listening skills
- Articulate and enunciate words and sentences clearly and efficiently
- Show confidence and clarity in public speaking projects

Course Outcomes

1. Students will have developed listening skills.
2. Students will be able to articulate words and sentences clearly and efficiently.
3. Students will be able to pronounce clearly and correctly.
4. Students will show confidence in public speaking projects.

Unit – A Speaking and Listening
● IPA for Language Learning - Basic Phonetics
● Movie-Clippings
● Role Plays

• Group Discussions
• Mock Interviews

Project File: Each student will prepare a project file on any of the topics given by class teacher. Student should be able to justify the contents of his/her scrap file. The file must be handwritten, not typed. Students must acknowledge all the sources of information in his/her scrap file.

Reference 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)
2. www.englishforeveryone.org
3. www.talkenglish.com
4. www.mindtools.com

Course Title: Optics and Lasers

Course Code: PHY153A
Total Lectures: 60

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.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	To impart students' knowledge of interference phenomena and applications.
2	To gain insights about the Fraunhoffer diffraction in detail.
3	To understand the concept of polarization, and its applications in day to day life.
4	To understand the concept of LASER, its working mechanism and various types and applications.

UNIT I

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.

UNIT II

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.

UNIT III

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.

UNIT IV

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; Qswitching; 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: PHY154

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.

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	CHE211B	Inorganic Chemistry-II	Core	4	0	0	4
2	CHE212A	Inorganic Chemistry Lab-II	Core	0	0	4	2
3	CHE213A	Organic Chemistry-II	Core	4	0	0	4
4	CHE214A	Organic Chemistry Lab-II	Core	0	0	4	2
5	CHE215A	Physical Chemistry-III	Core	4	0	0	4
6	CHE216A	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	CHE270A	Nanotechnology	4	0	0	4
4	BOT243	Plant Anatomy and Embryology	4	0	0	4

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

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE271A	Analytical Clinical Biochemistry	2	0	0	2
2	CHE272A	Chemical Technology & Society	2	0	0	2

Course Title: Inorganic Chemistry-II

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

Course Code: CHE211B

Total Lectures: 60

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.

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*

CO-1 Learn the fundamental principles of metallurgy and understand the techniques for mineral processing. understand techniques for the extraction of metals from metallic ores. Apply thermodynamic concepts like that of Gibbs energy and entropy to the principles of extraction of metals.

CO-2 Understand various models of Acid-base theories, the relative strength of acids and bases. Types of acid-base reactions and leveling solvents. Hard and Soft Acids and Bases (HSAB) and its application.

CO-3 Understand the chemistry and applications of s- and p-block elements. Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table. Understand oxidation states concerning elements in unusual and rare oxidation states.

CO-4 To identify the location of the noble gases on the periodic table, describe the physical properties of the noble gas elements, outline the trends in properties of the noble gases, recognize that some compounds of the noble gases have been made, describe the sources and uses of the noble gases.

UNIT I

General Principles of Metallurgy **(8 Lectures)**

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.

UNIT II

Acids and Bases **(8 Lectures)**

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

UNIT III

Inorganic Polymers **(7 Lectures)**

General properties of Inorganic polymers. Types of inorganic polymers, comparison with organic polymers, Borazines, silicates and polyphosphazines, and polyphosphates. Polymeric Sulphur and Sulphur nitrides

UNIT IV

Chemistry of s and p Block Elements: **(25 Lectures)**

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, Oxides and oxo acids of nitrogen, Phosphorus, and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

UNIT V

Noble Gases: **(12 Lectures)**

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; Structures of XeF_2, XeF_4 and XeF_6; and oxides of Xenon. Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2).

Reference Books:

1. Concise Inorganic Chemistry (4th Edition) By J. D. Lee.
2. Principles of Inorganic Chemistry by B.R. Puri, L.R. Sharma, K.C. Kalia
3. Inorganic Chemistry (5th Edition) by Gary L. Miessler, Paul J. Fischer, Donald A. Tarr.
4. Shriver and Atkins' Inorganic Chemistry, 5th Edition
5. Advanced Inorganic Chemistry: A Comprehensive Text Book by F. Albert Cotton and Geoffrey Wilkinson.
6. Concepts and Models of Inorganic Chemistry by Bodie E. Douglas; Darl H. McDaniel; John J. Alexander
7. http://symmetry.otterbein.edu/tutorial/index.html
8. https://nptel.ac.in/courses/113105024/

Course Title: Inorganic Chemistry Lab-II

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

Course Code: CHE212A

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.

Course Outcomes

CO1 The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in industry as a chemist or fulfilling their goals in academia by executing research projects.**CO2** They will use titration as a skill for quantitative analysis.

CO2 The course will help them to understand the synthetic routes/methodologies to synthesize inorganic compounds.

CO3 The course will teach them iodometry an analytical tool for quantitative estimation of various species.

(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 tris(acetylacetonato)manganese(III)

(iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

(iv) Preparation of potassium trioxalatochromate(III).

(v) Preparation of tris(thiourea)copper(II) sulphate.

Reference Books:

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

Course Title: Organic Chemistry-II

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

Course Code: CHE213A

Total Lectures: 60

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.

Course Outcomes

CO1: To understand the reactivity/stereochemistry of nucleophilic substitution reaction and elimination reactions of alkyl halides.
CO2: To learn different types of mechanism of aromatic nucleophilic substitution reaction.
CO3: To understand the physical and chemical properties of alcohols, phenols and ethers.
CO4: To understand the chemistry of nucleophilic addition reactions.
CO4: To learn the chemistry of enol/enolate ions and chemical reactions of active methylene compounds.
CO5: To know the physical properties of carboxylic acid and its derivatives and understand their reactivity towards nucleophilic substitution reactions.

UNIT I

Chemistry of Halogenated Hydrocarbons: (15 Lectures)

Alkyl halides*:* Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with energy profile diagrams and stereochemical aspects, and effect of substrates structure, nucleophiles and solvent *etc*.; nucleophilic substitution vs. elimination.

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

UNIT II

Alcohols, Phenols, Ethers and Epoxides: (15 Lectures)

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

Phenols: Nomenclature, physical properties, acidity of phenols and substituent effects, comparative acidic strengths of alcohols and phenols;preparation and reaction of phenols: ring substitution reactions, Reimer–Tiemann reaction, Gatterman synthesis, Kolbe's–Schmidt Reactions, Hauben-Hoesch reaction, Fries and Claisen rearrangements;oxidation of phenols, Dakin oxidation.

Ethers and Epoxides: Nomenclature, preparation and reactions: the Williamson ether synthesis, acid catalysed cleavage of ethers, preparation of epoxides, Conversion of vicinal halohydrins to epoxides, reactions of epoxides with alcohols, ammonia derivatives, $LiAlH_4$ and with Grignard and organolithium reagents.

UNIT III

Carbonyl Compounds: (15 Lectures)

Structure, reactivity and preparation; Nucleophilic additions, hydration of aldehydes and ketones, cyanohydrin formation, acetal formation; Nucleophilic addition-elimination reactions with ammonia derivatives; Addition of Grignard reagents and organolithium reagents to aldehydes and ketones; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt condensation, Perkin reaction, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, substitution reactions, α-haloform reaction; oxidation of aldehyde/ketone, Baeyer-Villiger oxidation; and reduction reactions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, and MPV).

Addition reactions of unsaturated carbonyl compounds: Michael addition, Robinson annulation.
Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT IV

Carboxylic Acids and their Derivatives: (15 Lectures)

Preparation, physical properties and reactions of monocarboxylic acids:carboxylation of Grignard reagents, oxidation of alkyl benzenes, oxidation of primary alcohols, aldehydes, hydrolysis of nitriles; Hell-Volhard-Zelinsky reaction, Reduction of carboxylic 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 substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation, Curtius rearrangement and Schmidt reaction.

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

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

Course Code: CHE214A

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.

Course Outcomes

CO1: To develop the basic instinct of analytical skills in organic qualitative analysis.
CO2: To analyse and characterise simple organic functional groups.
CO3: To understand and develop the talent in young minds of organic Synthesis.
CO4: To know the conventional- and green- methodologies of organic preparation.

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) and β one 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.
ix. 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: Qualitative Analysis,* University Press, 2000.

Course Title: Physical chemistry-III

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

Course Code: CHE215A

Total Lectures: 60

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.

Course Outcomes

CO1	The learners will be able to understand the concept of reaction rates and be able to explain how reactions occur at molecular level
CO2	The learners will be able to use Arrhenius equation, to calculate rate constant, Activation energy.
CO3	The learners will be able Identify and understand the principles of chemical equilibrium thermodynamics to solve multiphase equilibria and chemical reaction equilibria
CO4	Learner will be able to derive the various thermodynamic equations.
CO5	To think analytically and relate the learned concepts with their surroundings

UNIT I

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, simple eutectic diagrams of Bi-Cd, Pb-Ag systems, desilverization of Pb; compound formation with congruent M. Pt. CuCl-$FeCl_3$, Fe_2Cl_6-H_2O and Mg-Zn. Compound formation with incongruent M.Pt. (peritectic reactions) – NaCl-H_2O, $FeCl_3$- H_2O, $CuSO_4$- H_2O

system. Three component systems, water-chloroform-acetic acid system; two partially miscible pairs, three partially miscible pairs,

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional 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.

UNIT II

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, reaction of nth order, Temperature dependence of reaction rates; activation energy; Arrhenius equation, Numerical Problems. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates, Lindemann mechanism 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.

UNIT III

Catalysis: (8 Lectures)

Types of catalyst; general characteristics of a catalyst; acid-base catalysis; Enzyme catalysis, Michaelis-Menten mechanism, linewearver-burk method, The Eadie-Hofstee; Method Mechanisms of catalyzed reactions at solid surfaces; surface catalyzed unimolecular and bimolecular reactions.

UNIT IV

Surface chemistry: (6 Lectures)

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state. derivation of Langmuir, Freundlich, Tempkin and BET adsorption isotherms, estimation of surface area by BET equation,

Reference Books:

1. Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.*, 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, 2014..
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, 2015.
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP, 2009.
9. Levine, I. N. *Physical Chemistry 6th Ed.*, Tata McGraw-Hill, 2011.
10. Metz, C. R. *Physical Chemistry 2nd Ed.*, Tata McGraw-Hill, 2008.

Course Title: Physical Chemistry Lab-III

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

Course Code: CHE216A

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.

Course Outcomes

CO1	The learners will acquire the practical knowledge of different mechanisms of kinetics
CO2	The learners will be able to draw phase diagrams on the basis of their observations
CO3	The learners will be able to identify the difference between various types of surface reactions
CO4	Learner will be able to verify the different laws related with the taught phenomenon.

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 3rd Ed.;* W.H. Freeman & Co.: New York, 2003.

Course Title: Mathematics for Chemists-II

Course Code: MTH 260 A

Total Lectures: 60

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.

Course Outcomes (COs): After successfully completing this course the students will be able to
CO1: Learn the concept of domain and range of a function and the concepts of limit and continuity
CO2: Learn different formulas to find derivative of a given function
CO3: Applications of derivatives like to identify increasing/ decreasing functions, maxima/minima of functions, Rolle's, Lagrange's and Mean Value Theorems etc.
CO4: Different methods to find integration, definite integrals

UNIT I **(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.

UNIT II **(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**.**

UNIT III **(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 theorem and Maclaurian's theorem with Lagrange's form of remainder and applications of formal expansions of functions. (Proofs of theorems are not required).

UNIT IV **(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
Total Lectures:60

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.

UNIT I (12 Lectures)

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. 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.

UNIT II (20 Lectures)

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

UNIT III (18 Lectures)

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

UNIT IV (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: CHE270A

Total Lectures: 60

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.

Course Outcomes

CO1 The students will be able to understand the various theories, band structures, nanostructures its properties and applications

CO2 The students will acquire knowledge of various concepts and synthesis methodologies related to nanostructures

CO3 The student will get knowledge about various characterization techniques related to nanostructures.

CO4 The students will be familiar with carbon structures, its types, doping and applications of nanotechnology.

UNIT I (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.

UNIT II (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.

UNIT III (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.

UNIT IV (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

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

Course Code: CHE271A

Total Lectures: 30

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.

Course Outcomes

CO1: To understands the structure, properties and functions of carbohydrates, lipids and proteins

CO2: To study the Biochemistry of diseases with diagnostic approaches of blood and urine sample

CO3: To identify and estimate biological molecules such as carbohydrate, lipids, proteins and nucleic acids

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins: (30 Lectures)

Review of concepts studied in the core course:
Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency ofenergy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
Isolation and characterization of polysachharides.
Proteins: Classification, biological importance; Primary and secondary and tertiary structuresof 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 DNAand RNA: Replication, Transcription and Translation, Introduction to Gene therapy.
Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzymeinhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.
Blood: Composition and functions of blood, blood coagulation. Blood collection andpreservation 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

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

Course Code: CHE272A

Total Lectures: 30

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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Gain knowledge about the basic principles of separation techniques like distillation, extraction and adsorption
CO2	Get an understanding regarding different equipment used in industry such as mills, pumps, emulgators along with introduction to clean technology
CO3	Explore issues related to society and technology from chemical perspective
CO4	Understand about water, air and different materials like plastics and polymers with view point of energy

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	CHE217A	Inorganic Chemistry-III	Core	4	0	0	4
2	CHE218A	Inorganic Chemistry Lab-III	Core	0	0	4	2
3	CHE219A	Organic Chemistry-III	Core	4	0	0	4
4	CHE220A	Organic Chemistry Lab-III	Core	0	0	4	2
5	CHE221A	Physical Chemistry-IV	Core	4	0	0	4
6	CHE222A	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	ZOO257	Human Physiology	4	0	0	4
	ZOO258	Human Physiology Lab	0	0	3	2

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

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE281A	Fuel Chemistry	2	0	0	2
2	CHE282A	Pharmaceutical Chemistry	2	0	0	2
3	CSA252	Computer for Chemists	2	0	0	2
4		Swach Bharat Internship	0	0	0	2

Course Title: Inorganic Chemistry-III

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

Course Code: CHE217A

Total Lecture: 60

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.

Course Outcomes

CO1 The course will make students learn some of the advanced topics in inorganic chemistry which includes the general properties of various elements of *d* and *f* block elements of periodic table, coordination compounds and role of metals in biology under bioinorganic chemistry.

CO2 Understand properties of *d* block elements and reveal their physical and chemical properties specifically with relevance to their color and oxidation states.

CO3 highlights the *f* block elements and how these elements which are known as inner transition elements differ from transition elements

CO4 Will make students understand the chemistry of coordination compounds, their chemistry and behaviour. The metals undergo formation of coordination compounds with various ligands and learning chemistry of these compounds is of utmost importance.

CO5 Will teach them the roles of metals in biology especially bioorganic complexes like hemoglobin and myoglobin. In addition it includes application of metals in medicines.

UNIT I

Transition Elements: (15 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 first transition series in various oxidation states (excluding their metallurgy).

UNIT II

Lanthanoids and Actinoids: (15 Lectures)

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

Werner's theory, electro-neutrality principle. Valence bond theory for bonding in coordination compounds; concept of multiple bonding and back bonding, strength and weaknesses of valence bond approach.

UNIT III

Coordination Chemistry: (15 Lectures)

Various definitions, types of ligands: classical ligands, non-classical ligands (π-bonding or π-acid ligands); Multi-dentate ligands, The Chelate effects , conformation of Chelate rings, stereochemistry and various coordination numbers, isomerism in coordination compounds, nomenclature, stability of coordination compounds, thermodynamic and kinetic stability, stability constants, experimental and statistical ratios of stability constants, factors which influence the stability constant and chelate effect.

UNIT IV

Bioinorganic Chemistry: (15 Lectures)

Metal ions present in biological systems, Essential elements in biological systems. Essential trace elements and bulk elements. Role of Na^+, K^+, Ca^{2+}, and Mg^{2+} in biological systems. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), Iron and its application in bio-systems, structure and role of Hemoglobin and Myoglobin; carbon dioxide transport and Bohr effect. Sodium/K-pump, carbonic anhydrase and carboxypeptidase. Use of chelating agents in medicine.

Reference Books:

1 Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
2 Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry*, Panima Publishing Company 1994.
3 Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry*. Wiley-VCH, 1999
4 Greenwood, N.N. & Earnshaw A., *Chemistry of the Elements*, Butterworth-Heinemann,1997.
5 Principles of Inorganic Chemistry by B.R. Puri, L.R. Sharma, K.C. Kalia

Course Title: Inorganic Chemistry Lab-III

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

Course Code: CHE218A

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.

Course Outcomes

CO1 The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in industry as a chemist or fulfilling their goals in academia by executing research projects

CO2 The course will help them to understand the synthetic routes/methodologies to synthesize inorganic compounds.

CO3 The course will teach them gravimetric analysis an analytical tool for quantitative estimation of various analytes

CO4 The course will teach them gravimetric analysis an analytical tool for quantitative estimation of various analytes.

CO5 The course is intended to introduce chromatography as separation technique for separating metal ions

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: CHE219A

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

Total Lectures: 60

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.

Course Outcomes

CO1: To study the physical and chemical properties of *N*-atom containing small organic compounds.
CO2: To understand the nomenclature of heterocyclic compounds and their physical properties.
CO3: To learn the synthesis of various heterocyclic molecules and its reactions.
CO4: To study the aromaticity, preparation and chemical reactions of polynuclear hydrocarbons.
CO5: To understand the chemistry of terpenes and alkaloids.

UNIT I **(15 Lectures)**

Nitrogen Containing Functional Groups
Preparation and important reactions of nitro and compounds, Nef reaction, nitriles and isonitriles

Amines: Nomenclature, Structure and bonding, Basicity of amines and Effect of substituent and solvent on basicity; Preparation and properties: Through Nucleophilic Substitution Reactions Gabriel phthalimide synthesis, reduction of azides, nitriles, oximes, amides, and nitro compounds, Reductive amination, Hofmann Rearrangement, Curtius Rearrangement, Schmidt reaction, Mannich reaction; Reaction of amines: Carbylamine reaction, Hoffmann's exhaustive methylation, Electrophilic aromatic substitution in arylamines, nitrosation of alkylamines and arylamines, oxidation of amines, Hofmann-elimination reaction, Cope elimination; tetraalkylammonium salts as Phase Transfer Catalysts; Distinction between 1°, 2° and 3° amines with Hinsberg reagent
Diazonium Salts: Preparation and their synthetic applications, Azo coupling

UNIT II (15 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.

UNIT III (15 Lectures)

Polynuclear Hydrocarbons

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

UNIT IV (15 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 structure and synthesis of Citral, Neralα 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

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

Course Code: CHE220A

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.

Course Outcomes

CO1: To determine the extra element in organic compounds.
CO2: To analyse and characterize the *N*-atom containing functional groups.
CO3: To enable the students towards qualitative analysis of unknown organic compounds containing functional group.

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

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

Course Code: CHE221A

Total Lectures: 60

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.

Course Outcomes

CO1	To Understand the concepts of conductance and its applications
CO2	To understands the principles of electrochemistry
CO3	Analyse the cell reactions and EMF of the cell
CO4	To familiarize the students with electrical & magnetic Properties of atoms and molecules

UNIT I **(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) Determination of degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) determination of solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

UNIT II (20 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.

UNIT III (8 Lectures)

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).

UNIT IV (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 polarizability 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 6th 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, 2011.
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

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

Course Code: CHE222A

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.

Course Outcomes

CO1	To understand the principles of Conductometry
CO2	To understand the principles of Potentiometry

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 3$^{r\ d}$Ed.;* W.H. Freeman & Co.: New York, 2003.

Course Title: Electricity Magnetism and Electronics

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

Course Code: PHY253A
Total Lectures: 60

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.

On completion of the course, the student will have the ability to:

Course Outcomes (CO)

CO1 Understand the vector analysis concepts for electrostatics and gain knowledge in electric field and electric potential formulation of different charge distributions

CO2 Gain knowledge in magnetostatics and electromagnetic induction along with magnetic field formulation of various current carrying coils

CO3 Knowledge of conduction mechanism in semiconductors and qualitative theory of PN junction diode and VI characteristics.

CO4 Application of PN junction diodes as rectifiers, filters and photodiodes

CO5 Knowledge of the junction transistors, their configuration types , characteristics and application as amplifier

UNIT I **(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.

UNIT II (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

UNIT III (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.

UNIT IV (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

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

Course Code: PHY 254

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.

On completion of the course, the student will have the ability to:

Course Outcomes (CO)

CO1 Hands on training for carrying out precise measurements and handling sensitive equipments of electronics.

CO2 Verification of forward and reverse IV characteristics of diodes- pn junction, zener, tunnel and photodiode

CO3 Study of the IV characteristics of transistors- JFET, MOSFET, junction transistor and solar cell device

CO4 Determination of the frequency of A.C. mains using sonometer.

CO5 Determination of the unknown capacitance and inductance using De-Sauty's and Anderson's bridge.

CO6 Study of the half and full wave rectifiers and investigate the effect of L, C, LC and π filter circuits on rectifier output.

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: Fuel Chemistry

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

Course Code: CHE281A

Total Lectures: 30

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 the 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.

Course Outcomes

CO1: To understand the various sources of energy and to study the various types of coal

CO2: To understand the refining and application of petroleum

CO3:: To study the reforming pf petroleum, non-petroleum fuels and petrochemicals

CO4: To understand the behaviour of lubricants

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 of coal. 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
Course Code: CHE282A

Total Lectures: 30

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 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.

Course Outcomes:

CO1: To understand the Drug discovery, design and development with Basic Retrosynthetic approach and its synthesis.

CO2: To study the aerobic and anaerobic fermentation with production of various chemicals

CO3: To understand the synthesis of medicine at laboratory such as aspirin and antacid

Drugs & Pharmaceuticals **Theory: 30 Lectures**

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 I **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 II **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 III **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 IV **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	CHE311A	Organic Chemistry-IV	Core	4	0	0	4
2	CHE312A	Organic Chemistry Lab-IV	Core	0	0	4	2
3	CHE313A	Physical Chemistry-V	Core	4	0	0	4
4	CHE314A	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	CHE371B	Analytical Methods in Chemistry	4	0	0	4
	CHE372A	Analytical Methods in Chemistry Lab	0	0	4	2
2	CHE373A	Novel Inorganic Solids	4	0	0	4
	CHE374A	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	CHE375A	Polymer Chemistry	4	0	0	4
	CHE376A	Polymer Chemistry lab	0	0	4	2
2	CHE377A	Research Methodology for Chemistry	5	1	0	6
3	CHE378A	Molecular Modelling & Drug Design	4	0	0	4
	CHE379A	Molecular Modelling & Drug Design Lab	0	0	4	2

Course Title: Organic Chemistry-IV

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

Course Code: CHE311A

Total Lectures: 60

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.

Course Outcomes

CO1: To understand the structure and properties of nucleic acids and gain insight into concepts of heredity through the study of replication, transcription and translation.
CO2: To know the structure, properties and synthesis of amino acids and peptides.
CO3: To learn the metabolic pathways, their inter-relationship and energy production from biochemical processes.
CO4: To study the different classes of drugs, their synthesis and applications.

UNIT I

Nucleic Acids **(15 Lectures)**

General of Nucleic acid. Structure, synthesis and reactions of Purine and Pyrimidine bases: Adenine, Guanine, Cytosine, Uracil and Thymine.

Structure and synthesis of Nucleosides and Nucleotide.

Structure and synthesis of Polynucleotide: Structure of DNA and RNA.

Biological function of nucleic acid: DNA replication.

RNA and its types: Transcription or synthesis of m-RNA, Genetic code and biosynthesis of proteins i.e. Translation.

Amino Acids, Peptides and Proteins)

Amino acids, Peptides, Proteins and their classification: General and biological importance.

Natural α-AminoAcid: Essential and Non-essential amino acid. Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis of amino acid; Study of peptides: determination of their primary structures by end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups. Solid-phase synthesis. Types of structure of protein.

UNIT II

Enzymes (15 Lectures

Chemical nature of enzymes. Nomenclature and classification. Salient characteristics. Mode of enzyme action. Factors influencing enzyme activity. Isoenzymes or Isozymes. Enzyme Kinetics. Uses and application.

Enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition). Coenzymes and cofactors and their role in biological reactions.

UNIT III

Lipids (15 Lectures)

General, Biological functions, Classification of lipids, Fats and oils, Common fatty acids present in fats and oils, Extraction and refining of oils, General physical properties, General chemical properties, Industrial importance, Analysis / identification of fats and oils: Acid value, Saponification value, Iodine value, Reichert-Meissl value, Distinction between animal and vegetable fats, Uses.

Metabolism of Carbohydrate, Protein and Lipid (Concept of Energy in Biosystems)

General, Carbohydrate metabolism: Anaerobic Glycolysis (EMP Pathway), Aerobic metabolism (Krebs Cycle), Protein metabolism: Formation of Urea, Lipid metabolism: Beta oxidation of fatty acids, Alpha oxidation of fatty acids, Biosynthesis of fatty acids and fats. Inter relationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

UNIT IV

Chemotherapy (The life saving agents: Pharmaceutical Compounds) (12 Lectures)

General, Classification, Drug action (Specific and Non-specific), Bactericidal: Sulpha drugs & Antibiotics, Antimalarials: Chloroquine & Plasmoquine, HIV / AIDS: Zidovudine, Carbovir, Antipyretics and Analgesics: Aspirin, Methyl salicylate, Paracetamol, Antiseptics and Disinfectants: Halo compounds, Phenolic compounds, Surfactants, Dyes as antiseptic, Tranquillizers: Sedatives & Antidepressants, Diabetes: Cause & control, Drugs in cancer therapy. Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin 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. IVth Edition. W.H. Freeman and Co., 2009
3.Jain, M. K., Sharma S. C. Modern Organic Chemistry.
4. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. Harper's Illustrated Biochemistry.XXVIIIth edition. Lange Medical Books/McGraw-Hill., 2009

Course Title: Organic Chemistry Lab-IV

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

Course Code: CHE312A

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.

Course Outcomes

CO1: To determine the basic parameter of oil and fats such as acid value, iodine value and saponification value.
CO2: To understand the effect of salivary amylase on starch at different temperature.
CO3: To study the titration curve of glycine
CO4: To isolate and characterise DNA and estimation of glycine and proteins

60 Lectures

1. Estimation of glycine by Sorenson's formalin method.
2. Estimation of Cane Sugar.
3. Acid value of oil or fat..
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. To isolate caesin and lactose from milk.

Reference Books:

1. *Manual of Biochemistry Workshop*, 2012, Department of Chemistry, University of Delhi.

2. Arthur, I. V. *Quantitative Organic Analysis*, Pearson.
3. Advanced Practical Organic Chemistry by N. K. Vishnoi and O. P. Agarwal.

Course Title: Physical Chemistry-V

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

Course Code: CHE313A

Total Lectures: 60

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.

Course Outcomes

CO1	Students are expected to get a very good understanding of the basics of quantum chemistry
CO2	To solve mathematical function and wave functions
CO3	To understand the concept of spectroscopy and its applications in analysis
CO4	To understand the concept of photochemistry and its use in various chemical and physical processes.

UNIT I **(24 Lectures)**

Quantum Chemistry

Black body radiation, Planck's radiation law, photoelectric effect, Compton effect, De- Broglie hypothesis the Heisenberg's uncertainly principle, Rydberg's relation for explaining atomic spectrum of hydrogen. Functions, even and odd, well behaved functions, Operators and operator algebra.

Solution of classical wave equation by separation of variable method, Eigen value equation, Hamiltonian operator. Solution of particle in one, two and three dimensional box, Degeneracy, The

Schrodinger Equation in general and its importance. Physical Interpretation of wave function.

Commutative laws, vectors, Angular momentum of one particle system, orbital angular momentum, the ladder operator method for angular momentum.

Hermitian operator and some important theorems. Eigen functions of commuting operators. Postulates of quantum mechanics, the linear harmonic oscillator, rigid rotator model of rotation of diatomic molecule, transformation to spherical polar coordinates, separation of variables, spherical harmonics, discussion of solution.

The Hydrogen Atom, Outline of various steps in the solution of the electronic Schrödinger equation for hydrogen atom, Radial and angular parts of the hydrogen atomic wave functions and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s.

Electron spin and Pauli's Principle, Spin orbital, the Asymmetric wave functions for Helium atom in ground and excited state.

UNIT II (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.

UNIT III (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 3rd , Academic Press, 2005.
5. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press, 2015.

Course Title: Physical Chemistry Lab-V

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

Course Code: CHE314A

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.

Course Outcomes

CO1 To understand the principles UV/Visible spectroscopy

CO2 To enable the students to develop analytical skills.

CO3 To develop skill in setting up an experimental method to determine the physical properties.

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 λ determine the $_{max}$ 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: CHE371B

Total Lectures: 60

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 the 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.

Course Outcomes

On completion of this course, students will be able to

CO1	Understand qualitative and quantitative methods of analysis
CO2	Learn various quantitative methods of analysis like volumetric and gravimetric methods
CO3	Comprehend basic principles and applications of AAS and AES in heavy metal detection
CO4	Understand the XRD and TGA as important analytical techniques
CO5	Obtain reliable and reproducible data from the understanding of various electro analytical techniques

UNIT I

Qualitative and quantitative aspects of analysis: (20 Lectures)

Sampling, evaluation of analytical data, errors, accuracy and precision, normal law of distribution

Volumetric and Gravimetric Methods of Analysis

Theory of volumetric and gravimetric methods of analysis, equivalent points, standard solutions, Primary and Secondary standards, and point detection, theory of indicators and their selection for volumetric analysis, precipitation methods, purity of precipitates, optimum conditions for precipitation, washing and filtration of precipitates, drying and ignition of precipitates, important organic precipitants, estimation of nickel by the use of organic precipitants.

UNIT II

Atomic Absorption Spectrometry: (10 Lectures)

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 methods of removal.

UNIT III

Thermal methods of analysis:

(15 Lectures)

Theory of thermogravimetry (TGA and DTA), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electro analytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric, amperometric and conductometric titrations. Introduction of Coulometric methods, Voltammetry, polarography.

UNIT IV

Acid-Base Titrations: (15 Lectures)

Preparation of standard solutions of acids and bases, indicators, their pH titration curves, typical applications of neutralization titrations.

Precipitation Titrations:

Solubility of precipitates, solubility product and analytical calculations based on it, titration curves, The Volhard and the Mohr's methods of analysis, adsorption indicators

Reference Books:

1.Vogel, Arthur I: A Textbook 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

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

Course Code: CHE372A

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 the 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.

Course Outcomes

On completion of this course, students will be able to

CO1	Relate the theoretical separation techniques and practical concepts of paper chromatography
CO2	Separate mixtures of heavy metals and dyes using TLC
CO3	Calculate pH of aerated drinks, fruit juices, shampoo, soaps etc.
CO4	Determine dissolved oxygen and hardness in water samples
CO5	Perform gravimetric analysis of different cations and anions to determine their concentration in solution
CO6	Perform Soil analysis to determine its pH, conductivity, bulk density and moisture content

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) 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 flame photometric techniques.

5. Analysis of soil:

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii)Estimation of calcium, magnesium, phosphate

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).

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

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

Course Code: CHE373A

Total Lectures: 60

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 the 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.

Course Outcomes

CO1 Students will understand several methods of synthesis of inorganic solids.

CO2 Students will study about inorganic materials and their uses in various technologies**.**

CO3 Students will be introduced to materials that can be used in engineering and construction.

UNIT I (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.

UNIT II (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.

UNIT III (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.

UNIT IV (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

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

Course Code: CHE374A

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.

Course Outcomes:

CO1 Students will develop a knowledge of the preparation for each experiment by studying lab handouts and links.

CO2 Students will learn about safety precautions and lab techniques for conducting their experiments.

CO3 The students will gain knowledge of handling required instruments and learn to record experimental observations.

CO4 Students will study about specific properties of some inorganic materials. They'll also learn the synthesis of advanced materials like hydrogels and metal nanoparticles.

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

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

Course Code: CHE375A

Total Lectures: 60

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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Know the basics of polymeric materials, their functionalities and importance
CO2	Understand the kinetics and mechanism of copolymerization, degree of crystallinity and structure-property relationships
CO3	Determine the molecular weight and glass transition temperatures of polymers
CO4	Learn polymer solubility, Huggin's theory, and physical, thermal, flow and mechanical properties of polymers

UNIT I **(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.

UNIT II **(14 Lectures)**

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.

UNIT III (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).

UNIT IV (18 Lectures)

Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of 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: polyolefin's, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, 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

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

Course Code: CHE376A

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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Do synthesis of macromolecules by using various techniques of polymerization
CO2	Determine molecular weight and viscosity using viscometry
CO3	Analyze different types of polymers using various instrumental techniques
CO4	Study mechanical properties and applications of polymers

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 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: CHE377A

Total Lectures: 75

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 the 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.

Course Outcomes:

CO1 The students will learn how to do a literature review and about digital research sources.

CO2 Students will gain knowledge of research paper writing and its ethical considerations.

CO3 The students will learn how to use chemicals safely as well as how to dispose of them.

CO4 The students will learn about experiment design and the application of various statistical approaches for data analysis. They will also study the basics principles of electronics.

UNIT I **(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.

UNIT II **(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.

UNIT III (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.

UNIT IV (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*. 2ndEd. 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

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

Course Code: CHE378A

Total Lectures: 60

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 designfor Chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Course Outcomes:

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

CO-1 Gain some knowledge on modern approaches used in molecular modelling.
CO-2 Force field models and minimization methods
CO-3 Understand how Monte Carlo simulation works and how and when to apply it
CO-4 Powerful computer-based technology used to identify and design molecules for new medications

UNIT I **(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.

UNIT II **(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.

UNIT III (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.

UNIT IV (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

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

Course Code: CHE379A

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 designlab. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Course Outcomes:

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

CO-1 Compare and optimize C-C bond lengths in various single, double and triple bond molecules.
CO-2 Determine the enthalpy of isomerization of various cis & trans isomers.
CO-3 Build and minimize organic compounds with various functional groups.
CO-4 Compare and optimize bond angles for the second row dihydrides with the results from qualitative MO theory.

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	CHE315A	Inorganic Chemistry-IV	Core	4	0	0	4
2	CHE316A	Inorganic Chemistry-IV Lab	Core	0	0	4	2
3	CHE317A	Organic Chemistry-V	Core	4	0	0	4
4	CHE318A	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	CHE330A	Physical and Chemical Aspects of Biological chemistry	4	0	0	4
	CHE331A	Physical and Chemical Aspects of Biological chemistry Lab	0	0	3	2
3	BTY241	Molecular Biology	4	0	0	4
	BTY242	Molecular Biology Lab	0	0	3	2

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

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE381A	Green Chemistry	4	0	0	4
	CHE382A	Green Chemistry Lab	0	0	4	2
2	CHE383A	Applications of Computers in Chemistry	4	0	0	4
	CHE384A	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	CHE385B	Instrumental Methods of Analysis	4	0	0	4
	CHE386A	Instrumental Methods of Analysis lab	0	0	4	2
2	CHE387A	Industrial Chemicals & Environment	4	0	0	4
	CHE388A	Industrial Chemicals & Environment lab	0	0	4	2

Course Title: Inorganic Chemistry-IV

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

Course Code: CHE315A

Total Lectures: 60
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 the importance of academic and laboratory skills for 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.

Course Outcomes

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

CO-1 Understand symmetry operations and symmetry elements of the small molecules. Understand crystal field and molecular orbital theories, their terms and concepts. How CFSE affects thermodynamic properties and explanation of various properties of metal complexes.

CO-2 Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls. Identify important structural features of the metal alkyls and explain the concept of multicenter bonding in these compounds. Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufactured by Fischer-Tropsch process.

CO-3 Apply 18-electron rule to rationalize the stability of metal carbonyls and related species. General methods of preparation of mono and binuclear carbonyls. Structures and bonding in metal carbonyls.

CO-4 Understand inorganic reaction mechanisms. Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Mechanism of substitution in octahedral complexes.

UNIT I

(15 Lectures)

Molecular symmetry: Symmetry operations and symmetry elements, Identity operator, Proper Rotation, Improper rotation, Reflection, Inversion, orbital symmetry, Symmetry groups. Symmetry elements of the molecules $BaCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, SF_6, CO_2.

Crystal field theory: The splitting of d-orbitals in different fields (octahedral, tetrahedral, square planar), Consequences and applications of orbital splitting, crystal field stabilization energy, magnetic properties, Factors affecting the extent of splitting and spectro-chemical series, colour of transition metal complexes. Structural effect of crystal field splitting; ionic radii, Jahn-Teller effect in octahedral and tetrahedral complexes.

Modified crystal field theory: Ligand field Theory: Evidence of covalent bonding. Molecular orbital theory: sigma and □ bonding in octahedral complexes, sigma and □ bonding in tetrahedral complexes, sigma and □ bonding in square planar complexes.

UNIT II

Organometallic Compounds **(15 Lectures)**

Introduction to Organometallic Chemistry: Classification of ligands, EAN rule, Concept of hapticity of organic ligands.

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 multicenter bonding in these compounds. Role of triethyl aluminium in polymerization of ethane (Ziegler–Natta Catalyst). Species present in ether solution of the Grignard reagent and their structures, Schlenk equilibrium.

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

Catalysis by Organometallic Compounds: Study of the following industrial processes and their mechanism:

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

UNIT III

(15 Lectures)

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 backbonding.

UNIT IV

Reaction Kinetics and Mechanism **(15 Lectures)**

Introduction to inorganic reaction mechanism. 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.

Reference Books:

1. Huheey, J.E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed. Pearson.
2. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education).
3. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons, 2008.
4. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press.
5. Spessard, G.O., & Gary L. Miessler. Organometallic Chemistry., NJ: Prentice-Hall,1996.
6. Puri, B.R.; Sharma L.R.; Kalia, K. C. Principles of Inorganic chemistry, 32nd ed., 2014.
7. https://nptel.ac.in/courses/104104080/23
8. https://nptel.ac.in/courses/104105033/32
9. https://nptel.ac.in/courses/104103069/21
10. https://onlinecourses.nptel.ac.in/noc18_cy09/preview

Course Title: Inorganic Chemistry Lab-IV

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

Course Code: CHE316A

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.

Course Outcomes

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

CO-1 Understand and explain the basic principles of qualitative inorganic analysis.
CO-2 Understand the concept of synthesis of metal complexes and study their properties.
CO-3 Understand the characterization of synthesized metal complexes.

Qualitative semi micro 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+}. Find the λ_{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

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

Course Code: CHE317A

Total Lectures: 60

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.

Course Outcomes

CO1: To understand the basic concept of UV-ViS, IR and NMR spectroscopy and their applications in structure elucidation of small organic molecules.
CO2: To understand the classification, structure and stereochemistry of monosaccharides and their interconversions.
CO3: To know the chemistry of disaccharides and polysaccharides.
CO4: To learn the basic chemistry of dyes their synthesis and applications.
CO5: To know the classification of polymer and understand the concept of molecular weight determination of macromolecules.
CO6: To understand the mechanism of polymerization reactions and preparation of different types of plastic and fiber.

UNIT I

Organic Spectroscopy-I **(15 Lectures)**

General principles: Introduction to absorption and emission spectroscopy (The electromagnetic spectrum).
UV Spectroscopy: Basis, Solvents, Transition in UV spectroscopy, Selection rules & transition probability, Terms used in UV spectroscopy, UV spectra of unsaturated compounds, Woodward's

rules for calculating λ_{max} in different dienes, Woodward's rules for calculating λ_{max} of enones and dienons, Woodward's rules for calculating λ_{max} in different Aromatic compounds. Distinction between cis and trans isomers.

IR Spectroscopy: Basis, Sampling, Stretching and bending vibrations, Fundamental and non-fundamental molecular vibrations, Vibrational frequency, Finger print region in IR spectra & its significance, Major bands in the IR spectra of different classes of organic compounds. Effect of H-bonding, conjugation, resonance and ring size on IR absorptions.

UNIT II

Organic Spectroscopy-II **(15 Lectures)**

NMR Spectroscopy: Basis, Relaxation processes in NMR spectroscopy, Number of signals, Position of signals (Chemical Shift), Factor affecting chemical shift, Peak area and proton counting, Splitting of signals, Coupling constant, Equivalence of protons, Interpretation of NMR spectra of organic compounds. Applications of IR, UV and NMR for identification of simple organic molecules.

UNIT III

Carbohydrates **(15 Lectures)**

General, Definition, Classification, Reducing & Non-reducing sugars, Configuration of Aldotriose & aldopentoses.
Monosaccharides: Introduction, Glucose, Fructose (Occurrence, Manufacture, Physical properties, Uses, Structure / Constitution, Chemical properties, Epimer & epimerisation), Structure of aldopentoses & aldohexoses, The Kiliani Fisher synthesis, The Ruff degradation, Wohl degradation, Epimerisation of an aldohexoses, Conversion of aldohexoses into ketohexoses & vice-versa, Glycosides.
Disaccharides: Introduction, Sucrose, Maltose, Lactose (Properties, Uses, Structure / Constitution), Cellobiose.
Polysaccharides: Introduction, Starch, Cellulose, Glycogens (Properties, Uses, Structure / Constitution)

Dyes and Pigments

Classification, colour and constitution: Natural & Synthetic dyes, Based on structure, Based on application. 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. Pigment (Anthocyanins & flavones), Food colours.

UNIT IV

Polymers (The Giant Molecules) (15 Lectures)

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 on Ziegler-Natta polymerization 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 1st Ed.*, 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 of Natural 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*, Pragati Prakashan 2010.
9. Kemp, W. *Organic Spectroscopy*, Palgrave.
10. Jain, M. K., Sharma S. C. Modern Organic Chemistry

Course Title: Organic Chemistry Lab-V

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

Course Code: CHE318A

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.

Course Outcomes

CO1: The extraction of caffeine from tea leaves
CO2: Synthesis of polymer
CO3: Qualitative analysis of organic compounds containing mono-functional groups.
CO4: Identification the simple organic compounds using IR and NMR spectra
CO5: Preparation of methyl orange dye.

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. 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.
5. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
6. 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.

Course Title: Mechanics and Waves

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

Course Code: PHY 353
Total Lectures: 60

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.

On completion of the course, the student will have the ability to:

Course Outcomes (CO)

CO1 Understand the inertial frame and Newton's laws of motion.

CO2 Differentiate between conservative and non-conservative forces,

CO3 Describe the nature of motion under central force and Kepler's law.

CO4 Understand the physical characteristics of SHM and obtain the solution of the oscillator using differential equations

CO5 Understanding of the type of waves, the wave equation and its solution

CO6 Calculate reflected and transmitted energy coefficients of waves.

UNIT I **(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.

UNIT II (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.

UNIT III (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.

UNIT IV (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

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

Course Code: PHY 354

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.

On completion of the course, the student will have the ability to:

Course Outcomes (CO)

CO1 Understand the fundamentals in the basic areas of Mechanics and Waves Laboratory like use of verniercaliper, screw gauge.

CO2 Appraise the Young's modulus of the beam,the moment inertia and rigidity modules for flywheel thin wire Torsion pendulum

CO3 Determine value of g using simple pendulum, bar pendulum, cater pendulum

CO4 Evaluate the height of building using sextant trained for error analysis and troubleshoot involved in the experiments performed.

(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 meterand other measuringinstruments based on applications of the experiments. Use ofPlumb 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 suspensionand 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 toits 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 travelingmicroscope/laser, (ii) Flexural vibrations of a bar.
8. To study one dimensional collision using two hanging spheres of differentmaterials.
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 squarewaves, output from a rectifier, verification (qualitative) of law of electromagneticinduction and frequency of A.C. mains.
12. To measure thermo e.m.f. of a thermocouple as a function of temperature and findinversion 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.

1. 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

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

Course Code: CHE330A

Total Lectures: 60

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.

Course Outcomes:

CO1 To learn different types of bonds.

CO2 To understand different type of reactions and apply concept of acid and base in biological reactions.

CO3 To calculate pH of various physiological buffers and solutions of biological importance.

CO4 To apply basic concepts of phenomenon depending on concentration gradient.

UNIT I **(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 intermolecular hydrogen bonds, effects of hydrogen bonding, Van der Waals forces. Electrophiles and Nucleophiles.

UNIT II **(16 Lectures)**

Water, Acid, Base and Chemical reaction:

Water as 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

UNIT III (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.

UNIT IV (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

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

Course Code: CHE331A

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.

Course Outcomes:

CO1 To enable the students to develop analytical skills.

CO2 Importance of calibration and cleaning of different types of apparatus used in lab

CO3 To learn the concept of pH

CO4 To learn the preparation of various solution of different concentration and dilution method.

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

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

Course Code: CHE381A

Total Lectures: 60

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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Acquire a knowledge of introductory green chemistry to understand its importance
CO2	Understand the standard principles of green chemistry and designing chemical synthesis
CO3	Learn the examples of green reactions including microwave, solid state and ultrasonic assisted reaction
CO4	Acquainted with the future trends in green chemistry in sustainable development

UNIT I **(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.

UNIT II **(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.

UNIT III (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.

UNIT IV (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

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

Course Code: CHE382A

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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Know basic use of safer green materials for small scale reactions
CO2	Use renewable resources and avoid unwanted reaction products
CO3	Understand the role of enzymes for various catalytic reactions
CO4	Get knowledge on usage of alternative green solvents and alternate sources of energy for chemical reactions

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

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

Course Code: CHE383A

Total Lectures: 60

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.

Course Outcomes:

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

CO-1 Learn the fundamentals of the computer system and its components.
CO-2 Understand and utilize the knowledge of differential and integral calculus
CO-3 Understand interpolation, extrapolation and curve fitting for numerous experimental data.
CO-4 Utilize the knowledge in molecular modelling.

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: CHE384A

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.

Course Objectives:

CO1 Apply the concept of Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

CO2 Student should be able to understand the concept of numerical integration (e.g., entropy/ enthalpy changes from heat capacity data), probability distributions (gas kinetic theory) and mean values.

CO3 The students will gain the professional skills of Gauss-Siedel method in colorimetry.

CO4 The student will be able to perform the simple exercises using molecular visualization software.

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: CHE385B

Total Lectures: 60

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 the 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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Gain knowledge about the basic principles of spectroscopy
CO2	Get familiar with principles, instrumentation techniques and applications of IR and Raman spectroscopy
CO3	Get knowledge related to UV-Visible spectroscopy and to identify the simple organic molecules on the basis of this technique
CO4	Understand the basic separation techniques i.e. Gas chromatography and liquid chromatography and their utilization
CO5	Know about instrumentation and applications of Mass Spectroscopy to identify the simple organic molecules
CO6	Understand the principles, instrumentation techniques and applications of NMR spectroscopy

UNIT I **(20 Lectures)**

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods, Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Raman Spectroscopy:

Introduction, selection rules, anisotropic polarizability, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, polarized and depolarized Raman Lines, rule of mutual exclusion.

UNIT II

Chromatographic separations: (15 Lectures)
Introduction, classification, elution, distribution constants, retention times, selectivity factor, introduction to GC and HPLC.

UNIT III (15 Lectures)

Mass spectroscopy:

Introduction, Instrumentation, different ionization techniques, Analysers, Nitrogen rule, McLafferty rearrangement, IHD, Metastable ions, introduction to fragmentation patterns of organic molecules.

UNIT IV (10 Lectures)

NMR spectroscopy:

Principle, Instrumentation, Factors affecting chemical shift, Spin-spin coupling, Applications.

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 Edition,
3. P.W. Atkins: *Physical Chemistry, Eleventh Edition, 2018*.
4. G.W. Castellan: *Physical Chemistry, Third Edition, 2004*.
5. C.N. Banwell: *Fundamentals of Molecular Spectroscopy, 4th Edition, 2017*.
6. Brian Smith: *Infrared Spectral Interpretations: A Systematic Approach,1998*.
7. W.J. Moore: *Physical Chemistry,5th Edition, 1998*.

Course Title: Instrumental Methods of Chemical Analysis Lab

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

Course Code: CHE386A

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 the 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.

Course Outcomes:

On completion of this course, students will be able to

CO1	Comply with correct safety procedures during lab work
CO2	Determine structures of organic molecules using UV-Visible spectroscopy and IR spectroscopy
CO3	Perform quantitative analysis of mixtures using chromatographic techniques
CO4	Analyze reaction kinetics using UV-Visible spectroscopy

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*
2. Willard, Merritt, Dean, Settle*Instrumental Methods of Analysis*, 7th Edition

Course Title: Industrial Chemicals and Environment

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

Course Code: CHE387A

Total Lectures: 60

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.

Course Outcomes:

CO1: Students will gain the knowledge of Industrial Gases and Inorganic Chemical

CO2: Students will become aware about the environment and factors causing pollution; water pollution and purification methods.

CO3: Students will become familiar with energy sources and nuclear pollution

CO4: Students will learn about the importance of biocatalysts in green chemistry.

UNIT I (14 Lectures)

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following 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 the following 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.

UNIT II (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.

UNIT III (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.

UNIT IV (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: CHE388A

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.

Course Outcomes:

CO1: Students will gain the necessary knowledge of basic concepts of Industrial Chemicals and Environment Lab

CO2: Students will learn to calculate BOD, COD, Dissolved O_2 and CO_2 in water samples.

CO3: Titration and double titration methods for calculation of different parameters in water like alkalinity

CO4: Students will be able to estimate the SPM in air samples

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