LINGAYA'S VIDYAPEETH

choose to know

(u/s 3 of UGC Act 1956)

SYLLABUS

BACHELOR OF SCIENCE- CHEMISTRY

(THREE YEAR FULL TIME PROGRAMME)

(SIX SEMESTER COURSE)

Year 2024-2027

Department of Chemistry

School of Basic & Applied Science

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)
(Approved By UGC, MHRD, AICTE, BCI, PCI & ACI)

LINGAYA'S VIDYAPEETH
SCHEME OF STUDIES
SESSION: 2024-27

School: Basic and Applied Sciences	**Batch: 2024-2027**
Department: Chemistry	**Year: First**
Course: B.Sc (Hons.) Chemistry	**Semester: Ist**

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	GE	BS-101	Wave and Optics	4	0	0	4	15	25	60	-	-	100
2	GE	BS-103	Differential Calculus	4	0	0	4	15	25	60	-	-	100
3	PCC	BS-105	Physical Chemistry-I	4	0	0	4	15	25	60	-	-	100
4	AEC	HSS-107	English and Communication Skills	2	0	0	2	15	25	60	-	-	100
5	GE	BS-151	Wave and Optics Laboratory-I	0	0	4	2	-	-	-	60	40	100
6	PCC	BS-155	Physical Chemistry Laboratory-I	0	0	4	2	-	-	-	60	40	100
			Total---->	**14**	**0**	**8**	**18**	**60**	**100**	**240**	**120**	**80**	**600**

School: Basic and Applied Sciences								**Batch: 2024-2027**					
Department: Chemistry								**Year: I**					
Course: B.Sc (Hons.) Chemistry								**Semester: IInd**					
SN	**Cate-gory**	**Course Code**	**Course Name**	**Periods**			**Credits**	**Evaluation Scheme**					**Subject Total Marks**
								Theory			**Practical**		
				L	**T**	**P**		**ABQ**	**MSE**	**ESE**	**IP**	**EXP**	
1	PCC	BCH-102	Inorganic Chemistry-I	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-104	Organic Chemistry-I	4	0	0	4	15	25	60	-	-	100
3	DSE	BCH-106	Analytical Methods in Chemistry	4	0	0	4	15	25	60	-	-	100
4	Department Elective	BCH-108	Electricity & Magnetism /Algebra/Integral Calculus	4	0	0	4	15	25	60	-	-	100
5	AEC	CE-108	Environmental Science & Ecology	2	0	0	2	15	25	60	-	-	100
6	GE	BCH-152	Inorganic Chemistry Laboratory-II	0	0	4	2	-	-	-	60	40	100
7	PCC	BCH-154	Organic Chemistry Laboratory-I	0	0	4	2	-	-	-	60	40	100
			Total---->	**18**	**0**	**8**	**22**	**75**	**125**	**300**	**120**	**80**	**700**

School: Basic and Applied Sciences								Batch: 2024-2027					
Department: Chemistry								Year: II					
Course: B.Sc (Hons.) Chemistry								Semester :III[rd]					
SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-201	Inorganic Chemistry-II	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-203	Organic Chemistry-II	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-205	Physical Chemistry –II	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-207	Polymer Chemistry	3	1	0	4	15	25	60	-	-	100
5	PCC	BCH-251	Inorganic Chemistry-Laboratory-II	0	0	4	2	-	-	-	60	40	100
6	PCC	BCH-253	Organic Chemistry-Laboratory-II	0	0	4	2	-	-	-	60	40	100
7	PCC	BCH-255	Physical Chemistry-Laboratory-II	0	0	4	2	-	-	-	60	40	100
8	SEC	BCH-257	Chemistry of Cosmetics and perfumes	0	0	4	2	-	-	-	60	40	100
			Total---->	**15**	**1**	**16**	**24**	**60**	**100**	**240**	**240**	**160**	**800**

School: Basic and Applied Sciences								**Batch: 2024-2027**					
Department: Chemistry								**Year: II**					
Course: B.Sc (Hons.) Chemistry								**Semester: IVth**					
SN	**Cate-gory**	**Course Code**	**Course Name**	**Periods**			**Credits**	**Evaluation Scheme**					**Subject Total Marks**
								Theory			**Practical**		
				L	**T**	**P**		**ABQ**	**MSE**	**ESE**	**IP**	**EXP**	
1	PCC	BCH-202	Inorganic Chemistry-III	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-204	Organic Chemistry-III	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-206	Physical Chemistry-III	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-208	Industrial Chemicals & Environment	3	1	0	4	15	25	60	-	-	100
5	PCC	BCH-252	Inorganic Chemistry-Laboratory-III	0	0	4	2	-	-	-	60	40	100
6	PCC	BCH-254	Organic Chemistry-Laboratory-III	0	0	4	2	-	-	-	60	40	100
7	PCC	BCH-256	Physical Chemistry-Laboratory-III	0	0	4	2	-	-	-	60	40	100
			Total---->	**15**	**1**	**12**	**22**	**60**	**100**	**240**	**180**	**120**	**700**

School: Basic and Applied Sciences	Batch: 2024-2027
Department: Chemistry	Year: IIIrd
Course: B.Sc (Hons.) Chemistry	Semester: Vth

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-301	Inorganic Chemistry-IV	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-303	Organic Chemistry-IV	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-305	Physical Chemistry-IV	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-307	Green Chemistry	3	1	0	4	15	25	60	-	-	100
5	PCC	BCH-351	Inorganic Chemistry-Laboratory-IV	0	0	4	2	-	-	-	60	40	100
6	PCC	BCH-353	Organic Chemistry-Laboratory-IV	0	0	4	2	-	-	-	60	40	100
7	PCC	BCH-355	Physical Chemistry-Laboratory-IV	0	0	4	2	-	-	-	60	40	100
8	PCC	BCH-357	Industrial Training/Internship	0	0	4	2	-	-	-	-	-	100
				15	**1**	**12**	**24**	**60**	**100**	**240**	**180**	**120**	**800**

School: Basic and Applied Sciences	Batch: 2024-2027
Department: Chemistry	Year: III
Course: B.Sc (Hons.) Chemistry	Semester: VIth

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-302	Inorganic Chemistry-V	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-304	Organic Chemistry-V	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-306	Physical Chemistry-V	4	0	0	4	15	25	60	-	-	100
4	SEC	BCH-308	Fuel Chemistry	2	0	0	2	15	25	60	-	-	100
5	PCC	BCH-352	Inorganic Chemistry-Laboratory-V	0	0	4	2	-	-	-	60	40	100
6	PCC	BCH-354	Organic Chemistry-Laboratory-V	0	0	4	2	-	-	-	60	40	100
7	PCC	BCH-356	Physical Chemistry-Laboratory-V	0	0	4	2	-	-	-	60	40	100
8	PROJ	BCH-358	Project	0	0	12	6	-	-	-	-	--	100
			Total---->	**14**		**24**	**26**	**60**	**100**	**240**	**180**	**120**	**800**

Abbreviations:

PCC-Programme Core Courses
GE: Generic Elective
DSE: Discipline Specific Elective
SEC: Skill Enhancement Courses
AEC: Ability Enhancement Courses
PROJ: Project
HSS: Humanity and Social Science
L: Lecture
T: Tutorial
P: Practical
ABQ: Assignment Based Quiz
MSE: Mid Semester Examination
ESE: End Semester Examination
IP: Internal Practical
EXP: External Practical

PROGRAM OUTCOMES (PO'S)

PO1: Identify and resolve complex scientific issues in national and local level.
PO2: Analyze and interpret data using analytical instruments to investigate chemical problems.
PO3: To solve chemical problems, choose, plan, and implement suitable experiment techniques, as well as instrumentation handling.
PO4: Recognize and use contextual multidisciplinary information to evaluate societal, health, safety, and global problem that are important to research practices.
PO5: Adopt scientific ideas about environmental use and long-term sustainability.
PO6: Enhance skills for future employability through activities such as seminar, communication skills, industrial visit, and internship.
PO7: Recall the chemistry courses that are available for competitive test.
PO8: The students attain sound knowledge in the areas of organic, inorganic, physical, pharmaceutical chemistry and material for pursing higher education and research.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO1: To gain an understanding of various principles of organic, inorganic, and physical chemistry as well as their biological implications and applications in everyday life.

PSO2: Chemistry for industries: planning, conducting experiment, and confidently handling equipment.

SEMESTER-I

BS-101: Wave and Optics

(Semester I)

L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

Course explains the basic ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

Course Outcomes:

CO1: To Illustrate the wide applicability of vibration and wave properties of light

CO2: To Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical system

CO3: To apply mathematical, statistical, and computational skills to develop solutions

CO4: To analyze the general view of the manifestation of wave phenomena in general and optical systems in particular

CO5: Evaluating, assessing, and interpreting their results.

Unit	Contents	Lecture/ Tutorials
I	**Superposition of Collinear Harmonic oscillations:** Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.	8
II	**Wave Motion & Velocity of Waves:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound waves and Laplace's Correction.	14
III	**Superposition of Two Harmonic Waves:** Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves	10
IV	**Wave Optics**: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.	10

V	**Diffraction**: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit. Fraunhofer Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.	10

Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Pos COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3	PSO4
CO1	1	3	-	1	2	2	1	1	1	1
CO2	1	3	1	-	1	2	-	2	1	1
CO3	1	3	-	3	1	2	2	-	2	-
CO4	2	3	-	1	2	1	-	-	-	-
CO5	1	1	2	1	-	1	1	1	1	2

BS-103: Differential Calculus
(Semester I)

L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:
The primary objective of this course is to introduce the basic tools of calculus and to understand the extension of the studies of single variable differential calculus to functions of two or more independent variables.

Course Outcomes:
CO1: To earn the conceptual variations when advancing in calculus from one variable to multivariable discussions
CO2: To understand concepts of limit and continuity on R through ϵ-δ definition
CO3: To Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference
CO4: To analyze the applications of mean value theorem and Taylor's theorem.

Unit	Contents	Lecture/Tutorials
I	Methods of differentiations of various functions, Limit and Continuity of real valued functions, Successive differentiations and Leibnitz theorem.	10
II	Mean-value theorem and its applications, Roll's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Expansions of functions of one variable, Taylor's theorem and Maclaurin's series expansions function of several variables.	11
III	Introduction of Envelope and Evolutes, equations of tangent and normal, representation of functions of two variables, curve tracing and asymptotes	11
IV	Partial Differentiation and its applications, Limits and continuity of functions of two variables; Homogeneous function Euler's theorem Taylor's theorem and Higher order partial derivatives, Maxima and minima for functions of several variables, Lagrange's multiplier	10

TEXT BOOKS/REFERENCE BOOKS:
1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	2	2	2	2	-	-	1	1	1
CO2	2	2	2	2	1	-	-	-	2	-
CO3	2	3	1	2	1	-	-	1	2	1
CO4	2	1	1	1	1	1	1	-	2	-

BS-105: Physical Chemistry-I (Semester I)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:
The objective of the course is to provide the depth knowledge about the Chemical thermodynamics & chemical equilibrium and colligative properties of solutions.

Course Outcomes:
CO1. To learn about the basics laws of thermodynamics.
CO2. To understand about the principle of thermo chemistry and various laws of heat.
CO3. To apply the concept of partial molar properties.
CO4. To analyze various thermodynamic properties
CO5. To evaluate various colligative properties of solutions.

Unit	Contents	Lecture/Tutorials
1.	**Chemical Thermodynamics:** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.	**8**
2.	**Thermo chemistry:** Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity.	**16**
3.	**Systems of Variable Composition:** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.	**8**
4	**Chemical Equilibrium:** Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment.	**10**
5.	**Solutions and Colligative Properties**: Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic	**10**

	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.	

TEXTBOOKS/REFERENCE BOOKS:

1.Peter, A. & Paula, J. de. Physical Chemistry 10th Ed., Oxford University Press (2014).
2.Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3.Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4.McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.:
5.Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6.Levine, I .N. Physical Chemistry 6th Ed., Tata McGraw Hill (2010).
7.Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	2	-	2	3	3	2
CO2	2	1	-	-	2	3	2	3	2	2
CO3	2	1	2	-	1	1	2	2	3	3
CO4	2	-	1	2	2	2	3	2	3	3
CO5	2	1	2	2	2	2	3	2	2	2

BS:151 Wave and Optics Laboratory
(Semester I)

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**13**	Viva-voce + Practical exam + Practical record file	:	**40**

Course Objectives:
The objective of the course General Physics Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

Course Outcomes:
CO1: To learn about the Katter's pendulum.
CO2: To understanding of modulus of rigidity.
CO3: To apply the concept of coefficient of viscosity.
CO4: To evaluate gravitation force and its value by using bar pendulum.

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ 2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Note: Each student is required to perform at least seven experiments.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

POs Cos	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-	2	2	3	3
CO2	1	1	1	1	-	2	1	-
CO3	2	3	2	1	3	3	1	-
CO4	2	2	1	-	2	1	-	-

Course Code	Subject Name	L-T-P	Credits
BCH-155	Physical Chemistry Laboratory-I (Semester I)	0-0-4	2

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
Students will know understand the concept of thermochemistry

Course Outcomes:
CO1. To determine the enthalpy of ionization and hydration.
CO2. To determine heat capacity of calorimeter.
CO3. To study the solubility of benzoic acid in water.

Thermochemistry

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(c) Calculation of the enthalpy of ionization of ethanoic acid.
(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(f) Determination of enthalpy of hydration of copper sulphate.
(g) Study of the solubility of benzoic acid in water and determination of ΔH.

TEXTBOOKS/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 AgeInternational: New Delhi (2001).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	2	2	2	2	1	3	3	3
CO2	1	3	3	2	1	1	3	2	2	3
CO3	1	1	3	1	2	2	2	2	3	2

Lab Technician Lab Incharge HOD

SEMESTER-II

Course Code	Subject Name	L-T-P	Credits
BCH-102	Inorganic Chemistry-I (Semester II)	**4-0-0**	**4**

L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

1. To gain the knowledge of basic inorganic chemistry such as atomic structure, chemical bonds etc.
2. Course will also explains about various chemical bonds and their properties

Course Outcomes:

CO1.To learn the general concept of atomic structure
CO2.To understands about the basic properties of elements and chemical bonds
CO3.To apply the concept of boning
CO4. To analyze the properties of chemical bonds and various chemical forces
C5. To evaluate various chemical properties w.r.t bond alength, bong angle, bond order etc.

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Unit	Contents	Lecture/Tutorials /Tutorials
I	**Atomic Structure:** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger'swave equation, significance of ψ and ψ2. Quantum numbers and their significance.Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wavefunctions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and forbitals. Contour boundary and probability diagrams.Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and itslimitations, Variation of orbital energy with atomic number	12
II	**Periodicity of Elements:** s, p, d, f block elements (a) Effective nuclear charge, shielding or screening effect, Slater rules, (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Applications of ionization enthalpy. (f) Electron gain enthalpy, (g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of eall these properties in periodic Table, Hybridization.	10
III	**Chemical Bonding-I:** (i) Ionic bond: radius ratioPacking of ions in crystals. Born-Landé equation with derivation, expression for lattice energy. Born-Haber cycle and its application. (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Bent's rule, Resonance and resonance energy,	12

	Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl,BeF_2, CO_2, Formal charge, Valence shell electron pair repulsion theory (VSEPR), multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.	
IV	**Chemical Bonding-II:** Metallic Bond: Semiconductors and insulators, defects in solids.(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.	9
V	**Oxidation-Reduction:** Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.	5

TEXTBOOK/REFERENCE BOOKS:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	-	1	-	1	-	3	3	3	1
CO2	1	1	-	-	-	1	3	3	2	2
CO3	2	1	1	-	-	2	2	2	2	2
CO4	1	-	1	3	2	1	3	1	2	1
CO5	2	2	1	-	-	1	2	1	2	2

BCH-104 : Organic Chemistry –I (Semester II)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

1. To gain the knowledge of general organic chemistry such as hybridization, electronic displacements and intermediates etc.
2. To Differentiate chiral and achiral molecules.
3. Identify the stereo centers in a molecule and assign the configuration as R or S.

Course Outcomes:

CO1.To learn the general organic chemistry such as hybridization and electronic displacements
CO2.To understands the involvement of reactive intermediates, their structure and reactivity.
CO3.To apply the concept of the stereo centers in a molecule and assign the configuration as R or S.
CO4.To analyze the mechanism of reactions involving Carbon-Carbon sigma and pi Bond.
CO5.To evaluate various chemical properties of organic compounds viz. reactivity, dipole moment etc

Unit	Contents	Lecture/Tutorials /Tutorials
I	**Basics of Organic Chemistry-I:** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.	11
II	**Basics of Organic Chemistry-II:** Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.	10
III	**Stereochemistry:** Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.	13
IV	**Chemistry of Aliphatic Hydrocarbons: (i) Carbon-Carbon sigma bonds:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.	9
V	**Chemistry of Aliphatic Hydrocarbons (ii) Carbon-Carbon pi bonds:** Mechanism of E1 and E2 reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). Diels-Alder reaction..	9

TEXTBOOKS/REFERENCE BOOKS:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. Pearson Education).
2. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	1	-	3	3	3	1
CO2	1	2	-	-	1	2	3	3	2	1
CO3	1	2	1	-	-	1	3	3	2	2
CO4	1	-	1	3	1	1	3	3	3	2
CO5	1	2	-	1	-	1	2	1	2	2

BCH-106: Analytical Methods in Chemistry (Semester II)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The objective of the course to understand the basic principles of analytical techniques and instrumentations.

Course Outcomes:

CO1. To learn about basics of various analytical properties.

CO2. To understand the separation techniques, UV-visible, IR and electronic spectroscopy.

CO3. To apply the concept of the spectroscopy for the analysis of molecular structures.

CO4. To analyze the principle and instrumentation of TGA.

CO5. To evaluate the molecular structure on the basis of the IIR, UV, NMR and various separation techniques.

Unit	Contents	Lecture/Tutorials
1.	**Qualitative and quantitative aspects of analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.	**12**
2.	**Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.	**12**
3.	**Infrared Spectrometry:** Basic principles of instrumentation (choice of source, monochromatic & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.	**8**
4.	**Thermal methods of analysis** Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.	**8**
5	**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, Paper Chromatography, TLC and HPLC**.**	**12**

TEXTBOOKS/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.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	-	-	3	1	2	1	3	1
CO2	2	1	-	-	3	2	2	1	2	1
CO3	2	1	2	-	3	-	3	2	3	2
CO4	2	-	1	2	3	2	3	2	3	2
CO5	2	-	1	1	1	2	1	2	2	2

BCH-152: Inorganic Chemistry Laboratory-I
(Semester II)

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**13**	Viva-voce + Practical exam + Practical record file	:	**40**

Course Objectives:
The objective of the course Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

Course Outcomes:

CO1. Students will learn the concept of normality and molarities for titration.
CO2. Determination of Carbonate, bicarbonate and alkali in various samples.
CO3. To learn the concept of Crystallization for purification of sample.

S. No.	Practical Description
1	**Titrimetric Analysis:** Calibration and use of apparatus Preparation of solutions of different Molarity/Normality of titrants
2	Estimation of carbonate and hydroxide present together in mixture.
3	Determination of viscosity of (i) ethanol (ii) amyl alcohol and (iii) aqueous solution of sugar at room temperature
4	Estimation of free alkali present in different soaps/detergents
5	Determine the surface tension of given solution using drop number method.
6	**Preparation and purification through crystallization or distillation and ascertaining their purity through melting or boiling point**: (i) Phenyl benzoate from phenol and benzoyl chloride (ii) M-dinitrobenzene from nitrobenzene (use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available). (iii) Picric acid (iv) Aspirin from salicylic acid
7	Crystallization and decolourization of impure naphthalene from ethanol.

Reference Books:

1. O.P. Pandey, D.N. Bajpai& S. Giri, Practical Chemistry, S. Chand & CompanyLtd.
2. B. D. Khosla, V. C. Garg& A. Gulati, *Senior Practical Physical Chemistry,* S. Chand & Co.: New Delhi(2011).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	2	2	3	3	3
CO2	1	2	3	1	2	1	2	3	3	3
CO3	1	2	3	1	3	2	3	3	3	3

BCH-154: Organic Chemistry Laboratory-I
(Semester II)

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
The objective of the course is understood the preparation and qualitative and quantitative determination of metal ions.

Course Outcomes:
CO1. To learn the concept of inorganic Complex compound.
CO2. To understand the analytical methods for determination of metal ions by spectrophotometric methods. .
CO3. To understand the concept of thermodynamic parameters.

S. No.	Practical Description
1.	**Preparation** (i) Phenol formaldehyde resins (ii) Urea-formaldehyde.
2.	Extraction of caffeine from tea leaves
3.	**Analysis of Carbohydrate:** (i)Reducing and non-reducing sugars (ii) Carbohydrate and a non-carbohydrate (iii) Aldoses and ketoses
4.	Functional group test: test for alcohol, phenols, ethers and carboxylic acid
5.	**Synthesis** (i)Oxalic Acid (ii) Aniline
6.	To determine the saponification value of an oil or a fat.

TEXTBOOKS/REFERENCE BOOKS:

1. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge.
2. Inorganic Synthesis, MC Graw Hill.
3. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic press.
4. Standard methods of chemical analysis by W.W. Scaff, Technical Press.
5. Vogel's Qualitative Inorganic Analysis (revised), Orient Longman.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	2	2	3	3	3
CO2	1	2	3	1	2	1	2	3	3	3
CO3	1	2	3	1	3	2	3	3	3	3

SEMESTER-III

BCH-201: Inorganic Chemistry-II (Semester III)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The course deals with the metallurgy and chemical & physical properties of P block elements and inorganic polymers.

Course Outcomes:

CO1. To study and learn about the basics of metallurgy, acid base and various s and p block elements.
CO2. To understand the concept of extraction of metals and properties of periodic elements.
CO3: To apply the concept of Acid and Base and various compounds of s and p block elements
CO4. To analyze the physical and chemical properties of the various compounds.
CO5. To evaluate the physical and chemical properties of acid base, Inorganic Polymer and hydrides of p block elements.

Unit	Contents	Lecture/Tutorials
1.	**General Principles of Metallurgy** Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams forreduction 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.	**10**
2.	**Acids and Bases** Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle	**10**
3.	**Chemistry of s and p Block Elements** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial hydrides. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.	**16**
4	**Noble Gase**s Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).	**8**
5.	**Inorganic Polymers** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates	**8**

TEXTBOOKS/REFERENCE BOOKS:

1. Cotton, F.A.G.; Wilkinson & Gaus, P.L. Bsasic Inorganic Chemistry 3rd Ed.; Wiley India,

2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.

3. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

5. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	1	1	3	3	3	1
CO2	1	1	-	-	1	-	3	3	2	1
CO3	1	2	2	-	-	1	3	3	3	2
CO4	1	-	1	2	1	1	3	3	3	2
CO5	1	2	1	1	2	2	2	2	2	2

BCH-203: Organic Chemistry-II (Semester III)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The present curriculum enhances the knowledge of organic chemistry of students; they should aware with various types of mechanism to the organic molecules..

Course Outcomes:

CO1. To learn about the chemistry of Nucleophilic substitution reaction to alkyl and aryl halides.

CO2. To understand the general concept of various organic compounds.

CO3. To apply the concept of reactivity and stability on various organic compounds.

CO4. To analyze the structure, reactivity & stability of various organic compounds.

CO5. To evaluate various chemical properties of organic compounds

S. No	Contents	Lecture/Tutorials
1	**Chemistry of Halogenated Hydrocarbons:** *Alkyl halides:* Nucleophilic substitution reactions – $S_N1$and S_N2 mechanisms. *Aryl halides:* Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.	**12**
2	**Alcohols, Phenols, Ethers and Epoxides:** *Alcohols:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement, *Phenols:* Preparation and properties; Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements. *Ethers and Epoxides:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$.	**14**
3	**Carbonyl Compounds:** Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid, Michael addition. Active methylene compounds: Keto-enol tautomerism	**10**
4	**Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of mono-carboxylic acids: Typical reactions of dicarboxylic acids, hydroxy and unsaturated acids: succinic/phthalic, lactic, citric, maleic and fumaric acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.	**9**
5	**Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids.	**7**

TEXTBOOKS/REFERENCE BOOKS:

1. Inczedy, J. Analytical applications of complex equilibria Halsted Press: New York, NY (1976).
2. Ringbom, A. Complexation in Analytical Chemistry Wiley: New York (1963).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	-	-	1	1	3	3	3	1
CO2	1	1	-	-	1	2	3	3	2	1
CO3	1	1	2	-	-	1	3	3	3	2
CO4	1	-	1	2	1	-	3	3	3	2
CO5	-	1	2	1	-	-	2	2	2	1

BCH-205: Physical Chemistry-II (Semester III)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The objective of the course is to understand the solid, state and gaseous state, and concept of buffer solution.

Course Outcomes:

CO1. To learn the concept of solid state, liquid state, gaseous state and ionic equilibrium.
CO2. To understand the idea of solid state, liquid state and gaseous state.
CO3. To apply the concept of the various phenomenon such as equilibrium on solid, liquid and gases.
CO4. To analyze various solid, liquid and gaseous structures.
CO5. To evaluate the various properties of solid, liquid and gaseous.

Unit	Contents	Lecture/Tutorials
1.	**Gaseous state** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, andits variation with pressure for different gases. Causes of deviation from ideal behaviour. Vander Waals equation of state, its derivation and application in explaining real gas behavior, mention of other equations of state; virial equation of state; vander Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and vander Waals constants, law of corresponding states.	**10**
2.	**Liquid state** Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their Determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.	**10**
3.	**Solid state** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern	**12**

	method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.	
4	**Ionic equilibria-I** 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	**10**
5.	**Ionic equilibria-II** (10 Lectures) Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.	**10**

TEXTBOOKS/REFERENCE BOOKS:

1. Physical Chemistry, G. M. Barrow, International Student Edition, McGrawHill.
2. Physical Chemistry through Problems, S. K. Dogra and S. Dogra Wiley EasternLtd.
3. Physical Chemistry, P. W. Atkins, & J. de Paula, 10th Ed., Oxford University Press(2014).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	2	1	3	2	3	3	3	3
CO2	1	2	2	1	3	1	3	3	3	3
CO3	2	2	2	1	3	1	3	3	3	3
CO4	2	3	3	2	3	-	3	3	3	3
CO5	2	2	1	1	2	2	3	1	2	2

BCH-207: Polymer Chemistry (Semester III)					
L+T+P	:	**3+1+0**	Mid-Semester exam	:	**25**
Credits:	:	**7**	ABQ	:	**15**
Contact hours	:	**48**	End-semester exam	:	**60**

Course Objectives:

The objective of the course is to have the knowledge of classification, preparation and properties of polymeric materials.

Course Outcomes:

CO1. To learn about the basics classification and synthesis of polymer.
CO2. To understand the kinetics of polymerization.
CO3. To apply the concept of crystallinity on various polymers.
CO4. To analyze the criteria of polymer solubility and various parameters.
CO5. To evaluate the mechanism for the synthesis of polymers.

Unit	Contents	Lecture/Tutorials
1.	**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. Bifunctional systems, Poly-functional systems	**8**
2.	**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.	**8**
3.	**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. Determination of molecular weight of polymers (*Mn*, *Mw*, 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, Factors affecting glass transition temperature (Tg).	**14**
4	**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.	**10**
5.	**Properties of Polymer**s: (Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and 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,	**10**

	[polyacetylene, polyaniline, poly(p-phenylene sulphidepolypyrrole, polythiophene)].	

TEXTBOOKS/REFERENCE BOOKS:

1. R.B. Seymour & C.E. Carraher: Polymer Chemistry: An Introduction, Marcel Dekker,Inc. New York, 1981.
2. G. Odian: Principles of Polymerization, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971.
4. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	-	-	2	1	2	1	3	1
CO2	2	1	-	-	2	1	2	1	2	1
CO3	2	1	2	-	1	2	2	2	3	2
CO4	2	-	1	2	2	2	3	2	3	2
CO5	1	2	2	3	2	2	3	1	2	2

BCH-251: Inorganic Chemistry Laboratory-II
(Semester III)

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
Students will get the knowledge of titration and estimation and preparation of Inorganic compounds.

Course Outcomes:
CO1. T**o** estimation various metal ions through Iodometric titration.
CO2. To synthesize inorganic compounds and organic compounds.
CO3. To determine chloride and dissolve oxygen.

S. No.	Practical Description
1.	Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution(Iodimetrically).
2.	Estimation of available chlorine in bleaching powder iodometrically.
3.	**Inorganic Preparations:** Cuprous chloride,Cu_2Cl_2 Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$. Preparation of Aluminium potassium sulphate $K_2SO_4.Al(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.
4.	Acetylation of aniline
5.	Benzolyation of β-naphthol
6.	Synthesis of Salicylic acid by green approach
7.	pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
8.	Determination of dissolved oxygen in water
9.	Measurement of chloride, sulphate and salinity of water samples by simple titration.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	2	2	3	3	3
CO2	1	2	3	1	2	1	2	3	3	3
CO3	1	2	3	1	3	2	3	3	3	3

Course Code	Subject Name	L-T-P	Credits
BCH-253	Organic Chemistry Laboratory-II (Semester III)	0-0-4	2

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
Students will get the knowledge of estimation of various functional groups and preparation of organic compounds.

Course Outcomes:
CO1. T**o** estimate various functional groups.
CO2. To prepare various organic compounds using conventional approach.
CO3. To synthesis various organic compounds through green approach.

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) and phenols (β-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 one of the following phenols (β-naphthol, resorcinol, pcresol) bySchotten-Baumann reaction.
iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
iv. Bromination of any one of the following:
a. Acetanilide by conventional methods
b. Acetanilide using green approach (Bromate-bromide method)
v. Nitration of any one of the following:
a. Acetanilide/nitrobenzene by conventional method
b. Salicylic acid by green approach (using ceric ammonium nitrate).
vi. Selective reduction of meta dinitrobenzene to m-nitroaniline.
vii. Reduction of p-nitrobenzaldehyde by sodium borohydride.
viii. Hydrolysis of amides and esters.
ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
x. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
xi. Aldol condensation using either conventional or green method.
xii. Benzil-Benzilic acid rearrangement.
The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

TEXTBOOKS/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)

3. Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	3	2	2	3	2	3	2	2
CO2	1	2	3	1	2	1	1	3	3	2
CO3	1	1	3	1	2	1	1	2	2	3

Course Code	Subject Name	L-T-P	Credits
BCH-255	Physical Chemistry Laboratory-II (Semester III)	0-0-4	2

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
The objective of the practical subject is to study the various physical properties

Course Outcomes:
CO1. T**o** determine viscosity and surface tensions
CO2. To study the effect of pH on acid-base reaction through pHmetry.
CO3. To determine the dissociation constant of acid and base.

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.

TEXTBOOKS/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 Chemistry, 8th Ed.; McGraw-Hill: New York (2003).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	2	2	2	2	1
CO2	1	1	2	1	1	1	2	3	2	2
CO3	2	1	2	1	1	2	1	1	3	2

Course Code	Subject Name	L-T-P	Credits
BCH-257	Chemistry of Cosmetics and Perfumes (Semester III)	0-0-4	2

Course Objectives:
T o give students the opportunity to review the scientific method and basic laboratory skills used in cosmetics products.

Course Outcomes:
CO1. T**o** prepare and synthesize various cosmetics products such as shampoo, talcum powder and cold cream.
CO2. To prepare and synthesize various perfume products.

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

List of Experiments

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

TEXTBOOKS/REFERENCE BOOKS:

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. Engineering Chemistry DhanpatRai& Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	2	2	2	2	1
CO2	1	1	2	1	1	1	2	3	2	2
CO3	2	1	2	1	1	2	1	1	3	2

S

SEMESTER-IV

BCH-202: Inorganic Chemistry-III (Semester IV)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The course deals with detail study of transition metal elements, lanthanides & actinides and various coordination compounds and their properties along with the significance of metal ions present in biological system.

Course Outcomes:

CO1. To learn the various coordination compounds and Transitin metals and Lanthanides.
CO2. To learn the nomenclature of coordination compounds transition metal complex and Lanthanides
CO3. To apply the concept of physical and chemical properties of transition metals and Lanthanides.
CO4.To analyze physical and chemical properties.
CO5. To evaluate the various properties, their uses and toxicity.

Unit	Contents	Lecture/Tutorials
1.	**Coordination Chemistry-I:** Werner's theory, valence bond theory (inner and outer orbital complexes), electro neutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.	**12**
2.	**Coordination Chemistry-II**: IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.	**10**
3.	**Transition Elements**: 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.). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).	**12**
4	**Lanthanoids and Actinides:** Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).	**6**
5.	**Bioinorganic Chemistry**: Metal ions present in biological systems, classification of elements according to their action in biological system. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its applications, Haemoglobin; Storage and transfer of iron.	**12**

TEXTBOOKS/REFERENCE BOOKS:

1. Purcell, K.F &Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
2. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.

3. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. &Earnshaw A. *Chemistry of the Elements*, Butterworth- Heinemann, 1997.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	2	2	3	2	3	2
CO2	2	1	-	-	2	1	3	2	3	2
CO3	2	1	2	-	1	1	3	2	3	3
CO4	2	-	1	2	2	-	3	2	3	3
CO5	2	2	1	2	2	2	2	1	2	2

BCH-204: Organic Chemistry-III (Semester IV)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

This course introduces basic features, structural aspects as well as applications of Nitrogen containing compounds such polynuclear hydrocarbon, heterocyclic compounds, alkaloids and terpene.

Course Outcomes:

CO1. To study the classification of heterocyclic compounds.

CO2. To understand the structural properties of various hydrocarbon and heterocyclic compounds.

CO3. To apply the concept of reactive intermediate and its mechanism of action on various heterocyclic compounds.

CO4. To analyze the biological importance, classification and structure of heterocyclic compounds and alkaloids.

CO5. To evaluate the structure and properties of various heterocyclic

Unit	Contents	Lecture/Tutorials
1.	**Nitrogen Containing Functional Groups**: Preparation and important reactions of nitro and compounds, nitriles and isonitrilesAmines: Effect of substituent and solvent on basicity; Preparation and properties: Gabrielphthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2°and 3°amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications	**12**
2.	**Polynuclear Hydrocarbons:** Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclearhydrocarbons.	**08**
3.	**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, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction.	**18**
4	**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.	**8**
5.	**Terpenes**: Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.	**6**

TEXTBOOKS/REFERENCE BOOKS:

1. 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 of
4. Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
6.Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	2	1	2	2	3	2
CO2	2	1	-	-	2	2	2	2	3	2
CO3	2	1	2	-	1	2	2	2	3	3
CO4	2	-	1	2	2	1	2	2	3	3
CO5	1	1	2	2	1	1	1	2	2	2

BCH-206: Physical Chemistry-III (Semester IV)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The objective of the course is to provide the depth knowledge about the catalysis, conductance, concentration cells, Chemical kinetics and surface phenomena.

Course Outcomes:

CO1. To learn about the concept of catalysis, equilibria and electrochemical reactions.
CO2. To understand the laws of conductivity, anodic and cathodic reactions and equilibria.
CO3. To apply the phenomena of equilibria, electrochemistry and catalysis.
CO4. To analyze the mechanism and kinetics of rate of reactions.
CO5. To evaluate various chemical, electrochemical and surface properties.

Unit	Contents	Lecture/Tutorials
1.	**Catalysis**: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis- Menten mechanism, acid-base catalysis.	**6**
2.	**Electrochemistry**: 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-Huckel-Onsager equation. 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.	**12**
3.	**Phase Equilibria**: Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots.	**10**
4	**Chemical Kinetics**: Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii)consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.	**16**
5.	**Surface chemistry:** Adsorption and Absorption, Adsorbate, Adsorbent, Physical adsorption, chemisorption, Nature of adsorbed state. BET Theorem, Langmuir and Freundlich adsorption Isotherm	**8**

TEXTBOOKS/REFERENCE BOOKS:

1. Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed., Oxford University Press(2014).
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 3rd Ed.*, Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP (2009).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	2	2	2	3	3	2
CO2	2	1	-	-	2	1	2	3	2	2
CO3	2	1	2	-	1	-	2	2	3	3
CO4	2	-	1	2	2	2	3	2	3	3
CO5	1	2	1	1	2	1	2	1	2	1

BCH-208: Industrial Chemicals and Environments (Semester IV)					
L+T+P	:	**3+1+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The objective of the course is to have the knowledge of classification and manufacturing of the industrial chemicals, fertilizers and surface coating materials.

Course Outcomes:

CO1. To learn the basic concept of energy & Environment.
CO2. To understand about the pollution and their control measures.
CO3. To apply the concept of nuclear reactions, pollutions controls and metallurgy.
CO4. To analyze the origin and source of energy in environment.
CO5. To evaluate the concept of industrial chemicals.

Unit	Contents	Lecture/Tutorials
1.	**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.	**10**
2.	**Industrial Metallurgy**: Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.	**6**
3.	**Environment and its segments**: Ecosystems, Air Pollution: Major regions of 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, NOx, H_2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx 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, *Water Pollution*: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, 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.	**20**
4	**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,	**9**

	nuclear disaster and its management.	
5.	**Biocatalysis:** Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.	**7**

TEXTBOOKS/REFERENCE BOOKS:

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

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	-	-	2	2	2	1	3	1
CO2	2	1	-	-	2	1	2	1	2	1
CO3	2	1	2	-	1	2	2	2	3	2
CO4	2	-	1	2	2	-	3	2	3	2
CO5	1	1	2	1	2	1	3	3	2	2

BCH-252: Inorganic Chemistry Laboratory-III
(Semester IV)

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
The students have the detailed knowledge of analysis of different element, quantitative organic compound analysis and also have the spectroscopic determination method.

Course Outcomes:
CO1. To Estimate the metals in a various complex compounds.
CO2. To synthesized various coordination complexes.
CO3. To separate various metal ions using paper chromatography..

S. No.	Practical Description
1.	Estimation of iron as Fe_2O_3 by precipitating iron as Fe(OH)3.
2.	Estimation of nickel (II) using Dimethylglyoxime (DMG).
3.	To estimate the amount of barium in the whole of the given solution of barium chloride.
4.	**Inorganic Preparations:** a. Hexammine Nickel(II) Chloride, $[Ni(NH_3)_6]Cl_2$ b. Hexammino Cobaltic Chloride, $[Co(NH_3)_6]Cl_3$ c. Tetraamminecarbonatocobalt (III) ion d. Potassium Trioxalato Aluminate $K_3[Al(C_2O_4)_3]$ e. Potassiumtrisoxalato ferrate (III)
5.	**Paper chromatographic separation of following metal ions:** i. Ni (II) and Co (II) ii. Fe (III) and Al (III)

TEXTBOOKS/REFERENCE BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	2	2	3	3	3
CO2	1	2	3	1	2	1	2	3	3	3
CO3	1	2	3	1	3	2	3	3	3	3

Lab Technician Lab Incharge HOD

Course Code	Subject Name	L-T-P	Credits
BCH-254	Organic Chemistry Laboratory-III (Semester IV)	0-0-4	2

L+T+P : **0+0+4**

Credits: : **2**

Contact hours : **52**

Viva-voce + Continuous lab performance : **60**

Viva-voce + Practical Exam + Practical record file : **40**

Course Objectives:

The students have the detailed knowledge of analysis of different extra element and qualitative analysis of organic compounds.

Course Outcomes:

CO1. To detect extra elements.

CO2. To determine various nitrogen containing functional groups.

CO3. To analyze various organic compounds including alcohol and carboxylic acid.

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)

TEXTBOOKS/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)
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).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	3	2	2	3	2	3	3	1
CO2	1	1	2	1	2	1	1	2	2	2
CO3	1	1	2	1	2	2	3	1	2	3

Lab Technician Lab Incharge HOD

Course Code	Subject Name	L-T-P	Credits
BCH-256	Physical Chemistry Laboratory-III (Semester IV)	0-0-4	2

L+T+P : **0+0+4**

Credits: : **2**

Contact hours : **52**

Viva-voce + Continuous lab performance : **60**

Viva-voce + Practical Exam + Practical record file : **40**

Course Objectives:

The students have the detailed knowledge of analysis of different extra element and qualitative analysis of organic compounds.

Course Outcomes:

CO1. To determine, cell constant, concentrations, pH etc

CO2. To conduct various conductometric titrations.

CO3. To perform various potentiometry titrations.

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

TEXTBOOKS/REFERENCE BOOKS:

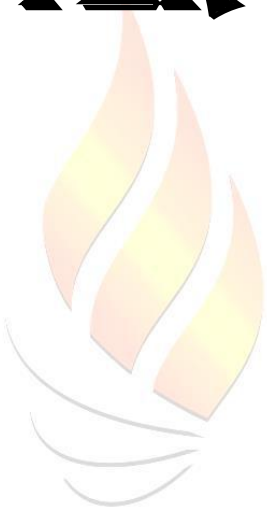
1. Khosla, B. D.; Garg, V. C. &Gulati, A., Senior Practical Physical Chemistry, R.Chand & Co.: New Delhi (2011).

2. Athawale, V. D. &Mathur, P. Experimental Physical Chemistry New AgeInternational: New Delhi (2001).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	2	2	2	2	1	3	3	3
CO2	1	3	3	2	1	1	3	2	2	3
CO3	1	1	3	1	2	2	2	2	3	2

Lab Technician Lab Incharge HOD

SEMESTER-V



BCH-301: Inorganic Chemistry- IV (Semester V)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The course deals with detail study of hydrides, oxides, halides and sulphides of Group V, VII, VII elements along with the theoretical principles of qualitative analysis of cations and anions.

Course Outcomes:

CO1. To learn about the physical and chemical properties of various periodic elements.
CO2. To understand the physical and chemical properties of various periodic elements.
CO3. To apply the concept of Comparative study of periodic elements.
CO4. To analyze the physical and chemical properties of periodic elements.
CO5. To evaluate the physical and chemical properties of various elements.

Unit	Contents	Lecture/Tutorials
1.	**Group I Elements:** Hydrogen: Isotopes (separation method not needed). Ortho and para hydrogen, Hydrides and their classification. Alkali metals: Chemical properties of the metals: reaction with water, air, nitrogen; uses of s-block metals and their compounds, Compounds of s-block metals: oxides, hydroxides, peroxides, superoxides.	**10**
2.	**Group II Elements**: Alkaline earthmetals: Comparative study of these elements with special reference to their hydrides, oxides, hydroxide and halides. Diagonal relationship, solvation and Complexes of s-block metals including their applications in Biosystems.	**10**
3.	**Group III Elements :** Comparative study of physical and chemical properties of these elements with special reference to their oxides, hydrides, halides and nitirides. Preparation and properties of boric acids (ortho&meta boric acids) and borax, borax bead test. Boron Hydrides, structure and bonding in diboranes, borazine, borohydrides.	**10**
4.	**Group IV Elements:** Comparative study of physical and chemicals properties of these elements with special references to their oxides, hydrides, nitrides, sulphides and carbides, fluorocarbons, study of silicates (structural aspects only), silicones, allotropy, inert pair effect, metallic and nonmetallic character, catenation and hetero catenation.	**10**
5	**Group V Elements:** Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halides, oxyhalides and sulphides, Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid; oxoacids of phosphorus: orthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetrapolyphosphoric acids	**12**

TEXTBOOKS/REFERENCE BOOKS:

1. Cotton, F.A.G.; Wilkinson &Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,

2. Huheey, J. E.; Keiter, E.A. &Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.

3. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

5. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	2	2	-	1	3	3	3	1
CO2	1	2	3	2	-	-	3	3	3	1
CO3	1	2	2	2	2	2	3	3	3	2
CO4	1	2	3	3	1	-	3	3	3	2
CO5	2	1	1	2	1	2	1	1	2	1

BCH-303: Organic Chemistry-IV (Semester V)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours: 52			End Semester Examination		**60**

Course Objectives:

This course introduces basic features, structural aspects as well as applications of organic compounds such as amino acid, protein, nucleic acid, carbohydrates, lipid, oil and detergents

Course Outcomes:

CO1. To learn about the classification and separation of biomolecules.
CO2. To understand the components of various biomolecules.
CO3. To apply the concept to understand the basic properties of biomolecules
CO5. To analyze biological importance, classification and structure of biomolecules.
CO5. To evaluate the mode of action and uses of various biomolecules.

Unit	Contents	Lecture/Tutorials
1.	**Amino Acids, Peptides and Proteins Amino acids:** Peptides and their classification: α-Amino Acids – stereochemistry, Synthesis, chromatographic separation, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis. Resolution of racemic amino acids, Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups - Solid-phase synthesis. Primary Secondary and tertiary structure of proteins.	**11**
2.	**Nucleic Acids:** Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides. DNA and RNA – Base pair formation and double helical structure. Comparison of structural stability**.**	**09**
3.	**Carbohydrates:** Occurrence, classification and their biological importance; Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Disaccharides – Structure elucidation of maltose, lactose and sucrose.; Polysaccharides – Elementary treatment of starch, cellulose and glycogen.	**12**
4	**Lipids**: Introduction to oils and fats; common fatty acids present in oils and fats, Saturated and unsaturated fatty acids. Classification of unsaturated fatty acids. Melting and boiling point of fatty acids. Hydrogenntion and Free radical reactions of fats and oils; Saponification value, acid value, iodine number; Reversion and rancidity	**11**
5.	**Fats, Oil and Detergents:** Occurrence, chemical composition and importance, hydrogenated oils, Rancidity, acid value, saponification and iodine numbers, difference between toilet and washing soaps, comparison of soap and detergents, classification and principle of cleansing action of detergents	**9**

TEXTBOOKS/REFERENCE BOOKS:

1. Atkins P. W. and De Paula J., Physical Chemistry, (tenth edition) Oxford University Press, 2014.
2. Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley 2003).
3. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	-	2	-	2	2	3	2
CO2	2	1	-	-	2	1	2	2	3	2
CO3	2	1	2	-	1	2	2	2	3	3
CO4	2	-	1	2	2	2	2	2	3	3
CO5	1	2	1	2	1	2	1	2	1	2

BCH-305 Physical Chemistry-IV (Semester V)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objective:
The objective of the course to understand the quantum Mechanics, angular momentum, chemical bonding and photochemistry

Course Outcomes:
CO1. To learn about Introduction, properties, mechanism and use of quantum mechanics.
CO2. To understand about Schrödinger equation in Cartesian and spherical polar coordinates and rigid rotators.
CO3. To apply the concept and application of approximation method.
CO4. To analyze different type of chemical bonding and qualitative treatment of homo and hetero-diatomic molecules.
CO5. To evaluate the laws of photochemistry and role of photochemical reaction in biological systems

Unit	Contents	Lecture/Tutorials
1.	**Quantum Chemistry :** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.	**12**
2.	**Qualitative treatment of hydrogen** : Setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom). Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H2 +. Bonding and antibonding orbitals.Qualitative extension to H2. Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).Localised and non-localised molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules.	**10**
3.	**Molecular Spectroscopy :** Interaction of electromagnetic radiation with	**12**

	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.	
4.	**Electronic spectroscopy:** Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and hosphorescence, 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.	**10**
5	**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.	**8**

TEXTBOOKS/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. Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).
5. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	-	1	1	2	1	2	2	3	1
CO2	1	1	-	2	2	2	2	2	3	1
CO3	1	-	1	3	3	-	2	3	3	2
CO4	1	-	1	3	3	2	2	3	3	2
CO5	1	1	1	1	1	2	1	2	2	2

BCH-307: Green Chemistry (Semester V)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The primary objective of this course is to make students aware of how chemical processes can be designed, developed and run in a sustainable way. Student will acquire the competence to think of chemistry as a sustainable activity. To give information about the design competitive chemical products and processes that attain the highest level of the pollution-prevention hierarchy by reducing pollution at its source

Course Outcomes:

CO1.To learns the basic principles of green and sustainable chemistry.
CO2.To understands the stoichiometric calculations and relate them to green process metrics.
CO3. To apply the green concept of and energy sources for chemical processes.
CO4. To analyze renewable requirements for the chemical industry, present and under development.
CO5. To evaluate the mechanism of Microwave assisted and Ultrasound wave assisted reactions.

Unit	Contents	Lecture/Tutorials
1.	**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.	**12**
2.	**Principles of Green Chemistry: ;** Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. careful use of blocking/ protecting groups.	**12**
3.	**Examples of Green Synthesis:** Green Synthesis of the following compounds: adipic acid, catechol, disodiumiminodiacetate (alternative to Strecker synthesis) • Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoicacid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents,Diels-Alder reaction and Decarboxylation reaction • Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonicalternative to Iodine)	**8**
4	**Examples of Green Synthesis/ Reactions and some real world cases:** Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2.Enzymatic Inter esterification for production of no Trans-Fats and Oils, Development of Fully Recyclable Carpet: Cradle to CradleCarpeting	**10**

5.	**Future Trends in Green Chemistry:** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis(C Green chemistry in sustainable development.	**10**

TEXTBOOKS/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'sHandbook of Industrial Chemistry, CBS Publishers, NewDelhi.
4. S.S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. NewDelhi.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	-	-	1	2	2	2	2	3	2
CO2	1	1	-	2	2	3	2	2	3	1
CO3	1	-	-	3	3	-	2	2	3	2
CO4	1	-	1	3	3	3	2	2	3	2
CO5	1	2	-	1	1	2	1	-	2	2

Subject Code	Subject Name	L-T-P	Credit
BCH-351	Inorganic Chemistry Laboratory-IV (Semester V)	0-0-4	2

L+T+P : **0+0+4**
Credits: : **2**
Contact hours : **52**

Viva-voce + Continuous lab performance : **60**

Viva-voce + Practical Exam + Practical record file : **40**

Course Objectives:
The students have the detailed knowledge of gravimetric analysis and estimation of different metal ions and various inorganic preparations.

Course Outcomes:
CO1. To Estimate the metals in a various complex compounds.
CO2. To synthesized various coordination complexes.
CO3. To estimate metal ions gravimetrically.

2. Estimations

Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
Estimation of available chlorine in bleaching powder iodometrically.
Estimation of hardness of water by EDTA
Find out gravimetrically the percentage of Cu in given solution of $CuSO_4.5H_2O$, 20g of which has been dissolved per litre.

3. Inorganic Preparations:

Magnesium Carbonate and Calcium Carbonate

Prussian Blue

Tri (Thiourea) Cuprous Chloride, $[Cu(NH_2CSNH_2)_3]Cl$

Penta Thiourea Dicuprous Nitrate, $[Cu(NH_2CSNH_2)_5] (NO_3)$

Iron(III) Acetylacetonate, $Fe(acac)_3$

TEXTBOOKS/REFERENCE BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	2	1	2	2	1	2	1	2
CO2	1	2	3	2	1	1	2	1	2	3
CO3	1	1	2	1	2	1	2	1	2	1

Course Code	Subject Name	L-T-P	Credits
BCH-353	Organic Chemistry Laboratory-IV (Semester V)	0-0-4	2

L+T+P : **0+0+4**

Credits: : **2**

Contact hours : **52**

Viva-voce + Continuous lab performance : **60**

Viva-voce + Practical Exam + Practical record file : **40**

Course Objectives:
The students will learn and perform practical techniques employed for systematic processes for the identification of unknown organic solid and liquid compounds

Course Outcomes:
CO1. Identify organic compounds by physical and chemical experimental methods.
CO2. To perform and identify functional groups in organic compounds by chemical tests in the laboratory with related reactions
CO3. To estimate saponification and iodine value.

1. Estimation of glycine by Sorenson's formalin method.

2. Study of the titration curve of glycine.

3. Estimation of proteins by Lowry's method.

4. Study of the action of salivary amylase on starch at optimum conditions.

5. Effect of temperature on the action of salivary amylase.

6. Saponification value of an oil or a fat.

7. Determination of Iodine number of an oil/ fat.

8. Isolation and characterization of DNA from onion/ cauliflower/peas.

TEXTBOOKS/REFERENCE BOOKS:

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

2. Arthur, I. V. *Quantitative Organic Analysis,* Pearson.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	2	1	2	2	1	2	1	2
CO2	1	2	3	2	1	1	2	1	2	3
CO3	1	1	2	1	2	1	2	1	2	1

Course Code	Subject Name	L-T-P	Credits
BCH-355	Physical Chemistry Laboratory-IV (Semester V)	0-0-4	2

L+T+P	:	**0+0+4**	Viva-voce + Continuous lab performance	:	**60**
Credits:	:	**2**			
Contact hours	:	**52**	Viva-voce + Practical Exam + Practical record file	:	**40**

Course Objectives:
Due to importance and essentiality of 'Physical Chemistry' in each branch of Sciences – shows usage of subject fundamentals-principals with practical knowledge to design experiments, analyze and interpret data so as to reach to valid conclusions.

Course Outcomes:
CO1. To determine composition of various phase equilibria.
CO2. To determine rate of different reactions.
CO3. To determine the saponification value, acid value and strength of various acid and base.

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) $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$

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.

TEXTBOOKS/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).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	1	1	2	1	1	2	1	1
CO2	2	1	3	2	1	2	2	2	3	3
CO3	3	2	3	1	1	3	1	1	2	2

SEMESTER-VI

BCH-302: Inorganic Chemistry-V (Semester VI)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The objective of the course to understand the chemistry of organometallic compounds and inorganic reaction mechanism

Course Outcomes:

CO1. To learn about general properties of qualitative analysis and Organometallic compounds.
CO2. To understand the basic concepts of organomettalic chemistry.
CO3. To apply the concept of fluxionality and hapticity of organomettalic compounds
CO4. To analyze the synthesis and properties of organomettalic compounds.
CO5. To evaluate the catalytic concept on organometallic compounds.

Unit	Contents	Lecture/Tutorials
1.	**Theoretical Principles in Qualitative Analysis:** Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.	**10**
2.	**Organometallic Compounds-I : D**efinition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Niusing VBT.π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls	**12**
3.	**Organometallic Compounds-II:** Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminiumin polymerisation of ethene (Ziegler – Natta Catalyst). Species present inether solution of Grignard reagent and their structures, Schlenk equilibrium.Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with thatof benzene. in bio-systems, Haemoglobin; Storage and transfer of iron.	**10**
4.	**Reaction Kinetics And Mechanism:** Introduction, Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes	**10**
5	**Catalysis by Organometallic Compounds**(10 Lectures) Study of the following industrial processes and their mechanism: 1. Alkene hydrogenation (Wilkinsons Catalyst) 2. Hydroformylation (Co salts)	**10**

	3. Wacker Process 4. Synthetic gasoline (Fischer Tropsch reaction) 5. Synthesis gas by metal carbonyl complexes	

TEXTBOOKS/REFERENCE BOOKS:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall,1996.
2. Cotton, F.A.G.; Wilkinson &Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.;Wiley India,
3. Huheey, J. E.; Keiter, E.A. &Keiter, R.L. Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
4. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
5. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models inInorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
6. Greenwood, N.N. &Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed,1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	-	-	1	2	1	2	2	3	2
CO2	1	1	-	2	2	-	2	2	3	1
CO3	1	-	-	3	3	2	2	2	3	2
CO4	1	-	1	3	3	1	2	2	3	2
CO5	1	-	1	3	3	2	2	2	3	2

BCH-304: Organic Chemistry-V (Semester VI)					
L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**4**	ABQ	:	**15**
Contact hours	:	**52**	End-semester exam	:	**60**

Course Objectives:

The objective of the course to understand introduction & principle of Spectroscopy and biomolecules.

Course Outcomes:

CO1 To study and learn the interaction of organic compounds with EMR.

CO2. To understand the principle and instrumentation of spectroscopy.

CO3. To apply the concept of preparation, properties and application of polymer, dyes and carbohydrate

CO4. To analyze various organic compounds, biomolecules and dyes through the interaction of EMR

CO5. To evaluate the dyes, polymers and various organic compounds.

Unit	Contents	Lecture/Tutorials
1.	**Organic Spectroscopy-I:** General principles Introduction to absorption and emission spectroscopy. UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis andtrans isomers.IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.	**14**
2.	**Organic Spectroscopy-I:** NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift andfactors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects inalkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simplecompounds. Applications of IR, UV and NMR for identification of simple organic molecules.	**10**
3.	**Carbohydrates**: Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimersand anomers, mutarotation, determination of ring size of glucose and fructose, Haworthprojections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischersynthesis and Ruff degradation;Disaccharides – Structure elucidation of maltose, lactose and sucrose.Polysaccharides – Elementary treatment of starch, cellulose and glycogen.	**14**
4.	**Dyes**: Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing;Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism ofDiazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal	**10**

	Violet;Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation andsynthesis of Alizarin and Indigotin; Edible Dyes with examples.	
5	**Polymers**: Introduction and classification including di-block, tri-block and amphiphilic polymers;Number average molecular weight, Weight average molecular weight, Degree ofpolymerization, Polydispersity Index.Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic andfree radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation ofalkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde,Polyurethanes) and thermosoftening (PVC, polythene);Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural andsynthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives;Introduction to liquid crystal polymers; Biodegradable and conducting polymers withexamples. , Flory- Huggins theory, Lower and Upper critical solution temperatures.	**12**

TEXTBOOKS/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 AgeInternational (P) Ltd. Pub.
5. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry ofNatural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage LearningIndia Edition, 2013.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, OxfordUniversity Press.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	-	-	1	2	1	2	2	3	1
CO2	1	1	-	2	2	1	2	2	3	1
CO3	2	-	-	3	3	2	2	3	3	2
CO4	2	-	1	3	3	2	2	3	3	2
CO5	2	1	1	2		2	1	2	1	2

Course Code	Subject Name	L-T-P	Credits
BCH-306	Physical Chemistry-V (Semester VI)	4-0-0	4

L+T+P	:	**4+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**2**	ABQ	:	**15**
Contact hours	:	**28**	End-semester exam	:	**60**

Course Objectives:
The objective of the course is to understand the concept of electrochemistry.

Course Outcomes:
CO1. To learn the basics concept of electrochemistry.
CO2. To study and understand the various properties and ideas of coal.
CO3. To apply the concept of electrochemical cells.
CO4. To analyze the standard electrode potentiala of various electrochemical cells.
CO5. To evaluate the properties of various electrochemical cells.

Unit	Contents	Lecture/Tutorials
1.	**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	**6**
2.	Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts	**16**
3.	**Electrochemistry I** 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.	**5**
4	**Electrochemistry II** Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) Ph values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of Potentiometric titrations (acid-base, redox, precipitation).	**15**
5.	**Electrical & Magnetic Properties of Atoms and Molecules** Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular	**6**

	interpretation	

Reference Books:

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

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	-	-	2	-	2	1	3	2
CO2	2	1	-	-	1	1	2	1	2	1
CO3	1	1	2	-	1	-	2	3	2	3
CO4	2	-	1	2	2	2	3	2	3	2
CO5	1	1	2	3	2	2	3	1	2	1

Course Code	Subject Name	L-T-P	Credits
BCH-308	Fuel Chemistry (Semester VI)	2-0-0	2

L+T+P	:	**2+0+0**	Mid-Semester exam	:	**25**
Credits:	:	**2**	ABQ	:	**15**
Contact hours	:	**28**	End-semester exam	:	**60**

Course Objectives:
The objective of the course is to have understand the concept of fuels like coal and petroleum..

Course Outcomes:
CO1. To learns the basics concept of fuels..
CO2. To understand the various principles and functioning of fuels.
CO3. To apply the concept crude oil on petroleum and other lubricants.
CO4. To analyze the mechanism of fractional distillation.
CO5. To evaluate the classification and properties of various fuels abd Lubricants..

Unit	Contents	Lecture/Tutorials
1.S	**Introduction:** Review of energy sources (renewable and non-renewable). Classification of fuels and theircalorific value.	**4**
2.	**Coal*:*** Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization ofcoal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar,uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification(Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.	**8**
3.	**Petroleum and Petrochemical Industry:** Composition of crude petroleum, Refining and different types of petroleum products and their applications.	**4**
4	**Fractional Distillation (Principle and process):** Cracking (Thermal and catalytic cracking),Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derivedfrom biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.	**6**
5.	**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.	**6**

TEXTBOOKS/REFERENCE BOOKS:

1.Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
2.Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	2	-	-	2	-	2	1	3	2
CO2	2	1	-	-	1	1	2	1	2	1
CO3	1	1	2	-	1	-	2	3	2	3
CO4	2	-	1	2	2	2	3	2	3	2
CO5	1	1	2	3	2	2	3	1	2	1

Course Code	Subject Name	L-T-P	Credits
BCH-352	Inorganic Chemistry Laboratory-V (Semester VI)	0-0-4	2

Course Objectives:
Due to importance and essentiality of 'Inorganic Chemistry', students will use and implement fundamentals-principals with practical knowledge to design experiments, analyze and interpret data to reach conclusions.

Course Outcomes:
CO1. To study volumetric analysis
CO2. Quantitative analysis of unknown metal ions.
CO3. Identification of organic compounds through spectroscopy

1. To estimate Calcium with EDTA.
2. To estimate Magnesium with EDTA
3. To determine the total permanent and temporary hardness of water by complexometric titrations.
4. To determine the strength of silver nitrate solution using Mohr's Method.
5. Synthesis of Tetramine Cupric Sulphate, $[Cu(NH_3)_4]SO_4 \cdot H_2O$
6. Determination of Dissolved Oxygen (DO) in water sample.
7. Preparation of $[Mn(acac)_3]$
8. Preparation of $K_3[Fe(C_2O_4)_3]$

TEXTBOOKS/REFERENCE BOOKS:

Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	1	1	2	2	1	2	2
CO2	2	1	3	2	1	3	1	2	2	1
CO3	2	1	2	2	3	1	1	1	1	1

Course Code	Subject Name	L-T-P	Credits
BCH-354	Organic Chemistry Laboratory-V (Semester VI)	0-0-4	2

Course Objectives:
Due to importance and essentiality of 'Organic Chemistry', students will use and implement fundamentals-principals with practical knowledge to design experiments, analyze and interpret data to reach conclusions.

Course Outcomes:
CO1. To extract and prepare various organic compounds.
CO2. Qualitative analysis of unknown organic compounds
CO3. Identification of organic compounds through spectroscopy

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.
5. Qualitative analysis of unknown organic compounds containing monofunctionalgroups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, aminesand amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid,nitrophenols, etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

TEXTBOOKS/REFERENCE BOOKS:

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

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	2	1	1	2	2	1	2	2	2
CO2	2	2	3	2	1	1	1	2	3	2
CO3	1	1	2	2	1	2	2	3	2	2

Course Code	Subject Name	L-T-P	Credits
BCH-356	Physical Chemistry Laboratory-IV (Semester VI)	0-0-4	2

Course Objectives:
Physical Chemistry Laboratory deals with the study of chemical kinetics, phase diagram and rate of various reactions.

Course Outcomes:
CO1. To determine composition of various phase equilibria.
CO2. To determine rate of different reactions.
CO3. To determine the solubility and partition coefficient.

1. Determination of rate constant for acid catalyzed ester hydrolysis.
2. Determine the solubility of KCl in water at room temperature.
3. Determine the partition coefficient of benzoic acid between water and benzene at room temperature
4. Study the adsorption of aqueous acetic acid by activated charcoal and to study the adsorption isotherm.
5. Determine the rate constant and order of reaction of hydrolysis of ester.
6. Determine the composition of given mixture consisting of two miscible liquids, A and B by viscosity measurements.
7. Determine the rate constant of hydrolysis of ethyl acetate and NaOH and to show that reaction is second order.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	1	2	1	2	2	2	1	2
CO2	2	2	1	1	1	1	2	2	1	3
CO3	1	1	2	2	2	2	3	3	2	1s

TEXTBOOKS/REFERENCE BOOKS:

2.Khosla, B. D.; Garg, V. C. &Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th 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).

BCH-358: Project/Dissertation

(Semester VI)

L+T+P : **0+0+12**
Credits: : **78**
Contact hours : **52**

Description
Students are required to work on the allotted topic and must make a presentation in front of advisory committee and B.Sc. Students. Students are expected to provide latest facts and updated information by consulting latest editions of textbooks, reference books, monographs, and peer-reviewed national & international research journals.

S.No.	**Course details**
1.	Research work
2.	Seminar
3.	Evaluation by Research committee
4.	Research work by taking 52 credit hours