



MANAV RACHNA UNIVERSITY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF CHEMISTRY

PROGRAM STRUCTURE

&

DETAILED SYLLABUS

B.Sc. (Hons.) Chemistry

BATCH: 2020-2023

MANAV RACHNA UNIVERSITY

DEPARTMENT OF CHEMISTRY

B.SC (CHU01)

SCHEME-B (Effective from July 2019)

SEMESTER-1

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	CONTACT HOURS PER WEEK	NO. OF CREDITS
MAH110B / MAH105B	FUNDAMENTAL OF MATHEMATICS/ STATISTICAL MATHEMATICS	MA	HARD	ALLIED CORE	3	1	0	0	4	4
PHH106B-T	ESSENTIALS OF PHYSICS	PH	HARD	ALLIED CORE	3	1	0	0	4	4
PHH106B-P	ESSENTIALS OF PHYSICS LAB	PH	PRACTICAL	ALLIED CORE	0	0	2	0	2	1
HLS102	COMMUNICATIVE ENGLISH	HUM	SOFT COURSE	ALLIED CORE	1	0	2	0	3	2
CSH101 B-T	PROGRAMMING FOR PROBLEM SOLVING USING C	CS	HARD	ALLIED CORE	2	1	0	0	3	3
CHS101 B-P	PROGRAMMING FOR PROBLEM SOLVING USING C- LAB	CS	PRACTICAL	ALLIED CORE	0	0	2	0	2	1
CHH101B-T	GREEN CHEMISTRY	CH	HARD	CORE	3	1	0	0	4	4
CHH101B-P	GREEN CHEMISTRY-LAB	CH	PRACTICAL	CORE	0	0	2	0	2	1
TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)					12	4	8	0	24	20

SEMESTER - 2

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/NTCC)	COURSE TYPE (Core/Elective etc)	L	T	P	O	CONTACT HOURS PER WEEK	NO. OF CREDITS
CHH102B-T	PHYSICAL CHEMISTRY-I	CH	HARD	CORE	3	1	0	0	4	4
CHH102B-P	PHYSICAL CHEMISTRY-I LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH103B-T	INORGANIC CHEMISTRY-I	CH	HARD	CORE	3	1	0	0	4	4
CHH103B-P	INORGANIC CHEMISTRY-I LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH104B-T	ORGANIC CHEMISTRY-I	CH	HARD	CORE	3	1	0	0	4	4
CHH104B-P	ORGANIC CHEMISTRY-I LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH137	ENVIRONMENTAL SCIENCE	CH	HARD	CORE	2	0	0	2	2	4
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				11	3	9	2	23	20.5
SUMMER TRAINING ON VALUE ADDED MODULES (CHN106B): 2 CREDITS										

SEMESTER - 3

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	CONTACT HOURS PER WEEK	NO. OF CREDITS
CHH201B-T	PHYSICAL CHEMISTRY-II	CH	HARD	CORE	3	1	0	0	4	4
CHH201B-P	PHYSICAL CHEMISTRY-II LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH202B-T	INORGANIC CHEMISTRY-II	CH	HARD	CORE	3	1	0	0	4	4
CHH202B-P	INORGANIC CHEMISTRY-II LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH203B-T	ORGANIC CHEMISTRY-II	CH	HARD	CORE	3	1	0	0	4	4
CHH203B-P	ORGANIC CHEMISTRY-II LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
ODD SEMESTER OPEN ELECTIVE	ODD SEMESTER BASKET OF ELECTOVES (Any one): EDUCATION: Applied Psychology(EDS288), Applied Philosophy(EDS289), Applied Sociology(EDS290) MANAGEMENT: Basics of economics(MCS231); Introduction to Finance(MCS232) CDC: Quantitaive Aptitude-I (CDO203) MINI PROJECT-I (CHN204B)		SOFT/NTCC		1 0	0 0	2 0	0 2	2 0	2
	FOREIGN LANGUAGE: GERMAN (FLS102) / SPANISH (FLS-101) / FRENCH(FLS103)	MRCFL	SOFT	ALLIED ELECTIVE	1	1	0	0	2	2
	TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)				12/ 10	4	9	0/2	25/23	20.5

SEMESTER - 4

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	CONTACT HOURS PER WEEK	NO. OF CREDITS
CHH205B-T	PHYSICAL CHEMISTRY-III	CH	HARD	CORE	3	1	0	0	4	4
CHH205B-P	PHYSICAL CHEMISTRY-III LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH206B-T	INORGANIC CHEMISTRY-III	CH	HARD	CORE	3	1	0	0	4	4
CHH206B-P	INORGANIC CHEMISTRY-III LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH207B-T	ORGANIC CHEMISTRY-III	CH	HARD	CORE	3	1	0	0	4	4
CHH207B-P	ORGANIC CHEMISTRY-III LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH208B CHH209B	POLYMER CHEMISTRY/ INDUSTRIAL CHEMISTRY	CH	HARD	ELECTIVE	3	1	0	0	4	4
EVEN SEMESTER OPEN ELECTIVE	EVEN SEMESTER BASKET OF ELECTIVES (Any one): Chemistry: Environment & Sustainable development (CHS234) CDC: Quantitative Aptitude-II (CDO204) LAW: Cyber Crime & Laws (LWS323) TECHNOLOGY: E-waste management (ECS249) MINI PROJECT-2 (CHN210B)		SOFT	ELECTIVE	2 0	0 0	0 0	0 2	2 0	2
CDO205	Career Skills-I	CDC	SOFT	AUDIT	2	0	0	0	2	Nil
TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)					14/ 12	4	9	0/ 2	27/ 25	22.5

SEMESTER - 5

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	CONTACT HOURS PER WEEK	NO. OF CREDITS
CHH301B-T	PHYSICAL CHEMISTRY-IV	CH	HARD	CORE	3	1	0	0	4	4
CHH301B-P	PHYSICAL CHEMISTRY-IV LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH302B-T	BIOCHEMISTRY & NATURAL PRODUCTS	CH	HARD	CORE	3	1	0	0	4	4
CHH302B-P	BIOCHEMISTRY & NATURAL PRODUCTS LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
CHH303B-T	ANALYTICAL CHEMISTRY & SPECTROSCOPY	CH	HARD	CORE	3	1	0	0	4	4
CHH303B-P	ANALYTICAL CHEMISTRY & SPECTROSCOPY LAB	CH	PRACTICAL	CORE	0	0	3	0	3	1.5
DOMAIN SPECIFIC ELECTIVES	CHEMISTRY IN AGRICULTURE (CHS304B)/ FUEL CHEMISTRY (CHS305B)/ NANO TECHNOLOGY (CHS306B)/ MINOR PROJECT (CHN307B)	CH			2 0	0 0	0 0	0 2	0 2	2
CDO303	Career Skills-II	CDC	Soft	AUDIT	2	0	0	0	2	Nil
TOTAL (L-T-P-O/CONTACT HOURS/CREDITS)					9/ 11	3	9	0/2	21/ 23	18.5

SEMESTER - 6

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	CONTACT HOURS PER WEEK	NO. OF CREDITS
CHH308B	FOOD SCIENCE / INSTRUMENTAL METHOD OF CHEMICAL ANALYSIS	CH	HARD	Elective	3	1	0	0	4	4
CHH310B	CHEMICALS & ENVIRONMENT /	CH	HARD	Elective	3	1	0	0	4	4
CHH311B	CLINICAL & PHARMACEUTICAL									
CHN312B	MAJOR PROJECT	CH	NTCC	CORE	0	0	0	8	2	8
CDO305	Career Skills-III	CDC	Soft	Audit	2	0	0	0	2	Nil



**MANAV RACHNA
UNIVERSITY**

Declared as State Private University vide Haryana Act 26 of 2014

PROGRAMME BOOKLET

**B.Sc. (Hons.) Chemistry (CHU01)
(Academic Session: 2020-2021)
(Syllabus: Scheme B)**

**Department of Chemistry
School of Applied Sciences
Manav Rachna University**

MANAV RACHNA UNIVERSITY

Vision

To educate students in frontier areas of knowledge enabling them to take up challenges as ethical and responsible global citizens

Mission

- To impart outcome based holistic education
- To disseminate education in frontier areas
- To produce globally competitive, ethical and socially responsible human resources
- To produce human resources sensitive to issues of Environment and Sustainable Development
- To develop Environment and Sustainable development as a thrust area of research and development.

Quality Policy

To continuously learn from the best practices, study role models and develop transparent procedures for empowerment of stakeholders.

Strategic Objectives

- To facilitate, enhance & promote innovation in curriculum design and delivery and have Outcome-oriented Learning Culture.
- To promote Research Environment and Management Practices.
- To enhance the quality of the student learning experience.
- To provide Resources and Infrastructure for Academic Excellence.

DEPARTMENT OF CHEMISTRY

Vision

To educate students in frontier areas of sustainable chemistry aspects through research and innovation for the society.

Mission

- To impart outcome based holistic education in thrust areas of the chemistry.
- To produce globally competent and socially responsible citizens.
- To develop human resource with better ethical and moral values.
- To innovate environmentally benign products using alternative approaches of the chemistry.

B.Sc. (Hons.) Chemistry

Programme Educational Objectives (PEOs)

- To provide students with a sound foundation in all the theoretical and experimental aspects of chemistry for educate and train the graduate and postgraduate students.
- Develop the ability to function and communicate effectively for higher education related with industrial domain of Chemistry and generate critical, creative and scientific skills and encourage the students for innovations
- Apply laboratory skills and critical thinking to develop applications for solving Industry oriented problems and develop projects in a multi-disciplinary environment for rivalling leadership skills.
- Work productively as chemistry professional by adopting to environment with lifelong learning and adhering to ethical standards and apply the knowledge acquired for the improvement of the society.

Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)

- Graduates will demonstrate knowledge of Chemistry and chemical technologies.
- Graduates will be able to design, carry out, record and analyze the results of chemical experiments.
- Graduates will be able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.
- Graduates will be skilled in problems solving, critical thinking and analytical reasoning.
- Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
- Graduates will demonstrate skills to use modern chemical equipments to solve an issue related to Chemistry.
- Graduates will demonstrate knowledge to use modern library searching and retrieval methods to obtain information about a topic.
- Graduates will be able to communicate effectively in both verbal and written form.
- Graduates will show the understanding to identify and solve chemical problems and explore new areas of research.
- Graduates will develop confidence for self-education and ability for life-long learning.
- Graduates can participate and succeed in competitive examinations.

Semester I							
Course Code	Course Name	Offering Department	Course Type	Structure			Credits
			Deptt./Allied Core/Elective/ Audit	L	T	P	
MAH110B/ MAH105B	FUNDAMENTAL OF MATHEMATICS/ STATISTICAL MATHEMATICS	MA	ALLIED ELECTIVE	3	1	0	4
PHH106B-T	ESSENTIALS OF PHYSICS	PH	ALLIED CORE	3	1	0	4
PHH106B-P	ESSENTIALS OF PHYSICS LAB	PH	ALLIED CORE	0	0	2	1
HLS102	COMMUNICATIVE ENGLISH	HUM	ALLIED CORE	1	0	2	2
CSH105B-T	PROGRAMMING FOR PROBLEM SOLVING USING C	CS	ALLIED CORE	2	1	0	3
CSH105B-P	PROGRAMMING FOR PROBLEM SOLVING USING C LAB	CS	ALLIED CORE	0	0	2	1
CHH101B-T	GREEN CHEMISTRY	CH	CORE	3	1	0	4
CHH101B-P	GREEN CHEMISTRY LAB	CH	CORE	0	0	2	1
Semester II							
Course Code	Course Name	Offering Department	Course Type	Structure			Credits
			Deptt./Allied Core/Elective/ Audit	L	T	P	
CHH102B-T	Physical Chemistry-I	CH	CORE	3	1	0	4
CHH102B-P	Physical Chemistry-I Lab	CH	CORE	0	0	3	1.5
CHH103B-	Inorganic	CH	CORE	3	1	0	4

T	Chemistry-I						
CHH103B-P	Inorganic Chemistry-I Lab	CH	CORE	0	0	3	1.5
CHH104B-T	Organic Chemistry-I	CH	CORE	3	1	0	4
CHH104B-P	Organic Chemistry-I Lab	CH	CORE	0	0	3	1.5
CHH137	Environmental Science	CH	CORE	2	0	4	4
SUMMER TRAINING ON VALUE ADDED MODULES (CHN106B): Credits 2							
Semester III							
Course Code	Course Name	Offering Department	Course Type	Structure			Credits
			Deptt./Allied Core/Elective/Audit	L	T	P	
CHH201B-T	PHYSICAL CHEMISTRY-II	CH	CORE	3	1	0	4
CHH201B-P	PHYSICAL CHEMISTRY-II LAB	CH	CORE	0	0	3	1.5
CHH202B-T	INORGANIC CHEMISTRY-II	CH	CORE	3	1	0	4
CHH202B-P	INORGANIC CHEMISTRY-II LAB	CH	CORE	0	0	3	1.5
CHH203B-T	ORGANIC CHEMISTRY-II	CH	CORE	3	1	0	4
CHH203B-P	ORGANIC CHEMISTRY-II LAB	CH	CORE	0	0	3	1.5
	ODD SEMESTER OPEN ELECTIVE						
EDS288 EDS289 EDS290	Applied Psychology Applied Philosophy Applied Sociology	EDU EDU EDU	ALLIED ELECTIVE	1	0	2	2
MCS231 MCS232	Basics of Economics Introduction to Finance	MGM MGM					
CDO203	Quantitative	CDC					

CHN204B	Aptitude-I MINI PROJECT-I	CH		0	0	2	2
FLS101 FLS102 FLS103	FOREIGN LANGUAGE SPANISH GERMAN FRENCH	MRCFL	ALLIED ELECTIVE	1	1	0	2
Semester IV							
Course Code	Course Name	Offering Departme nt	Course Type	Structure			Credit s
			Deptt./Allied Core/Electiv e/ Audit	L	T	P	
CHH205B- T	PHYSICAL CHEMISTRY-III	CH	CORE	3	1	0	4
CHH205B- P	PHYSICAL CHEMISTRY-III LAB	CH	CORE	0	0	3	1.5
CHH206B- T	INORGANIC CHEMISTRY-III	CH	CORE	3	1	0	4
CHH206B- P	INORGANIC CHEMISTRY-III LAB	CH	CORE	0	0	3	1.5
CHH207B- T	ORGANIC CHEMISTRY-III	CH	CORE	3	1	0	4
CHH207B- P	ORGANIC CHEMISTRY-III LAB	CH	CORE	0	0	3	1.5
CHH208B/ CHH209B	POLYMER CHEMISTRY/ INDUSTRIAL CHEMISTRY	CH	ELECTIVE	3	1	0	4
	EVEN SEMESTER OPEN ELECTIVE						
CHS234	Environment & Sustainable Development	CH	ALLIED ELECTIVE	2	0	0	2
ECS249	E-waste Management	ECE					
LWS323	Cyber Crime &	LW					

CDO204	Laws Quantitative Aptitude-II	CDC CH	ELECTIVE	0	0	0	
CHN210B	MINI PROJECT-II						
CDO205	CAREER SKILLS-I	CDC	AUDIT	2	0	0	NIL
Semester V							
Course Code	Course Name	Offering Department	Course Type	Structure			Credits
			Deptt./Allied Core/Elective/ Audit	L	T	P	
CHH301B-T	PHYSICAL CHEMISTRY-IV	CH	CORE	3	1	0	4
CHH301B-P	PHYSICAL CHEMISTRY-IV LAB	CH	CORE	0	0	3	1.5
CHH302B-T	BIOMOLECULES & NATURAL PRODUCTS	CH	CORE	3	1	0	4
CHH302B-P	BIOMOLECULES & NATURAL PRODUCTS-LAB	CH	CORE	0	0	3	1.5
CHH303B-T	ANALYTICAL CHEMISTRY & SPECTROSCOPY	CH	CORE	3	1	0	4
CHH303B-P	ANALYTICAL CHEMISTRY & SPECTROSCOPY-LAB	CH	CORE	0	0	3	1.5
CHS304B CHS305B CHS306B CHN307B	DOMAIN SPECIFIC ELECTIVES CHEMISTRY IN AGRICULTURE FUEL CHEMISTRY NANOTECHNOLOGY MINOR PROJECT	CH	ELECTIVE	2 0	0 0	0 2	2
CDO303	CAREER SKILLS-II	CDC	AUDIT	2	0	0	NIL
Semester VI							
Course	Course Name	Offering	Course Type	Structure			Credit

Code		Department	Deptt./Allied	L	T	P	s
			Core/Elective/ Audit				
CHH308B/ CHH309B	FOOD CHEMISTRY/ INSTRUMENTAL METHOD OF CHEMICAL ANALYSIS	CH	ELECTIVE	3	1	0	4
CHS310B/ CHS311B	CHEMICALS & ENVIRONMENT/ CLINICAL & PHARMACEUTICAL CHEMISTRY	CH	ELECTIVE	3	1	0	4
CHN312B	MAJOR PROJECT	CH	CORE	0	0	0	8
CDO305	CAREER SKILLS- III	CH	AUDIT	2	0	0	NIL

Programme Structure

Total Credits Scheme

S. No.	Semester	Contact Hours	Credits
1	I	24	20
2	II	23	20.5
3	Summer Training (Post II Sem)	NA	2
4	III	25/23	20.5
5	IV	27/25	22.5
6	V	21/23	18.5
7	VI	10	16
	Total	126-132	120

B.Sc. (Hons.) Chemistry - CHU01
Semester-I

Course Code	Course Name	Offering Department	Course Type	Structure			Credits
				L	T	P	
MAH110B/ MAH105B	Fundamental of Mathematics/Statistical Mathematics	MA	ALLIED ELECTIVE	3	1	0	4
PHH106B-T	Essentials of Physics	PH	ALLIED CORE	3	1	0	4
PHH106B-P	Essentials of Physics Lab	PH	ALLIED CORE	0	0	2	1
HLS102	Communicative English	HUM	ALLIED CORE	1	0	2	2
CSH105B-T	Programming for Problem Solving Using C	CS	ALLIED CORE	2	1	0	3
CSH105B-P	Programming for Problem Solving Using C Lab	CS	ALLIED CORE	0	0	2	1
CHH101B-T	Green Chemistry	CH	CORE	3	1	0	4
CHH101B-P	Green Chemistry Lab	CH	CORE	0	0	2	1
TOTAL (L-T-P) /CREDITS)				12	4	8	20

SEMESTER I Detailed Syllabus

Course Title /Code	Fundamental of Mathematics (MAH110B)	
Course Type	Allied Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	Students would be able to understand and apply concepts of differentiation and integration and apply the same for solving the mathematical problems and their applications.	
Course Outcomes		Mapping
CO1	Demonstrate understanding of concepts of differentiation	Skill Development
CO2	Demonstrate understanding of concepts of integration and compute problems on integration	Skill Development
CO3	Apply concepts of differentiation and integration to solve ordinary differential equation of first order and first degree	Skill Development
CO4	Apply concepts of differentiation and integration to formulate and solve partial differential equation and its applications.	Skill Development
Pre -Requisites	Basic fundamentals of Mathematics	

SECTION-A

DIFFERENTIATION: Introduction, Differentiation by 1st principle, Geometrical meaning of derivative at a point, Fundamental Rules of Differentiation: Derivative of sum of two functions, product Rule, Quotient Rule, Derivative of function of a function (Chain Rule). Logarithmic differentiation.

SECTION-B

INTEGRATION: Primitive or Anti-derivative, Indefinite integrals, Fundamental integration formulas, Geometrical interpretation of indefinite integrals, Integrals of some special form. Integration by Parts. Definite Integrals.

SECTION-C

DIFFERENTIAL EQUATIONS: Introduction, definition, Order and degree of a differential equation, Formation of a differential equations, Solution of a differential equations, differential equations of first order and first degree and their solution.

SECTION-D

PARTIAL DIFFERENTIAL EQUATIONS: Functions of two or more variables, Partial derivatives, Partial differential equations, formation of PDE, Solution of PDE by direct integration method, Method of separation of variables and its applications.

Reference Books:

1. Mathematics for class XI-XII- By R D Sharma
2. Mathematics for class XI- XII – NCERT
3. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.

CO-PO Mapping

Course Code	Course	Course Outcomes	Program Outcomes										
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MAH110B	Fundamental of Mathematics	CO1	–	–	–	2	–	–	–	2	–	3	2
		CO2	–	–	–	2	–	–	–	2	–	3	2
		CO3	–	–	–	2	–	–	–	2	–	3	2
		CO4	–	–	–	2	–	–	–	2	–	3	2

Course Title/ Code	STATISTICAL MATHEMATICS (MAH105B) (For Students having Maths in 10+2)	
Course Type	Core (Allied)	
L-T-P Structure	3-1-0	
Credits	4	
Course Objectives	To equip the students with the concepts of Measures of Central Tendency, Measures of Dispersion, Skewness, Moments & Kurtosis and Correlation & Regression Analysis.	
Course Outcomes (COs)		Mapping
CO1	Understand of the fundamental concepts and techniques used in statistics.	Skill Development
CO2	Examine the different types of variations and its application in those calculations.	Skill Development
CO3	Analyze different methods of moments.	Skill Development
CO4	Identify basic correlation & regression with application.	Skill Development
Pre-requisites	Basic knowledge of 12th level mathematics.	

SECTION A

Measures of Central Tendency: Introduction, types of averages- Mean, Median, Mode, Geometric mean, Harmonic mean, Relationship among averages, Quartile, Percentile

SECTION B

Measures of Dispersion: Introduction, Significance of measuring variations, Range, Quartile deviation, Mean deviation, Standard deviation, Relation between them, Coefficient of variation, Relation between coefficient of variation and standard deviation

SECTION C

Skewness, Moments & Kurtosis: Introduction, Difference between dispersion and skewness, Measures of skewness, Karl Pearson's coefficient of skewness, Bowley's coefficient of skewness, Kelly's coefficient of skewness, Moments, Moments about arbitrary origin, about zero, about mean, Measures of Kurtosis.

SECTION D

Correlation & Regression Analysis: Introduction, Types of correlation, Karl Pearson's coefficient of correlation, Probable error, Rank correlation, Spearman's correlation coefficient, Concurrent deviation method, Introduction to regression analysis, Difference between correlation and regression analysis, Regression lines and Regression equations.

Recommended books:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

4. S. P. Gupta, Statistical Methods, Sultan Chand & Sons, Educational publishers, New Delhi

5. S.C. Gupta, Fundamentals of Statistics, Himalaya Publishing House.

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MAH105B	STATISTICAL MATHEMATICS	CO1	-	-	-	2	-	-	-	2	-	3	2
		CO2	-	-	-	2	-	-	-	2	-	3	2
		CO3	-	-	-	2	-	-	-	2	-	3	2
		CO4	-	-	-	2	-	-	-	2	-	3	2

Course Title/Code	Essentials of Physics (PHH106B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To give an in-depth exposure of Optical phenomena, Quantum mechanics and Electro-magnetic field theory and prepare the students to apply the knowledge to solve various problems of diffraction, interference and polarization. Students can apply the knowledge to the futuristic development of Optical fibers, LASERS and holograms.	
	Course Outcomes (COs)	Mapping
CO1	Produce and analyze the Interference Pattern Due to Division of Amplitude and produce required Quality Spectrum and analyze it using appropriate Diffraction Grating.	Employability
CO2	Measure the Concentration/Purity of Optically Active Materials Using Optical Devices and discuss the Construction, Working and Applications of LASERS and Optical Fiber.	Employability
CO3	Solve problem of one dimensional and three dimensional using concepts of Quantum Mechanics.	Skill Development
CO4	Apply electromagnetic wave equation for free space and find out different parameters	Skill Development
Prerequisites	Knowledge of Physics up to 10+2 standard	

SECTION-A

Physical Optics

Interference, Interference by Division Of Wave front and Amplitude, Interference in Thin Films (Uniform and Variable Thickness), Newton's Ring and its Applications, Michelson Interferometer and its Applications. Fraunhofer Diffraction at Single Slit, Plane Transmission Grating, Dispersive and Resolving Power of a Grating,

SECTION-B

Polarization and Laser

Polarized and Un-Polarized Light, Malus Law, Double Refraction, Nicol Prism, Quarter and Half Wave Plates, Laurent's Half Shade Polarimeter and its applications

Stimulated Absorption, Spontaneous and Stimulated Emission, Population Inversion, Conditions for Laser Action, Laser Properties and Laser Applications, Types of Laser: He-Ne Laser, Semiconductor Laser.

SECTION – C

Quantum Mechanics

Introduction to Quantum Mechanics, Planck's radiation law, Photoelectric Effect, Dual nature of matter, Schrodinger wave equations-time dependent and time independent, Physical significance of wave function, Particle in one dimensional box, Schrodinger Equation in Spherical Polar Coordinates, Hydrogen Atom, Vibrational and rotational spectra of molecules.

SECTION – D

Electromagnetic Theory:

Electric Flux Density, Gauss's Law and its Applications to a Spherical Symmetry and Uniformly Charged Infinite Plane Sheet, Energy Per Unit Volume, Ampere's Law and its Modification for Non-Steady Currents, Maxwell's Equations, Wave Propagation in Free Space, Dielectrics and Conducting Medium, Poynting Theorem and its Significance

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
PHH106 B-T	Essentials of Physics	CO1	3	-	-	-	3	-	-	-	2	2	3
		CO2	3	-	-	-	3	-	-	-	2	2	3
		CO3	3	-	-	-	3	-	-	-	2	2	3
		CO4	3	2	2	-	3	-	-	-	2	2	3

Course Title/Code	Essentials of Physics (PHH106B-P)	
Course Type	Core	
L-T-P Structure	0-0-2	
Credits	1	
Course Objective	To skill students in handling LASER, Optical Fiber, Gratings, PRISM, optical microscopy for various analysis and inculcate understanding of theoretical background of diffraction, interference and polarization phenomena.	
	Course Outcomes (COs)	Mapping
CO1	Students would be able to understand, explain and demonstrate and apply the fundamentals of interference and diffraction using grating, optical microscopy.	Employability
CO2	Students would be able to understand, analyze and apply the concept of LASERS and optical active materials using the experiments.	Employability
CO3	Students would be able to explain and apply the Quantum mechanics to perform experiments and evaluate standard constants using laboratory experiments.	Skill Development
CO4	Students would be able to explain and apply the wave-theory of electromagnetic waves and perform related experiments.	Skill Development
Prerequisites	Knowledge of Physics up to 10+2 standard	

ESSENTIALS OF PHYSICS-LAB (PHH106B-P)

List of Experiments:

1. To determine the wavelength of sodium light by Newton's rings experiment. Describe the interference pattern using polychromatic source of light.
2. To determine the wavelength of sodium light by Fresnel's biprism experiment.
3. To determine the wavelength of various colors of white light with the help of a plane transmission diffraction grating.
4. Determination of dispersive power of the given grating.
5. To determine the refractive index and Cauchy's constants of a prism by using spectrometer.
6. To determine the wavelength of sodium light by Michelson interferometer.
7. To determine the resolving power of a telescope.
8. To determine the pitch of a screw using He-Ne laser
9. To determine the specific rotation of optically active solution by using Laurent's half shade polarimeter.
10. To determine the numerical aperture of an optical fiber using laser light.
11. To determine the value of Planck's constant by using a Photoelectric Cell.
12. To determine the value of Planck's constant by using LEDs.

Suggested Books:

1. Fundamentals of Engineering Physics , M S Khurana, MR Pub, Delhi (**Text Book**)
2. Modern Physics for Engineers I & II, S P Taneja; R Chand Publication (**Text Book**)
3. Engineering Physics, Satya Prakash, Pragati Prakashan.
4. Concepts of Modern Physics, A. Beiser
5. Optics, A. Ghatak
6. Fundamentals of Molecular Spectroscopy-C N Banwell & E M Mccash
7. Introduction to Molecular Spectra – H E White

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
PHH106B-P	Essentials of Physics Lab	CO1	3	3	3	3	3	3	-	-	2	2	2
		CO2	3	3	3	3	3	3	-	-	2	2	2
		CO3	3	3	3	3	3	3	-	-	2	2	2
		CO4	3	3	3	3	3	3	-	-	2	2	2

Course Title/Code	Communicative English (HLS102)	
Course Type	Core	
L-T-P Structure	(1-0-2)	
Credits	2	
Course Objective	To imbibe students about the basics of communication skills & English Language by understanding the need of industry.	
Course Outcomes (COs)		Mapping
CO1	To know about all the words and phrases of English language.	Skill Development
CO2	To build the basic skills of effective communication	Skill Development
CO3	To know about the importance of Listening	Skill Development
CO4	To know about the importance of verbal and nonverbal movements.	Skill Development
Prerequisites (if any)	Basic understanding of English Language & grammar	

Section – A

Lexis:

Homonyms, Homophones, Homographs, Words often confused, One word Substitutes, Synonyms and Antonyms, Foreign Words, Phrasal Verbs & Idioms and Phrases

Section – B

Oral Communication:

Importance of Speech Sounds, Organs of Speech, Vowel Sounds, Consonant Sounds, IPA Symbols, Phonetic Transcription, Phoneme and Syllables, Intonation, Word Stress, Sentence Stress.

Section – C

Presentation Skills:

Body Language and Paralanguage, Gestures and Postures, Kinesics, Proxemics, Importance of Body Language in Presentation, Etiquette of the Telephone Handling and Business Meetings, Professional Presentation, Hearing and Listening, Essentials of Effective Listening, Importance of Effective Listening, Visual Presentation – How to prepare slide presentation.

Section – D

Technical Writing-II:

Business Letters, Job Application and Resume Writing, Developing Outlines, Circular, Memos, Blog Writing and Comments on Media.

Suggested Text Reading:

1. A Practical Course for Developing Writing Skills in English. J K Gangal: PHI Learning Pvt.
2. A Textbook of English Phonetics for Indian Students. T.Bala Subhrmaniam: Macmillan
3. English Vocabulary in Use. MaCarthy: Foundation Books, OUP. Print.
4. English Grammar, Competition and Correspondence. M.A. Pink and A.C. Thomas: S. Chand and Co. Print.
5. Reading Between the Line: Students Book. MacRae: Foundation Books. CUP, New Delhi.

List of Practical:

1. Extempore
2. Homonyms & Homophones
3. Foreign Words
4. Idioms & Phrases and Phrasal Words
5. Telephonic Conversation
6. Business Letter
7. Group Discussion
8. Organs of Speech
9. Phonetic Transcription
10. Job Application & CV Writing
11. Presentation
12. Circular & Memo
13. Mock Interview
14. Blog Writing

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
HLS102	Communicative English	CO1	-	-	-	1	-	-	-	3	-	-	1
		CO2	-	-	-	1	-	-	-	3	-	-	1
		CO3	-	-	-	1	-	-	-	3	-	-	1
		CO4	-	-	-	1	-	-	-	3	-	-	1

Course Title/Code	Programming for Problem Solving Using C (CSH105B-T)	
Course Type	Core (Deptt./Allied)/Elective (Deptt./Allied)/Audit	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To construct a program of moderate complexity from a specification	
Course Outcomes (COs)		Mapping
CO1	Analyze and apply Test Driven Development approach to design programs.	Skill Development and Employability
CO2	Understand and apply programming language constructs as per given problems	Skill Development and Employability
CO3	Understand and apply C programming language constructs on open source platform	Skill Development and Employability
CO4	learn to work in a team using different online platform for program development	Skill Development and Employability
Prerequisites (if any)		

Section-A

Programming and UNIX

Students will learn the basics of programming using Scratch, they will learn to use statements, expressions, conditions, selection, iteration, variables, functions, arrays, threads and events. In addition, they will be introduced to basic UNIX commands under Bash.

Introduction to Programming, test driven development, Scratch: Introduction, statements, expressions, conditions, selection, iteration, variables, functions, arrays. UNIX: Basic commands- pwd, ls, cd, rm, cat, less, mkdir, rmdir; permissions, root. C language: statements, expressions, conditions, selection iteration, variables, functions, arrays.

Section-B

Applying programming constructs

Students will learn how to write programs that satisfy unit tests. The instructor will build the unit tests, demonstrating how to break a problem down into smaller components. In the labs and homework, students will construct programs that satisfy the unit tests. Students become familiar with the constructs of the C programming language.

Moving to C: Data Types, constants, and variables, Statements, Expressions, Conditions, Selection, iteration, Functions and recursion

Decision making within a program, Conditions, Relational Operators, Logical Connectives, if statement, if-else statement, Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement, structured Programming

Arrays; One dimensional arrays: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; Null terminated strings as array of characters, Standard library string functions

Introduction to Top-down approach of problem solving, Modular programming and functions, Standard Library of C functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, Passing arguments to a Function: call by reference, call by value, Recursive Functions, arrays as function arguments .

Section-C

Practical programming:

During the third quarter of the class, students will begin building their own programs by decomposing problems into smaller tasks and writing unit tests that will check to see that the program accurately accomplishes the task using Test Driven Development. They will then write the program that satisfies their own unit tests. Students will learn to apply the constructs of the C programming language to create programs.

Students will learn to apply these programming techniques: Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions, Break, Continue and Goto, Type Conversion; Enumerations; Macros. Students will be able to use these techniques to develop programs

Section-D

Memory Management and Abstraction

During the final quarter, students will be introduced to dynamic memory allocation and dynamic data structures including: dynamic arrays. They will consolidate their ability to use the C programming techniques they have learned in the earlier sections.

Address operators, pointer type declaration, pointer assignment, pointer initialization, pointer arithmetic, functions and pointers, Arrays and Pointers, pointer arrays, pointers and structures, dynamic memory allocation, software configuration management, Modules, C Unit, GIT, SCRUM, MAKE. Dynamic Memory Allocation.

Text and Reference Books

1. The C Programming Language, Brian Kernighan and Dennis Ritchie
2. The Unix Programming Environment
3. Pro Git

CO-PO MAPPING

Course Code	Course	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CSH105 B-T	Programming for Problem solving using C	CO1	3	3	2	-	-	-	-	-	3	3	3
		CO2	3	3	3	-	-	-	-	-	2	2	2
		CO3	3	3	3	-	-	-	-	-	3	3	2
		CO4	3	3	3	-	-	-	-	-	2	2	3

Course Title/Code	Programming for Problem Solving Using C Lab (CSH105B-P)	
Course Type	Core (Deptt./Allied)/Elective (Deptt./Allied)/Audit	
L-T-P Structure	0-0-2	
Credits	1	
Course Objective	To construct a program of moderate complexity from a specification	
Course Outcomes (COs)		Mapping
CO1	Analyze and apply Test Driven Development approach to design programs.	Skill Development and Employability
CO2	Understand and apply programming language constructs as per given problems	Skill Development and Employability
CO3	Understand and apply C programming language constructs on open source platform	Skill Development and Employability
CO4	learn to work in a team using different online platform for program development	Skill Development and Employability
Prerequisites (if any)		

LIST OF EXPERIMENTS

1. Scratch : Covering Concepts of
 - I. Sequential Statements
 - II. Variables
 - III. Blocks
2. Unix Commands: pwd, mkdir, cd, ls, less, touch, cp, move, cat, rm, rmdir –r etc.
3. Moving to C Using nano and gcc.
4. Project on Calculator Using Agile Methodology, Nano, Cunit, Git, Scrum , Agile Methodology,

Nano, Gcc, Make. Covering Concepts :

- Statements

- Functions
- Arrays
- Structures
- Pointers
- File Handling

Suggested Books:

1. The C Programming Language, Brian Kernighan and Dennis Ritchie
2. The Unix Programming Environment
3. Pro Git

Help Pages

1. Eclipse C/C++ Development Guide

Wikipedia Pages

1. Test-driven development, http://en.wikipedia.org/wiki/Test-driven_development
2. Unit testing, http://en.wikipedia.org/wiki/Unit_testing

Tool Web Sites

1. Eclipse, <https://eclipse.org/users/>
2. Git, <http://git-scm.com/>
3. GCC, <https://gcc.gnu.org/onlinedocs/gcc-4.9.3/gcc/>
4. Make
5. Unix

Web tutorials

1. Harvard's CS50, <https://courses.edx.org/courses/HarvardX/CS50x3/2015/info>

CO-PO MAPPING

Course Code	Course	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CSH10 5B-P	Programming for Problem solving using C Lab	CO1	3	3	2	-	-	-	-	-	3	3	3
		CO2	3	3	3	-	-	-	-	-	2	2	2
		CO3	3	3	3	-	-	-	-	-	3	3	2
		CO4	3	3	3	-	-	-	-	-	2	2	3

Course Title/Code	Green Chemistry (CHH101B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To give basic knowledge of the green chemistry principles and its application in daily life.	
Course Outcomes (COs)		Mapping
CO1	To understand the knowledge of green chemistry and the twelve principles of Green Chemistry which they can apply to a range of work places for a safer, less toxic and healthier environment	Skill Development
CO2	To develop and demonstrate the knowledge of the green polymers and green lubricants	Skill Development
CO3	To develop and demonstrate the knowledge of green solvents and ability to synthesize the green organic compounds and materials through green synthetic routes	Skill Development
CO4	To develop Ability to apply the knowledge of the green chemistry in green engineering in industrial and daily life use	Skill Development
Prerequisites	Basic knowledge of Chemistry	

SECTION-A

Introduction to green Chemistry

Definition, history, need and goals of green chemistry, Green Chemistry in sustainable development, Importance of Green Chemistry. Limitations / Obstacles in the pursuit of the goals of Green Chemistry.

Basic Principles of Green Chemistry

Twelve Principles in Green Chemistry with their explanations and examples, Prevention of waste/by-products, Atom Economy, Prevention/Minimization of hazardous/toxic products, Designing safer chemicals, Selection of safer solvents and auxiliaries, Design for energy efficiency (use of microwave and ultrasonic radiations), Use of renewable Feedstock's, Avoidance of unnecessary derivatization, Use of catalytic reagents in preference to stoichiometric reagents, Designing biodegradable products, Prevention of chemical accidents (including releases, explosions and fires), Strengthening / Development of green techniques to prevent hazardous substances in chemical process.

SECTION-B

Green Lubricants & Polymers

Introduction to Lubrication (types and mechanism), Properties of lubricants (Viscosity and its determination, flash point & fire point, cloud point & pour point, aniline point, saponification value, acid value and iodine value) Applications of conventional and green lubricants, Introduction & Classification of polymers, Biodegradable and non-biodegradable polymers, Synthesis of Green Polymers, Polymer Composites.

SECTION-C

Green Synthesis: Comparison with Conventional Synthesis

Green Solvents and Reaction Conditions: Water as green solvent, Properties of water (Alkalinity, Hardness and Dissolved Oxygen and their determination), Phase diagram of one component system - Water and CO₂, Supercritical fluids, Ionic Liquids (Introduction, properties and Ions Structure), Liquid polymers-PEG, and Renewable Solvents (Alcohols, Esters, Terpenes and 2 Me THF)

Green reagents-Triplet Oxygen, Singlet Oxygen, Ozone, H₂O₂, Dioxirane, Dimethyl carbonate, Polymer supported Reagents

Green Catalysis- Green Catalysts/Biocatalysts, Phase transfer catalysts, Recoverable catalysts, Enzymes- their classes, specificity and selectivity.

Green Synthesis- Adipic acid, Adiponitrile, Ibuprofen, MMA, Sebacic acid and Biodiesel, Quantitative Solid-solid synthesis

SECTION-D

Green Engineering & Its Applications

Need and scope of green engineering, Basic principles of green engineering, Elimination of hazardous compounds by green compounds, Eco-friendly materials for computing Case studies of Real World / Indian Cases: Sony Ericsson: Bromine-and Chlorine-Free Mobile Phones, Bio-based composite resins design for electronic materials: Soy Plastics, US Presidential Green Chemistry Challenge Award Winners.

Reference Books:

1. P. T. Anastas, J. C. Warner, Green Chemistry: Theory and Practice, 1998. Oxford University Press
2. C. J. Gonzalez, David JC Constable, Green Chemistry and Engineering. 2011 John Wiley & Sons
3. EMO Chiellini and Roberto Solaro Biodegradable Polymers and Plastics. 2002 Kluwer Academic Publishers.
4. Paul T. Anastas, Robert H. Crabtree Green Catalysis. 2009 Wiley-VCH.
5. James H. Clark, Duncan J. Macquarrie Handbook of green chemistry and technology. 2002. John Wiley & Sons
6. Roger A. Sheldon, Isabel Arends, Ulf Hanefeld Green Chemistry and Catalysis. First Edition, 2007 Wiley-VCH.

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH101B-T	Green Chemistry	CO1	3	-	-	3	3	-	-	-	2	2	3
		CO2	3	-	-	3	3	-	-	-	2	2	3
		CO3	3	2	-	3	3	-	-	-	2	2	3
		CO4	3	2	-	3	3	-	-	-	2	2	3

Course Title/Code	Green Chemistry Lab (CHH101B-P)	
Course Type	Core	
L-T-P Structure	0-0-2	
Credits	1	
Course Objective	To skill students to characterize parameters of water and to synthesize and characterize polymers and other utility compounds and lubricants respectively.	
Course Outcomes (COs)		Mapping
CO1	Demonstration of various parameters of green solvent Water	Skill Development
CO2	demonstrate and evaluation of parameters for the lubricants	Skill Development
CO3	Able to synthesize the polymers	Skill Development
CO4	able to synthesize the compounds	Skill Development
Prerequisites	Basic knowledge of laboratory practices	

LAB EXPERIMENTS

1. To determine the alkalinity of given water sample
2. To determine Total, Permanent and temporary hardness of water sample
3. To determine total dissolved oxygen in a given sample of water
4. To determine Viscosity index of given lubricating oil by Redwood viscometer no 1
5. To determine flash point and fire point of lubricating oil by Pensky's Marten's apparatus
6. To prepare (a) Urea-formaldehyde resin (b) Phenol-formaldehyde resin.
7. To determine the concentration of given KMnO_4 solution using a Digital Photo-colorimeter
8. To determine total residual chlorine in water sample
9. To determine free carbon di oxide in given water sample.
10. To analyse the TDS and TSS in a given sample of water.

11. Any other Practical related to subject

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH101B -P	Green Chemistry Lab	CO1	3	3	1	-	3	3	-	-	2	2	2
		CO2	3	3	1	-	3	3	-	-	2	2	2
		CO3	3	3	2	-	3	3	-	-	2	2	2
		CO4	3	3	2	-	3	3	-	-	2	2	2

Semester-II

Course Code	Course Name	Offering Department	Course Type	Structure			Credits
			Deptt./Allied Core/Elective/Audit	L	T	P	
CHH102B-T	PHYSICAL CHEMISTRY-I	CH	CORE	3	1	0	4
CHH102B-P	PHYSICAL CHEMISTRY-I LAB	CH	CORE	0	0	3	1.5
CHH103B-T	INORGANIC CHEMISTRY-I	CH	CORE	3	1	0	4
CHH103B-P	INORGANIC CHEMISTRY-I LAB	CH	CORE	0	0	3	1.5
CHH104B-T	ORGANIC CHEMISTRY-I	CH	CORE	3	1	0	4
CHH104B-P	ORGANIC CHEMISTRY-I LAB	CH	CORE	0	0	3	1.5
CHH137	ENVIRONMENTAL SCIENCE	CH	CORE	2	0	0	4
TOTAL (L-T-P) /CREDITS)				11	3	9	20.5
SUMMER TRAINING ON VALUE ADDED MODULES (CHN106B): Credits 2							

Course Title/Code	PHYSICAL CHEMISTRY-I (CHH102B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	Students will be able to understand different states of matter and various laws governing the properties of solid, liquid and gaseous states. Emphasis will also be on the basic concept of ionic equilibrium and its applications.	
Course Outcomes (COs)		Mapping
CO1	To develop in-depth understanding of gas laws in various real-life situations and the kinetic theory of gases.	Skill Development
CO2	To understand Physical properties of Gases and its comparative study with gases.	Skill Development
CO3	To get familiarize with nature of the solid state, law of constancy and defects	Skill Development
CO4	To understand the Concept of ionic equilibria and its applications.	Skill Development
Prerequisites	Basics of 11th and 12th	

SECTION-A

Gaseous state:

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

SECTION-B

Liquid state:

Intermolecular forces in liquids, Dipole-dipole interactions, Hydrogen bonding, physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, units and their determination. Effect of addition of various solutes on surface tension and viscosity, Temperature variation of viscosity of liquids and comparison with that of gases. Refractive and its determination, Optical activity and its determination.

SECTION-C

Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices and its determination, Isotropy and anisotropy, Born-Haber cycle, structure of solid state (HCP, BCC, FCC) seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl, Defects in crystals, glasses and liquid crystals

SECTION-D

Ionic equilibria:

Acid-Bases: Arrhenius concept, Lewis concept, proton transfer theory, Strong moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009)
5. Essential of Physical Chemistry, Arun Bahl, B.S Bahl, G.D.Tuli.

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CHH102B -T	PHYSICAL CHEMISTRY-I	CO1	2	3	1	2	2	2	1	-	2	2	1
		CO2	2	2	1	2	1	2	1	-	3	2	2
		CO3	3	2	1	1	1	1	2	-	3	2	1
		CO4	2	2	2	3	2	-	2	-	3	1	2

Course Title/Code	PHYSICAL CHEMISTRY-I LAB (CHH102B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	To skill students handling stalagmometer, viscometer and pH meter.	
	Course Outcomes (COs)	Mapping
CO1	To develop in-depth understanding of gas laws in various real-life situations and the kinetic theory of gases.	Skill Development
CO2	To understand Physical properties of Gases and its comparative study with gases.	Skill Development
CO3	To get familiarize with nature of the solid state, law of constancy and defects	Skill Development
CO4	To understand the Concept of ionic equilibria and its applications.	Skill Development
Prerequisites	Basics experiments of 11 th and 12 th	

1. Surface tension measurements using a stalagmometer.

- Determine the surface tension by (i) drop number (ii) drop weight method.
- Study the variation of surface tension with different concentrations of detergent solutions.
Determine CMC

2. Viscosity measurement using Ostwald's viscometer.

- Determination of coefficient of viscosity of an unknown aqueous solution.
- Study the variation of coefficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar of PVA.
- Study the variation of viscosity with different concentrations of sugar solutions.

3. Solid State:

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

4. pH metry:

- Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.
- Preparation of buffer solutions of different pH values (i). Sodium acetate-acetic acid (ii). Ammonium chloride-ammonium hydroxide
- pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.
- Determination of dissociation constant of a weak acid.

5. Any other experiment related to subject

Reference Books

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

- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CHH102 B-P	PHYSICAL CHEMISTRY-I LAB	CO1	2	2	2	1	1	2	-	-	2	2	-
		CO2	2	1	2	2	1	2	1	-	3	1	1
		CO3	2	2	1	1	1	3	1	-	3	2	-
		CO4	2	2	2	3	2	2	1	-	3	1	1

Course Title/Code	Inorganic Chemistry-I (CHH103B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	Students would be able to learn the basics of atomic structure, Intermolecular forces and importance of pH, stereochemistry, learn basics of spectroscopic techniques and apply basics of these topics to industrial and domestic purposes.	
Course Outcomes (COs)		Mapping
CO1	To describe the basic concept of atom with understanding of atomic structure with the significance of wave mechanics and quantum numbers	Skill Development
CO2	To demonstrate the general trend in periodic properties and factors influencing the properties	Skill Development
CO3	To apply the concepts of ionic bonding and covalent bonding with their effects in chemical reactions in chemistry problems	Employability
CO4	To apply the knowledge in concepts of dipole moments, metallic bond and chemical forces involved in molecules to chemical reactions.	Employability
Prerequisites	XII	

Section-A

Atomic Structure:

Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Shapes of s, p, d and f orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Variation of orbital energy with atomic number, Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Schrödinger's wave equation, significance of ψ and ψ^2 , Quantum numbers and their significance, Normalized and orthogonal wave functions, Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves.

Section-B

Periodicity of Elements:

Brief discussion of the following properties of the elements, with reference to s & p-block in periodic table:

1. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge.
2. Atomic and ionic radii.
3. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy.
4. Electron gain enthalpy.
5. Electronegativity, Pauling's, Allred Rochow's, Mulliken scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Section-C

Chemical Bonding-I:

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its Limitations, packing of ions in crystals (hcp and ccp structure), Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy, Madelung constant, Born – Haber cycle and its application, Solvation energy.

Covalent bond: Lewis structure, Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule, Resonance and resonance energy, Covalent character in ionic compounds, polarizing power and Polarizability, Fajan's rules and consequences of polarization, Ionic character in covalent compounds:

Section-D

Chemical Bonding-II

Bond moment and dipole moment, Percentage ionic character from dipole moment and electronegativity difference

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

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

Referred Books:

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

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH103B-T	Inorganic Chemistry-I	CO1	1	-	-	2	-	-	-	-	-	-	1
		CO2	1	-	-	2	-	-	-	-	-	-	1
		CO3	1	-	-	2	-	-	-	-	-	-	1
		CO4	2	-	-	2	-	-	-	-	-	-	1

Course Title/Code	Inorganic Chemistry I Lab (CHH103B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credit	1.5	
Course Objective	Students familiarize in calibration of instruments, estimate solutions by acid-base titrations, determine the concentration of metal using redox titrations	
Course Outcomes (COs)		Mapping
CO1	To attain skill in handling instrument apparatus and making solutions	Skill Development
CO2	To familiarize the estimation of mixture of salts by acid base titrations	Skill Development
CO3	To familiarize the determination of metal ions concentrations by redox titrations.	Employability
Prerequisites	XII lab experiments	

List of Experiments

- **Titrimetric Analysis**
- Calibration and use of apparatus
- Preparation of solutions of titrants of different Molarity/Normality
- **Acid-Base Titrations**
 - Principles of acid-base titrations to be discussed.
- Estimation of sodium carbonate using standardized HCl.
- Estimation of carbonate and hydroxide present together in a mixture.

- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents
- **Oxidation-Reduction Titrimetry**
 - Principles of oxidation-reduction titrations (electrode potentials) to be discussed.
- Estimation of Fe(II) and oxalic acid using standardized KMnO₄ solution
- Estimation of oxalic acid and sodium oxalate in a given mixture.
- Estimation of Fe(II) with K₂Cr₂O₇ using internal indicator (diphenylamine, Nphenylanthranilic acid) and discussion of external indicator.
- **D. Any other experiment related to subject**

Referred Books:

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

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH103 B-P	Inorganic Chemistry-I Lab	CO1	2	1	-	1	-	-	-	-	-	-	-
		CO2	1	1	-	1	-	-	-	-	-	-	-
		CO3	1	1	-	1	-	-	-	-	-	-	-

Course Title/Code	Organic Chemistry-I (CHH104B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To give basic knowledge of the organic molecules their behaviour towards reacting materials	
Course Outcomes (COs)		Mapping
CO1	Able to identify the organic compounds with their IUPAC names and draw the structure & understand the general mechanism of reactions	Skill Development
CO2	Able to identify the isomerism in different organic molecules and effect on properties of molecules	Skill Development
CO3	Able to understand the basic characters of alkane alkene alkynes; its synthesis and chemical and physical properties.	Skill Development
CO4	Able to understand the basic characters of aromatic hydrocarbons; its synthesis and chemical and physical properties	Skill Development
Prerequisites	Basic knowledge of Organic Chemistry	

SECTION-A

Basics of Organic Chemistry:

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

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

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity 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.

SECTION B

Isomerism & Stereochemistry:

Conformational isomerism: Conformers, dihedral angle, torsional strain. Fischer Projection, Newmann and Sawhorse Projection, Conformational analysis of ethane and n-butane, conformers of cyclohexane (Chair, boat and skew boat forms), axial-equatorial positions and their interconversions, conformers of mono and disubstituted cyclohexanes, 1,2 and 1,3 interactions.

Geometrical isomerism: Cis-trans, syn-anti and E-Z notations, methods of distinguishing geometrical isomers using melting point, dipole moment, dehydration, cyclisation and heat of hydrogenation. Examples of geometrical isomerism and mono, di-substituted cyclohexanes.

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.

SECTION C

Aliphatic Hydrocarbons:

Alkanes: Synthesis and chemical reactivity of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Alkenes: general methods of synthesis of alkenes, Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Alkynes: General methods of synthesis, Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

SECTION D

Aromatic hydrocarbons:

Aromatic Hydrocarbons: Aromaticity, : Aromaticity Hückel's rule, aromatic character of arenes, Structure of benzene, general mechanism of electrophilic substitution, reactions of benzene, synthesis of aromatic compounds using nitration, halogenation, Friedel-Craft's reactions. Directing effects of the groups.

Reference Books:

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

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH104B-T	Organic Chemistry-I	CO1	3	-	-	3	3	-	-	-	2	2	3
		CO2	3	-	-	3	3	-	-	-	2	2	3
		CO3	3	2	-	3	3	-	-	-	2	2	3
		CO4	3	2	-	3	3	-	-	-	2	2	3

Course Title/Code	Organic Chemistry-I LAB (CHH104B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	To skill students to identify the organic compounds from the unknown sample	
Course Outcomes (COs)		Mapping
CO1	Student will will be able to purify the organic compounds through solvents	Skill Development
CO2	Student will will be able to identify the probable organic compounds through physical examination.	Skill Development
CO3	Student will be able to identify the functional groups in the given organic compounds	Skill Development
CO4	Students will be able to identify the aliphatic and aromatic acid compounds, phenols	Skill Development
Prerequisites	Basic knowledge of laboratory practices	

List of Experiments

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
 - Water
 - Alcohol
 - Alcohol-Water
 - Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
 - Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
 - Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
 - Chromatography
 - Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
 - Separation of a mixture of two sugars by ascending paper chromatography
 - Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)
 - Detection of extra elements
 - Organic Preparations
 - Bromination of acetanilide / aniline / phenol
 - Nitration of nitrobenzene / toluene.
9. **Any other experiment related to subject**

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)

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH104B -P	Organic Chemistry-I Lab	CO1	3	3	1	-	3	3	-	-	2	2	2
		CO2	3	3	1	-	3	3	-	-	2	2	2
		CO3	3	3	2	-	3	3	-	-	2	2	2
		CO4	3	3	2	-	3	3	-	-	2	2	2

Course Title/Code	Environmental Science (CHH137)	
Course Type	Core	
L-T-P Structure	2-0-4	
Credits	0/4	
Course Objective	To give an in-depth exposure of Quantum Chemistry and familiarize the students with various spectroscopic techniques like IR, Raman, NMR and ESR.	
Course Outcomes (COs)		Mapping
CO1	Understand and explain the multidisciplinary dimensions of environmental issues	Skill Development
CO2	Understand the primary environmental problems and suggest potential solutions	Entrepreneurship
CO3	Discuss about the various types of organisms and draw inferences about their interactions in different environmental settings/habitats	Skill Development
CO4	Defend/criticize the consequences of the interactions between social and environmental factors	Skill Development

SECTION A

Multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness

Renewable and non-renewable resources:

Natural resources and associated problems

- . Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
- a. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
- b. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- c. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
- d. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
- e. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
- f. Role of an individual in conservation of natural resources.
- g. Equitable use of resources for sustainable lifestyles.

SECTION B

Ecosystems

- **Concept of an ecosystem**

- **Structure and function of an ecosystem**
- **Producers, consumers and decomposers**
- **Energy flow in the ecosystem**
- **Ecological succession**
- **Food chains, food webs and ecological pyramids**
- **Introduction, types, characteristic features, structure and function of the following ecosystem:**
 - Forest ecosystem
 - Grassland ecosystem
 - Desert ecosystem
 - Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation

- **Introduction – Definition: genetic, species and ecosystem diversity.**
- **Biogeographical classification of India**
- **Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values**
- **Biodiversity at global, National and local levels**
- **India as a mega-diversity nation**
- **Hot-spots of biodiversity**
- **Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.**
- **Endangered and endemic species of India**
- **Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.**

SECTION C

Environmental Pollution

- **Definition, Cause, effects and control measures of :-**
 - . Air pollution
 - a. Water pollution
 - b. Soil pollution
 - c. Marine pollution
 - d. Noise pollution
 - e. Thermal pollution
 - f. Nuclear hazards
- **Solid waste Management: Causes, effects and control measures of urban and industrial wastes.**
- **Role of an individual in prevention of pollution.**
- **Pollution case studies.**
- **Disaster management: floods, earthquake, cyclone and landslides.**

Social Issues and the Environment

- **From Unsustainable to Sustainable development**
- **Urban problems related to energy**
- **Water conservation, rain water harvesting, watershed management**
- **Resettlement and rehabilitation of people; its problems and concerns, Case Studies**
- **Environmental ethics: Issues and possible solutions.**
- **Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies**
- **Wasteland reclamation**

- **Consumerism and waste products**
- **Environment Protection Act**
- **Air (Prevention and Control of Pollution) Act**
- **Water (Prevention and control of Pollution) Act**
- **Wildlife Protection Act**
- **Forest Conservation Act**
- **Issues involved in enforcement of environmental legislation**
- **Public awareness**

SECTION D

Human Population and the Environment

- Population growth, variation among nations.
- Population explosion – Family Welfare Programme
- Environment and human health
- Human Rights
- Value Education
- HIV/AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and human health.
- **Case Studies.**

ENVIRONMENTAL SCIENCES–FIELD WORK

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

Reference Books:

1. K.C. Agarwal, Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
3. R.C. Brunner, Hazardous Waste Incineration, McGraw Hill Inc.1989.
4. R. S. Clark, Marine Pollution, Clanderson Press Oxford (TB)
5. W. P. Cunningham, T. H. Cooper, E. Gorhani, M. T. Hepworth, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 2001.
6. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.
7. C. Baird and M. Cann, Environmental Chemistry, W.H. Freeman and Company, New York, 2012.
8. C.J-Gonzalez and D.J.C. Constable, Green Chemistry and engineering: A practical Design Approach A John Wiley & Sons, INC., publication, New Jersey, 2011
9. S. E. Manahan, Environmental Chemistry, CRC Press, 2005
10. Perspectives in Environmental Studies Kaushik & Kaushik New age international publishers Ltd.-New Delhi
11. John Grant, The Green marketing Manifesto, Wiley Publications

CO-PO Mapping

Course Code	Course	Course Outcomes	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH137	Environmental Science	CO1	-	-	-	-	-	-	2	3	1	3	-
		CO2	-	-	-	-	-	-	2	3	1	3	-
		CO3	-	-	-	-	-	-	2	3	1	3	-
		CO4	-	-	-	-	-	-	2	3	1	3	-

Semester-III

Course Code	Course Name	Offering Department	Course Type	Structure			Credits
			Deptt./Allied Core/Elective/Audit	L	T	P	
CHH201B -T	Physical Chemistry-II	CH	CORE	3	1	0	4
CHH201B -P	Physical Chemistry-II Lab	CH	CORE	0	0	3	1.5
CHH202B -T	Inorganic Chemistry-II	CH	CORE	3	1	0	4
CHH202B -P	Inorganic Chemistry-II Lab	CH	CORE	0	0	3	1.5
CHH203B -T	Organic Chemistry-II	CH	CORE	3	1	0	4
CHH203B -P	Organic Chemistry-II Lab	CH	CORE	0	0	3	1.5
EDS288 EDS289 EDS290	<p>ODD SEMESTER OPEN ELECTIVE</p> <p>Applied Psychology</p> <p>Applied Philosophy</p> <p>Applied Sociology</p>	<p>EDU</p> <p>EDU</p> <p>EDU</p>	<p>ALLIED ELECTIVE</p>	1	0	2	2

MCS231	Basics of Economics	MGM					
MCS232	Introduction to Finance	MGM					
CDO203	Quantitative Aptitude-I	CDC					
CHN204B	MINI PROJECT-I	CH	ELECTIVE	0	0	2	
	FOREIGN LANGUAGE						
FLS101	Spanish-I		ALLIED ELECTIVE	1	1	0	2
FLS102	German-I	MRCFL					
FLS103	French-I						
TOTAL (L-T-P) /CREDITS)				11	4	11	20.5

Course Title/Code	Physical Chemistry-II (CHH201B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To give an in-depth knowledge of basics of physical chemistry, based around the theme of systems, states and processes and apply these concepts to the study of solutions, chemical equilibria and phase equilibria.	
	Course Outcomes (COs)	Mapping
CO1	To develop in-depth understanding of thermodynamic laws and will be able to apply it to various processes and real systems.	Skill Development
CO2	To understand the basics of the third law of thermodynamics and various energy relations.	Skill Development
CO3	To get familiarize with different Colligative properties of Solution and to derive relation between colligative properties	Skill Development
CO4	To impart knowledge of chemical kinetics of reactions and temperature dependence of reaction rates.	Skill Development
CO5	To implement various learnings in research areas	Employability
Prerequisites	Basic Chemistry of Class 11th & 12th & Physical Chemistry-I	

Section A

Chemical Thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems,

First law: Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

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

Section –B

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

Section –C

Solutions of Non Electrolyte and Colligative Properties:

Raoult's and Henry's Laws derivation and their applications, Activity component of an ideal solution, Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute, Applications in calculating molar masses of normal dissociated and associated solutes in solution

Section -D

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 third order reactions, experimental methods of the determination of rate laws, pseudo unimolecular reactions, zero order reactions, half life time of reaction, Temperature dependence of reaction rates; Arrhenius equation; activation energy, Collision theory of reaction rates,

Reference Books

1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
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.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly
6. Asked Questions in Thermodynamics. CRC Press: NY (2011).
7. Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
8. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CHH201B -T	Physical Chemistry-II	CO1	3	2	1	1	1	-	1	-	2	2	2
		CO2	2	1	1	1	-	-	1	-	2	1	2
		CO3	2	2	1	1	1	-	1	-	2	2	1
		CO4	2	2	2	3	2	-	1	-	2	1	2
		CO5	1	1	1	1	1	-	1	-	3	2	1

Course Title/Code	Physical Chemistry-II LAB (CHH201B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	Students will be able to understand energy transfer for closed and control volume systems and develop ability to apply the laws of Thermodynamics as well as familiarize chemical kinetics by monitoring simple reactions for calculation of rate constant and activation energy.	
	Course Outcomes (COs)	Mapping
CO1	To develop in depth understanding of thermodynamic laws and will be able to apply it to various processes and real systems	Skill Development
CO2	To understand the basics of third law of thermodynamics and various energy relations.	Skill Development
CO3	To get familiarize with different Colligative properties of Solution and to derive relation between colligative properties	Skill Development
CO4	To impart knowledge of chemical kinetics of reactions and temperature dependence of reaction rates.	Employability
Prerequisites	Physical Chemistry-I	

1. Determination of heat capacity of a calorimeter for different volumes using (i) change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution of sulphuric acid or enthalpy of neutralization), and (ii) heat gained equal to heat lost by cold water and hot water respectively
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of the enthalpy of ionization of ethanoic acid.
4. Determination of integral enthalpy (endothermic and exothermic) solution of salts.
5. Determination of basicity of a diprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
6. Determination of enthalpy of hydration of salt.
7. Study of the solubility of benzoic acid in water and determination of ΔH .
8. **Any other experiment related to subject**

Reference Books

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

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CHH201B -P	Physical Chemistry-II Lab	CO1	1	2	2	1	1	1	-	-	2	2	2
		CO2	1	2	2	1	1	1	-	-	2	2	2
		CO3	1	3	2	1	1	1	-	-	2	2	2
		CO4	1	2	2	1	1	1	-	-	2	2	2

Course Title/Code	Inorganic Chemistry-II (CHH202B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	A: The student will understand the interdisciplinary nature of chemistry B: To use knowledge of metallurgy and other inorganic concepts to explain the chemical and physical properties of elements and compounds. C: The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research	
	Course Outcomes (COs)	Mapping
CO1	To understand concepts of redox reactions used to purify metals.	Employability
CO2	To gain knowledge about the general features of s-block elements and their compounds	Skill Development
CO3	To identify the special characteristics of p-block elements and nature of their compounds for industrial and research use	Skill Development
CO4	To study the preparation, properties, applications and other features of some common compounds used in industries and research	Employability
Prerequisites	Inorganic Chemistry-I	

Section-A

General Principles of Metallurgy

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

Section-B

Chemistry of s Block Elements:

. General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group.

- a. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
- b. Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.
- c. Complex formation tendency of s-block elements; structure of the following complexes: EDTA complexes of calcium and magnesium.

Section-C

Chemistry of p Block Elements:

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group

Structure, bonding and properties: Acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following:

- Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.
- Borazine
- Silicates, silicones,

Section-D

Preparation, properties, structure and uses of the following compounds:

- Phosphonitric halides $\{(\text{PNCl}_2)_n \text{ where } n = 3 \text{ and } 4\}$
- Oxides: oxides of phosphorus, sulphur and chlorine
- Oxoacids: oxoacids of phosphorus and chlorine; peroxyacids of sulphur
- Halides: halides of silicon and phosphorus.

Noble Gases

- Interhalogen and pseudohalogen compounds
- Clathrate compounds of noble gases, xenon fluorides.

Referred Books:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
3. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
5. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth- Heinemann. 1997.
6. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009
7. Shriver, D.F., Atkins P.W and Langford, C.H., Inorganic Chemistry 2nd Ed., Oxford University Press, 1994

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CHH202B -T	Inorganic Chemistry-II	CO1	3	2	-	-	-	-	-	1	2	3	-
		CO2	3	2	-	-	-	-	-	1	2	3	-
		CO3	3	2	-	-	-	-	-	1	2	3	-

		CO4	3	2	-	-	-	-	-	1	2	3	-
Course Title/Code	Inorganic Chemistry-II LAB (CHH202B-P)												
Course Type	Core												
L-T-P Structure	0-0-3												
Credits	1.5												
Course Objective	To skill students in handling instruments like pH meter, conductivity meter for various analysis for soil samples and other inorganic samples.												
Course Outcomes (COs)											Mapping		
CO1	Students shall be able to understand the use and application of small appliances for their practical use like pH meter, conductivity meter, etc										Skill Development		
CO2	Student shall be able to understand the use and application of the concepts of gravimetric determination										Employability		
Prerequisites	Inorganic Chemistry-I Lab												

A. Iodo/Iodimetric Titrations

. Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically)

i. Estimation of antimony in tartar-emetic iodometrically

B. Complexometric titrations using disodium salt of EDTA

1. Estimation of Mg^{2+} , Zn^{2+}

2. Estimation of Ca^{2+}

C. Inorganic Preparations

1. Cuprous Chloride, Cu_2Cl_2

2. Manganese(III) phosphate, $MnPO_4 \cdot H_2O$

3. Aluminium potassium sulphate $KAl(SO_4)_2 \cdot 12H_2O$ (Potash alum) or Chrome alum.

D. Any other experiment related to subject

Referred Books:

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

2. Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
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CHH202B -P	Inorganic Chemistry-II Lab	CO1	3	-	-	-	3	-	-	-	-	2	1
		CO2	3	-	-	-	3	-	-	-	-	2	1

Course Title/Code	Organic Chemistry-II (CHH203B-T)											
Course Type	Core											
L-T-P Structure	3-1-0											
Credits	4											
Course Objective	The objective of the course is to make the students understand the basic concept of some of the functional group chemistry including their methods of synthesis and chemical reactions.											
Course Outcomes (COs)										Mapping		
CO1	Perform inter-conversions of various functional groups in organic chemistry.										Skill Development	
CO2	Compare mechanisms for alcohol and phenol groups and learn the carbon-carbon bond formations, redox reactions with mechanistic understanding.										Skill Development	
CO3	Explain mechanism of carbonyl compounds and understand the stereo chemical aspect of reaction mechanism.										Skill Development	
CO4	Students will be able to explain the properties, synthesis and chemical reactions of carboxylic acids.										Skill Development	

Prerequisites	Organic Chemistry-I
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SECTION A

Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – SN^1 , SN^2 and SN^i mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation (including preparation from diazonium salts) & properties, nucleophilic aromatic substitution; SN^Ar , Benzyne mechanism.

Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions, Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds

SECTION B

Alcohols, Phenols, Ethers and Epoxides

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

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

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

SECTION C

Carbonyl Compounds:

Structure, reactivity, preparation and properties; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Keto-enol tautomerism and concept of enol chemistry, Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangement, haloform reaction, Baeyer Villiger oxidation, Clemmensen, Wolff-Kishner and Meerwein-Ponndorf Verley reduction. , reduction by $LiAlH_4$ & $NaBH_4$, Active methylene compounds; Keto-enol tautomerism, Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate

SECTION D

Carboxylic acids and their derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxyl acids and unsaturated acids: succinic/ phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group- Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Referred Books:

1. Morrison, R.T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
4. Norman, R.O.C. & Coxon, J. M. Principles of Organic synthesis

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CHH203B -T	Organic Chemistry- II	CO1	3	-	2	3	3	-	-	2	2	2	3
		CO2	3	-	2	3	3	-	-	2	2	2	3
		CO3	3	-	2	3	3	-	-	2	2	2	3
		CO4	3	-	2	3	3	-	-	2	2	2	3

Course Title/Code	Organic Chemistry-II Lab (CHH203B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	The objective of the course is to make the students understand the basic concept of some of the functional group chemistry including their methods of synthesis and chemical reactions.	
Course Outcomes (COs)		Mapping
CO1	To perform functional group test for alcohols, phenols, carbonyl and carboxylic acid group.	Skill Development
CO2	Organic preparations by acylation, oxidation and selective reduction.	Skill Development
CO3	Organic preparations: Semicarbazone, Hydrolysis of amides and esters,	Skill Development
CO4	Organic preparations: S-Benzylisothiuronium salt and Aldol condensation	Employability
Prerequisites	Organic Chemistry-I Lab	

List of experiments

- . **Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.**
- A. **Organic preparations:**

- . Acylation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, panisidine) and one of the following phenols (β naphthol, resorcinol, p- cresol).
- i. Oxidation of ethanol/ isopropanol (Iodoform reaction).
- ii. Selective reduction of meta dinitrobenzene to m-nitroaniline.
- iii. Hydrolysis of amides and esters.
- iv. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
- v. S- Benzylisothiuronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
- vi. Aldol condensation using either conventional or green method.

(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 and melting point.)

Any other experiment related to subject

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH203 B-P	Organic Chemistry -II Lab	CO1	3	1	-	2	2	-	-	-	2	2	2
		CO2	3	1	-	2	2	-	-	-	2	2	2
		CO3	3	1	-	2	2	-	-	-	2	2	2
		CO4	3	1	-	2	2	-	-	-	2	2	2

Course Title/Code	Applied Psychology (EDS288)	
Course Type	Allied Elective	
L-T-P Structure	1-0-0	
Credits	1	
Course Objective	To define psychology and its applications in various fields.	
Course Outcomes (COs)		Mapping
CO1	Ability to understand the conceptual framework of attitude along with cherishing out their attitude development	Skill Development
CO2	Ability to conceptualize psychology in social and organizational settings.	Skill Development
CO3	Ability to maintain and reform group dynamics.	Skill Development
CO4	Ability to understand the conceptual framework of personality along with cherishing out their personality development.	Skill Development
Prerequisites (if any)		

Section A

PSYCHOLOGY: ATTITUDE FORMATION

Psychology: Meaning, nature, and scope, Role of psychology across multi-disciplinary aspects, Introduction: Attitude, Stereotypes, Prejudice, and Discrimination, Formation of attitude and attitude change.

Section B

PERSONALITY AND PERSONALITY DEVELOPMENT

Definition of personality and personality development, State/ Trait approach to personality, Bandura's Social- Cognitive theory of personality

Section C

SOCIAL PSYCHOLOGY

Introduction to social identity, social cognition, and social influence, social conflicts and its resolutions, Group dynamics: Introduction, formation, types of groups, cooperation, competition, and conflict in groups

Section D

ORGANIZATIONAL PSYCHOLOGY

Organizational Psychology: Definition, fundamental concepts and importance, Introduction to job satisfaction, work motivation, and organizational commitment. Introduction to participation, empowerment, and team work

Text and Reference Books

1. Arrow, K. J. (1995). *Barrier to Conflict Resolution*. NY: W. W. Norton.
2. Bandura, A., & Walters, R. H. (1963). *Social Learning and Personality Development*. New York: Holt, Rinehart, & Winston.
3. Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice- Hall, Inc.
4. Baron, R. A., Byrne, D. (1997). *Social Psychology (8th Ed.)*. Boston, MA: Allyn& Bacon.
5. Baron, R. A. (2001). *Psychology (5th ed.)*. London: Pearson.
6. Cialdini, R. B. (2001). *Influence: Science and Practice (4th Ed.)*. Boston, MA: Allyn& Bacon.
7. Feldman, R. S. (2008). *Essentials of Understanding Psychology*. New Delhi: Tata McGraw Hill.
8. Friedkin, N. (1998). *A structural theory of social influence*. Cambridge: Cambridge University Press.
9. Gage, N. L., & Berliner, D. C. (1992). *Educational Psychology (5th Ed.)*. Boston, MA: Houghton Mifflin Co.
10. Hall, C. S., Lindzey, G. & Campbell, J. B. (2004). *Theories of Personality (4th Ed.)*. New York: Wiley.
11. Hunt, R. R., & Ellis, H. C. (2006). *Fundamentals of Cognitive Psychology*. New Delhi: Tata McGraw Hill.
12. McDavid, J. M., &Harari, H. (1994). *Social Psychology: Individuals, Groups, and Societies*. New Delhi: CBS Publishers.
13. Millward, L. (2005). *Understanding Occupational and Organizational Psychology*. London: Sage Publications.
14. Morgan, C. T., King, R. A., Weisz, J. R., &Schopler, J. (1993). *Introduction to Psychology. (7th Ed.)*. New Delhi: Tata McGraw Hill.
15. Woolfork, A. E. (2014). *Educational Psychology (12th Ed.)*. Boston: Allyn& Bacon.

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
EDS288	Applied Psychology	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	Applied Psychology Lab (EDS288)	
Course Type	Allied Elective	
L-T-P Structure	0-0-2	
Credits	1	
Course Objective	To define psychology and its applications in various fields.	
Course Outcomes (COs)		Mapping
CO1	Ability to understand the conceptual framework of attitude along with cherishing out their attitude development	Skill Development
CO2	Ability to conceptualize psychology in social and organizational settings.	Skill Development
CO3	Ability to maintain and reform group dynamics.	Skill Development
CO4	Ability to understand the conceptual framework of personality along with cherishing out their personality development.	Skill Development
Prerequisites (if any)		

List of Experiments

1. Prepare a story using different pictures in order to understand the personality
2. Prepare a SWOT Chart to identify strength and weakness of oneself
3. Role of psychology be proved as an asset in professional development
4. Give a brief account of your personality before and after the transaction of course content.
5. Identify different stereotype present in our Society and present your views on it.
6. Collect any five articles on discrimination prevalent in Society
7. List out Company incentives provided to their employee for work motivation.
8. Prepare a street play on social issues to understand the group dynamics
9. Reflection activities to understand the emotions and personality
10. List out the Do's and Don'ts of the Interview
11. Role of body language in attitude formation.

12. Situational Activities: Suppose you are captain of your football team. Draw out inputs to motivate your team, and maintain the team- spirit.
13. Write a brief note on any one attitude you want to change in yourself and the strategies to accomplish it.
14. The psychometric tests to be conducted by learners:
15. Sociometry test
16. Personality testing (16PF)
17. Vineland Social Maturity Scale
18. Rorschach inkblot test
19. Thematic Appreciation Test
20. Color personality Test
21. Any other suitable activities.

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
EDS288	Applied Psychology Lab	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	APPLIED PHILOSOPHY (EDS289)	
Course Type	Allied Elective	
L-T-P Structure	1-0-0	
Credits	2	
Course Objective	To confront the philosophical problems implicit in the experience of self, others and the society.	
Course Outcomes (COs)		Mapping
CO1	Ability to read critically the philosophy of influential philosophers with respect to society, Science and success in life	Skill Development
CO2	Ability to understand and apply concepts and theories of moral philosophy.	Skill Development
CO3	Ability to reflect philosophically and ethically on their own personal, professional and civic lives.	Skill Development
CO4	Ability to formulate for himself or herself a philosophy of life or world-view consistent with the objectives of liberal society.	Skill Development
Prerequisites (if any)		

SECTION A

INTRODUCTION TO PHILOSOPHY: Philosophy: Meaning, Nature and Scope, Practical uses of Philosophy, Branches of Philosophy.

SECTION B

THOUGHTS OF PHILOSOPHERS AND THEIR IMPLICATIONS: General Philosophy of John Dewey, Swami Vivekananda and RabindraNath Tagore, Philosophy of life and success: Steve Jobs, N.R. NarayanaMurthi, Dr. A.P.J. Abdul Kalam and Muhammad Yunus, Philosophy of Science and technology- Francis Bacon and Martin Heidegger.

SECTION C

PHILOSOPHICAL PERSPECTIVES OF SOCIO-POLITICAL SCENARIO IN INDIA: Nature of Democracy and its implications, Meaning and requirements of National Integration, Universal Human Rights

SECTION D

PHILOSOPHICAL PERSPECTIVES OF RELIGIOUS SCENARIO IN INDIA: Secularism—its nature and implications, Moral Philosophy of religion with special reference to Hinduism, Jainism, Buddhism, Islam, Christianity, Sikhism. Religious pluralism and Religious tolerance.

Text and Reference Books

1. Bhatia, K. & Bhatia, B. (1974) The Philosophical and Sociological Foundations of Education. Delhi: Doaba House.
2. Brubacher, John. S. (1969). Modern Philosophies of Education, New Delhi: Tata McGraw-Hill
3. Dewey, J. (1966). Democracy in Education, New York: Macmillan.
4. Ferre, F.(1995). Philosophy of Technology. University of Georgia Press.
5. Gandhi, M. K. (1956). Basic Education. Ahmedabad, Navajivan.
6. Goel, A. &Goel S. L. (2005). Human values and Education. New Delhi: Deep and Deep Publications Pvt. Ltd.
7. Palmer, Joy A. et.al. (2001). Fifty major thinkers on education from confucious to Dewey. New Delhi: Rutledge.
8. Rajput, J.S. (2006). Human Values and Education. New Delhi: Paragon Publications.
9. Walia, J.S. (2011). Philosophical, Sociological and Economic Bases of Education.

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
EDS289	APPLIED PHILOSOPHY	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	APPLIED PHILOSOPHY LAB (EDS289)	
Course Type	Allied Elective	
L-T-P Structure	0-0-2	
Credits	2	
Course Objective	To confront the philosophical problems implicit in the experience of self, others and the society.	
Course Outcomes (COs)		Mapping
CO1	Ability to read critically the philosophy of influential philosophers with respect to society, Science and success in life	Skill Development
CO2	Ability to understand and apply concepts and theories of moral philosophy.	Skill Development
CO3	Ability to reflect philosophically and ethically on their own personal, professional and civic lives.	Skill Development
CO4	Ability to formulate for himself or herself a philosophy of life or world-view consistent with the objectives of liberal society.	Skill Development
Prerequisites (if any)		

List of Experiments

- Prepare and present a report on ‘philosophy of life’ from the perspective of a young adult.
- Quiz and interactive sessions on various philosophical perspectives of contemporary philosophers.
- Organization of and participation in street plays /dramas/ declamation/ debates/ any other suitable activity on any theme of Philosophical perspectives of Socio-Political scenario in India.
- Group discussions on any suitable topics concerning contemporary society like aggression among youth, Over-ambitiousness in young generation, misuse of democracy, implications of secularism etc. and to reflect upon different viewpoints.
- Preparation of quotation boards to display quotes of great philosophers in the college premises.
- Picture interpretation and philosophical reflection on social themes like juvenile crime, begging in India, Social networking etc.
- Readings from the autobiographies and other publications of great philosophers e.g. ‘Wings of Fire’ followed by discussion session.
- Showing Videos on Unique personalities: life and philosophies followed by reflection exercises.

Any other suitable activity.

0CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
EDS288	APPLIED PHILOSOPHY LAB	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	APPLIED SOCIOLOGY (EDS290)	
Course Type	Allied Elective	
L-T-P Structure	1-0-0	
Credits	2	
Course Objective	To study the various contemporary issues of society and develop basic research skills in area of sociology.	
Course Outcomes (COs)		Mapping
CO1	Ability to discuss the fundamental concepts of sociology and its applications.	Skill Development
CO2	Development of the analytical skills of students about ways in which social processes affect our everyday lives.	Skill Development
CO3	Ability to understand the impact of various processes of social change and assess their impact on society.	Skill Development
CO4	Ability to analyze the social cultural dynamics that contribute to transformation of Indian reality	Skill Development
Prerequisites (if any)		

Section A

Introduction and Applications of Sociology:

- Society, Community, Social Institutions, Social Groups, Introduction to Applied Sociology
- Sociology and Social Processes
- Sociology and Social Change
- Sociology and Social Problems
- Clinical Sociology

Section B

Sociological Processes:

- Social Stratification, Social Mobility and their impact on society
- Socialization, Agents of Socialization, Assessing the effects of Socialization

- Social Movements: Concept, Impact of Environmental Movements in India: Chipko Movement, Narmada Bachao Andolan

Section C

Processes and Issues of Social Change:

- Social Change: Westernization, Urbanization, Privatization, Globalization, Sustainable development
- Issues in urban development-Population, poverty, unplanned growth and ecological issues
- Conflict management:
 - Intergroup: Causes, Resolutions
 - Organizational Conflict, Conflict Management and Grievance Handling

Section D

Field Survey & Report Writing:

- Need, Meaning of Survey
- Types of Survey
- Steps in Conducting Survey
- Data Collection Methods
- Salient Features of Report Writing

Text and Reference Books

1. Andrew, W. (1997) Introduction to the Sociology of Development. New Jersey, Palgrave Macmillan.
2. Berg, L.B. (2001). Qualitative Research Methods for the Social Sciences (4th edition). Boston: Allyn and Bacon
3. Bhatia, H.(1970). Elements of Social Psychology. Bombay: Somaiyya Publications Pvt Ltd.
4. Bhattacharyya D.K (2009). *Organizational Behavior*, Oxford University Press, UK.
5. DastuptaDriskle(2007) : Discourse on Applied Sociology Volume-II, 2007
6. Desai, B Sonalde et al. (2010). Human Development in India: Challenges for a Society in Transition. OUP
7. Deshpande, S.(2003). Contemporary India: A Sociological View. New Delhi: Viking.
8. Hall R.H (2009). *Organizational Structures, Processes & outcomes, Asia*: Pearson Education Publications.
9. Hodegetts R M. (2009). *Organizational Behavior*, Macmillan.
10. McMichael.P. (1996). Development and Social change: A global perspective. California Thousand Oaks.
11. Merton, R and Nisbet, (1976) Contemporary Social Problems, New York: Harcourt, Brace and World.
12. Metha, S. (2009). Women and Social Change, Jaipur: Sage.
13. Michael Edwards (2011). Civil Society in India, edited The Oxford Handbook of Civil Society, Oxford, Oxford University Press
14. Mitra et.al. (2009). Democracy, Agency and Social Change in India, New Delhi: Sage
15. Pratt Henry Fairchild(2009) : Outline of Applied Sociology, 2009
16. Ranjitekumar : Research Methodology, Person Education, Delhi.
17. Schaefer, R.T (2004). Sociology a Brief Introduction, (5thed.) New York: McGraw-Hill Inc..

18. Sirclaus Moser & G. Kalton: Survey Methods in Social Investigation, Heinemann Educational Books, London.
19. Sanderson. (2010). Social Psychology, New York: John Wiley.
20. Tepperman, L. & Curtis, J. (Eds.) (2009). Principles of Sociology: Canadian perspectives. Don Mills, ON: Oxford University Press.
21. Young, K. (2001). Handbook of Social Psychology, London: Routledge and Kegal Paul Ltd.

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
EDS290	APPLIED SOCIOLOGY	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	APPLIED SOCIOLOGY LAB (EDS290)	
Course Type	Allied Elective	
L-T-P Structure	0-0-2	
Credits	2	
Course Objective	To study the various contemporary issues of society and develop basic research skills in area of sociology.	
Course Outcomes (COs)		Mapping
CO1	Ability to discuss the fundamental concepts of sociology and its applications.	Skill Development
CO2	Development of the analytical skills of students about ways in which social processes affect our everyday lives.	Skill Development
CO3	Ability to understand the impact of various processes of social change and assess their impact on society.	Skill Development
CO4	Ability to analyze the social cultural dynamics that contribute to transformation of Indian reality	Skill Development
Prerequisites (if any)		

List of Experiments

1. Showing Videos on the life and philosophies of Famous sociologists and to acquaint the students about their different theories
2. Preparation of quotation board with the help of displaying the pictures and quotes of famous sociologists
3. Choose a theme of your interest- for e.g., crime, technology environmental concerns or any other and look through the Sunday editorials of any national daily of the last 3 months to locate related articles.
4. Role Play: Gender issues in everyday life, students will form small groups and present skits to address this issue creatively; this will be followed by discussions.

5. Students may be given the assignment of taking pro-active role in initiating social change in a local field
6. Visit a shopping mall and observe the interaction between employees and customers/visitors. Identify themes based on your observation and prepare a questionnaire based on this experience.
7. Look at a set of published letters of Gandhi, Nehru, C.F. Andrews and Tagore etc. and identify key social issues that are discussed in the contents of the letters and prepare a report on it.
8. Students will be asked to write a short essay on the pressures they feel of the experience in performing masculinity or femininity, Presentations and discussions based around the essays.
9. Debate or discussion on “Is the family the site of love and care” or “Is the family democratic?”
10. Discuss the impact of modernization, industrialization and globalization on the day-today life.
11. Students may be asked to apply any applied research technique
12. Design a survey on factors effecting marriage choices of young people.

Any other suitable activity

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
EDS290	APPLIED SOCIOLOGY Lab	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	Basics of Economics (MCS231)	
Course Type	Allied Elective	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective		
	Course Outcomes (COs)	Mapping
CO1	To acquaint the students with the fundamental knowledge Micro-Economics and its basic laws and principles.	Employability and Skill Development
CO2	To help students understand the theories of demand and supply and practically identify the different factors that affect demand and supply	Employability and Skill Development
CO3	To understand and analyze the different types of costs that form part of a production process and relate it with the laws of production.	Skill Development
CO4	To make the students understand and evaluate the different types of markets operating in an industry.	Skill Development
Prerequisites (if any)		

SECTION-A

Definition of Economics - various definitions, Nature of Economic problem, Production possibility curve, Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility - its practical application and importance.

SECTION-B

Meaning of Demand, Individual and Market demand schedule, Law of demand, shape of demand curve, Elasticity of demand, degrees of Price elasticity of demand, factors effecting elasticity of demand, practical importance & applications of the concept of elasticity of demand.

SECTION-C

Meaning of production and factors of production, laws of production, various concepts of cost - Fixed cost, variable cost, average cost, marginal cost, money cost, real cost and opportunity cost. Shape of short run cost curves.

SECTION-D

Meaning of Market, Types of Market -Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets).Supply and Law of Supply, Role of Demand & Supply in Price Determination and effect of changes in demand and supply on prices.

TEXT AND REFERENCE BOOKS

1. Principles of Economics: P.N. Chopra (Kalyani Publishers).
2. Economics for Engineers- T R Jain & O P Khanna
3. Micro Economic Theory – M.L. Jhingan (S.Chand).
4. Micro Economic Theory - H.L. Ahuja (S.Chand).
5. Modern Micro Economics: S.K. Mishra (Pragati Publications).
6. Economic Theory - A.B.N. Kulkarni& A.B. Kalkundrikar (R.Chand& Co.).
7. Indian Economy: RudarDutt& K.P.M. Sundhram

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
MCS231	Basics of Economics MCS231	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	Introduction to Finance (MCS232)	
Course Type	Allied Elective	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective		
Course Outcomes (COs)		Mapping
CO1	Understand of the fundamental concepts of Financial Management and Financial System.	Skill Development
CO2	Analyse the Financial statements and apply the knowledge in decision making	Skill Development
CO3	Identify the sources for raising capital in Business(s) and analyse	Skill Development
CO4	Identify different techniques of capital budgeting	Skill Development
Prerequisites (if any)		

SECTION-A

Introduction to Finance ; Forms of Business Organization ; Overview to financial statements , Balance Sheet, Profit and Loss Account , Cash Flow Statement.

SECTION-B

Financial Analysis and Planning; Financial Ratios, Break Even Analysis Sources of Long term Finance – Equity Capital, Preference Capital, Terms Loans, Debentures; Raising Long term Finance.

SECTION-C

Time Value of Money, Capital Budgeting- Techniques of Capital Budgeting, Net Present Value and Payback Period; Capital Structure and Cost of Capital.

SECTION-D

Working Capital: Introduction, Components of Current Assets and Current Liabilities, Operating Cycle, Estimation of Working Capital; Operating Income , Earning Before Interest and Tax (EBIT).

Text and Reference Books

Pandy, I.M., Financial Management, Vikas Publishing House, New Delhi
Khan M.Y, and Jain P.K., Financial Management, Tata McGraw Hill, New Delhi
Keown, Arthur J., Martin, John D., Petty, J. William and Scott, David F, Financial Management, Pearson Education
Chandra, Prasanna, Financial Management, TMH, New Delhi
Van Horne, James C., Financial Management and Policy, Prentice Hall of India
Brigham & Houston, Fundamentals of Financial Management, Thomson Learning, Bombay.
Kishore, R., Financial Management, Taxman's Publishing House, New Delhi

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
MCS2 32	Introduction to Finance	CO1	2	1	-	-	1	-	1	-	1	1	1
		CO2	1	2	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	2	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	2

Course Title/Code	Quantitative Aptitude-I (CDO203)	
Course Type	Allied Elective	
L-T-P Structure	1-1-0	
Credits	2	
Course Objective		
Course Outcomes (COs)		Mapping
CO1	Students will be able to analyse various forms of data	Skill Development
CO2	Students will be able to solve complex problems based on arithmetic reasoning.	Skill Development
CO3	Students will be able to apply short tricks on complex problems of number system.	Skill Development
Prerequisites (if any)	N.A.	

SECTION A

Unit 1: Number System

1.1 Simplification

1.1.1 BODMAS rule

1.1.2 Fractions and recurring decimals

1.1.3 Surds and indices

1.2 Numbers

1.2.1 Types of numbers and number tree

1.2.2 Divisibility Rule

1.2.3 HCF & LCM

SECTION B

Unit 2: Arithmetic I

2.1 Percentages

2.2 Ratio & Proportion

2.2.1 Proportionality

- 2.2.2 Variations
- 2.2.3 Partnership
- 2.3 Profit & Loss**
 - 2.3.1 Basic terminology & Formulae
 - 2.3.2 Error in Weights
 - 2.3.3 Marked Price and Discounts
- 2.4 Average**
- 2.5 Interest**
 - 2.5.1 Simple Interest
 - 2.5.2 Compound Interest
 - 2.5.3 Relation between SI & CI

SECTION C

Unit 3: Arithmetic II

3.1 Time & Work

- 3.1.1 Time and Work, Chain Rule
- 3.1.2 Work & Wages
- 3.1.3 Pipes & Cisterns

3.2 Time, Speed & Distance

- 3.2.1 Basics Formulas & Proportionality
- 3.2.2 Average & Relative Speed
- 3.2.3 Trains and Boats & Streams
- 3.2.4 Circular Motion and Clocks

3.3 Alligation & Mixtures

SECTION D

Unit 4: Reasoning Ability

- 4.1 Clocks
- 4.2 Coding Decoding
- 4.3 Arithmetic Reasoning
- 4.4 Blood Relation Test
- 4.5 Direction Sense Test

Text and Reference Books

1. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2017
2. A Modern Approach to Verbal & Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018

CO-PO Mapping

Course Code	Course	Course Outcome	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO
			1	2	3	4	5	6	7	8	9	10	11
CDO203	Quantitative Aptitude-I	CO1	1	2	3	-	1	-	1	-	1	1	3
		CO2	1	2	3	-	1	-	1	-	1	1	3
		CO3	1	2	3	-	2	-	1	-	1	1	3

Course Title/Code	Mini Project-I (CHN204B)	
Course Type	Core	
L-T-P Structure	0-0-2	
Credits	2	
Course Objective	To skill students to identify the problem related to chemistry and environment and explore the it's solution	
Course Outcomes (COs)		Mapping
CO1	To apply theoretical knowledge and practical skills to a research project and on the collection and analysis of scientific data	Skill Development
CO2	Work independently and collaboratively with peers to bring the project to satisfactory completion	Skill Development
CO3	Communicate a scientific argument convincingly at a level and style appropriate to the audience	Skill Development
Prerequisites	Basic knowledge of laboratory practices	

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHN204B	Mini Project-I	CO1	3	3	1	-	3	3	-	-	2	2	-
		CO2	3	3	1	-	3	3	-	-	2	2	-
		CO3	3	3	2	-	3	3	-	-	2	2	-
		CO4	3	3	2	-	3	3	-	-	2	2	-

Course Title/Code	Spanish-I/ FLS101	
Course Type	Allied Elective	
L-T-P Structure	1-1-0	
Credits	2	
Course Objective	To describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary	
Course Outcomes (COs)		Mapping
CO1	Ability to exchange greetings and do introductions using formal and informal expressions	Skill Development
CO2	Ability to Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary	Skill Development
CO3	Ability to express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed	Skill Development
CO4	Ability to identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed.	Skill Development
Prerequisites (if any)		

Spanish-I

SECTION-A

- Presentation on Spanish language
- Greetings and goodbye's
- Spanish letter
- Introduction of VerboSER

SECTION-B

- Uses of Verbo SER
- Introduction of Nationality
- Professions and vocabulary related to professions.
- Adjectives related to Verbo SER.
- Counting till number 20.

SECTION-C

- Introduction of Articles and Indefinite articles
- Interrogatives
- Adjectives to describe things and place and Counting till number 90
-

SECTION-D

- Introduction of Verbo ESTAR
- Uses of Verbo ESTAR with respect to positioning of objects
- Prepositions related to the positioning of an object

CO-PO MAPPING

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
FLS101	Spanish I	CO1	1	1	-	-	1	-	1	-	1	1	1
		CO2	1	1	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	1	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	1

Course Title/Code	German-I/ FLS102	
Course Type	Allied Elective	
L-T-P Structure	1-1-0	
Credits	2	
Course Objective	To describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary	
Course Outcomes (COs)		Mapping
CO1	Ability to exchange greetings and do introductions using formal and informal expressions	Skill Development
CO2	Ability to Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary	Skill Development
CO3	Ability to express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed	Skill Development
CO4	Ability to identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed.	Skill Development
Prerequisites (if any)		

German-I

Section-A

- Salutations/Greetings
- Introduction

Section-B

- Introduction cntd.
- Alphabets
- Numbers 1-20

Section-C

- Personal pronouns
- Hobbies and professions

Section-D

- Café related vocabulary and dialogues
- Revision personal pronouns

Section-E

- Café related vocabulary and dialogues cntd.

Common verbs and their conjugations

CO-PO MAPPING

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
FLS102	German-I	CO1	1	1	-	-	1	-	1	-	1	1	1
		CO2	1	1	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	1	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	1

Course Title/Code	French-I (FLS103)	
Course Type	Allied Elective	
L-T-P Structure	1-1-0	
Credits	2	
Course Objective	To describe themselves, other people, familiar places and objects in short discourse using simple sentences and basic vocabulary	
Course Outcomes (COs)		Mapping
CO1	Ability to exchange greetings and do introductions using formal and informal expressions	Skill Development
CO2	Ability to Learn Basic vocabulary that can be used to discuss everyday life and daily routines, using simple sentences and familiar vocabulary	Skill Development
CO3	Ability to express their likes and dislikes. Also will have understanding of simple conversations about familiar topics (e.g., greetings, weather and daily activities,) with repetition when needed	Skill Development
CO4	Ability to identify key details in a short, highly-contextualized audio text dealing with a familiar topic, relying on repetition and extra linguistic support when needed.	Skill Development
Prerequisites (if any)		

French-I

Section-A

- Les Salutations & forms of politeness
- Alphabets
- Taking leave expressions

Section-B

- Les pronoms sujets
- Les verbes ER
- Self introduction

Section-C

- Les noms
- Verbes Avoir, Etre, Aller & Faire
- Les articles define et indefini

Section-D

- Les mois de l'annee
- les jours de la semaine
- Repondez aux questions

CO-PO MAPPING

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
FLS103	French-I	CO1	1	1	-	-	1	-	1	-	1	1	1
		CO2	1	1	-	-	1	-	1	-	1	1	1
		CO3	1	1	-	-	1	-	1	-	1	1	1
		CO4	1	1	-	-	1	-	1	-	1	1	1

Semester-IV

Course Code	Course Name	Offering Department	Course Type	Structure			Credits
				Deptt./Allied Core/Elective /	L	T	
CHH205B-T	Physical Chemistry-III	CH	CORE	3	1	0	4
CHH205B-P	Physical Chemistry- III Lab	CH	CORE	0	0	3	1.5
CHH206B-T	Inorganic Chemistry- III	CH	CORE	3	1	0	4
CHH206B-P	Inorganic Chemistry- III Lab	CH	CORE	0	0	3	1.5
CHH207B-T	Organic Chemistry- III	CH	CORE	3	1	0	4
CHH207B-P	Organic Chemistry- III Lab	CH	CORE	0	0	3	1.5
CHH208B/	Polymer Chemistry/	CH	ELECTIVE	3	1	0	4

CHH209B	Industrial Chemistry						
CHS234	EVEN SEMESTER OPEN ELECTIVE Environment & Sustainable Development	CH	ALLIED ELECTIVE	2	0	0	2
ECS249	E-waste Management	ECE					
LWS323	Cyber Crime & Laws	LW					
CDO204	Quantitative Aptitude-II	CDC	ELECTIVE	0	0	2	
CHN210B	MINI PROJECT-II	CH					
CDO203	CAREER SKILLS-I	CDC	AUDIT	2	0	0	NIL
TOTAL (L-T-P) /CREDITS)				14/16	4	9	22.5

Course Title/Code	PHYSICAL CHEMISTRY-III (CHH205B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	Students will be able to understand phase equilibria in different component systems and analyze the qualitative and quantitative aspects of electrochemical cells.	
Course Outcomes (COs)		Mapping
CO1	To develop in depth understanding of phase equilibria in one, two and three component systems and to describe salient features of liquid-liquid and liquid-solid phase equilibrium plots	Skill Development
CO2	To identify and understand the principles of chemical equilibrium thermodynamics to solve multiphase equilibria and chemical reaction equilibria.	Skill Development
CO3	To analyse and Understand the qualitative and quantitative aspects of electrochemical cells and the nature of adsorption and their qualitative analysis	Employability
CO4	Learn analytical concepts of various reactions through different types of electrochemical cells and will be able to calculate the cell potential from standard cell potential using the Nernst Eqn.	Employability
Prerequisites	Physical Chemistry-I (CHH102B-T) & Physical Chemistry-II (CHH201B-T)	

Section-A

Phase Equilibria I:

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 (H_2O and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Three component systems: triangular plots, water-chloroform-acetic acid system.

Section-B

Phase Equilibria II:

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

Chemical Equilibrium

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

Section-C

Electrolysis and Electrical conductance:

Electrolysis and mechanism, Faraday's laws and its importance, conductance (Specific and equivalent, molar), measurement of electrolytic conductance, Determination of cell constant, ionic mobility, transport number—Hittorf's method, moving boundary method, Conductometry titrations.

Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich), nature of adsorbed state

Section-D

Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry, Chemical cells, reversible and irreversible cells with examples, Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and $\text{SbO/Sb}_2\text{O}_3$ 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), Primary and secondary batteries,

Referred Books:

1. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
2. Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
3. Puri, B.R., Sharma, L.R., Pathania, M.S., Principles of Physical chemistry, Vishal Publication Co., 2016
4. Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
5. Ball, D. W. Physical Chemistry Cengage India (2012).
6. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009). Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).

7. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

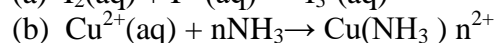
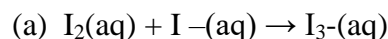
CO-PO Mapping

Course Code	Course	Course Outcomes	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	
CHH205 B-T	PHYSICAL CHEMISTRY-III	CO1	2	2	1	2	2	2	1	-	2	2	1	
		CO2	2	1	1	2	1	2	1	-	3	1	2	
		CO3	2	2	1	1	1	1	1	1	-	3	2	1
		CO4	2	2	2	3	2	-	1	-	3	1	2	

Course Title/Code	PHYSICAL CHEMISTRY-III LAB (CHH205B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	To skill students in learning analytical concepts of various reactions through different types of electrochemical cells and will be able to calculate the cell potential.	
Course Outcomes (COs)		Mapping
CO1	To develop in depth understanding of phase equilibria in one, two and three component systems and to describe salient features of liquid-liquid and liquid-solid phase equilibrium plots	Skill Development
CO2	To identify and understand the principles of chemical equilibrium thermodynamics to solve multiphase equilibria and chemical reaction equilibria.	Skill Development
CO3	To analyse and Understand the qualitative and quantitative aspects of electrochemical cells and the nature of adsorption and their qualitative analysis	Employability
CO4	Learn analytical concepts of various reactions through different types of electrochemical cells and will be able to calculate the cell potential from standard cell potential using the Nernst Eqn.	Employability
Prerequisites	Physical Chemistry-I Lab (CHH102B-P) & Physical Chemistry-II Lab (CHH201B-P)	

1. Phase Equilibria:

- Determination of critical solution temperature and composition at CST of the phenol-water system and to study the effect of impurities of sodium chloride and succinic acid on it.
- Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.
- Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.
- Study the equilibrium of at least one of the following reactions by the distribution method:



2. Potentiometry:

Perform the following potentiometric titrations:

- Strong acid vs. strong base
- Weak acid vs. strong base

- iii. Dibasic acid vs. strong base
- iv. Potassium dichromate vs. Mohr's salt

3. Adsorption:

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

4. Any other experiment related to subject

Referred Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). 25
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CHH20 5B-P	PHYSICAL CHEMIST RY-III LAB	CO1	2	2	2	1	1	2	-	-	2	2	2
		CO2	2	1	2	2	1	2	1	-	3	1	2
		CO3	2	2	1	1	1	1	1	-	3	2	1
		CO4	2	2	2	3	2	-	1	-	3	1	2

Course Title/Code	Inorganic Chemistry-III (CHH206B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	The objective of the course is to make the students understand the coordination chemistry, study of d block elements, actinide, lanthanides and applications of HSAB principle.	
Course Outcomes (COs)		Mapping
CO1	Learn and understand Molecular Orbital Theory and VSEPR theory.	Skill Development
CO2	To familiarize students with properties of Transition and Inner-transition Metal Complexes.	Skill Development
CO3	Learn and understand coordination chemistry and mechanism of metal-ligand bonding in transition metal complexes	Skill Development
CO4	Learn and understand concepts of acids and bases and applications of HSAB theory.	Skill Development
Prerequisites	Inorganic Chemistry-I & II	

Section-A

Chemical bonding-II

Molecular orbital theory, Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , C_2 , B_2 , F_2 , CO , NO , XeF_2 and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), Multiple bonding and bond lengths.

Section-B

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams) Different between the first, second and third transition series

Lanthanides and Actinides:

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

Section-C

Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Crystal field splitting of octahedral and tetrahedral complexes, measurement of $10 Dq$ (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of CF Splitting., Chelate effect

Section-D

Concepts of Acids and Bases

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

Referred 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. Cotton, F.A. & Wilkinson, G., Advanced Inorganic Chemistry Wiley-VCH, 1999
4. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
5. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, ButterworthHeinemann,1997.
6. Miessler, G. L. & Tarr, Donald A. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH206 B-T	Inorganic Chemistry-III	CO1	3	-	2	2	2	-	-	-	-	-	3
		CO2	3	-	2	2	2	-	-	-	-	-	3
		CO3	3	-	2	2	2	-	-	-	-	-	3
		CO4	3	-	2	2	2	-	-	-	-	-	3

Course Title/Code	Inorganic Chemistry-III Lab (CHH206B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	The objective of the course is to make the students understand the coordination chemistry, study of d block elements, including their synthesis and applications.	
Course Outcomes (COs)		Mapping
CO1	To understand general estimation of elements by various analytical methods.	Skill Development
CO2	To prepare coordination compounds.	Skill Development
CO3	To learn Properties of coordination compounds.	Skill Development
CO4	To learn properties of coordination compounds and ligand exchange reactions by substitution method.	Employability
Prerequisites	Inorganic Chemistry-I & II Lab	

Gravimetric Analysis:

- i. Estimation of nickel (II) using Dimethylglyoxime (DMG).

- ii. Estimation of copper as CuSCN
- iii. Estimation of iron as Fe₂O₃ by precipitating iron as Fe(OH)₃.
- iv. Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)₃(aluminium oxinate).

Inorganic Preparations:

- i. Tetraamminecopper (II) sulphate, [Cu(NH₃)₄]SO₄.H₂O
- ii. Acetylacetonate complexes of Cu²⁺/Fe³⁺
- iii. Tetraamminecarbonatocobalt (III) nitrate
- iv. Potassium tri(oxalato)ferrate(III)

Properties of Complexes

- i. Measurement of 10 Dq by spectrophotometric method
 - ii. Verification of spectrochemical series.
- Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetonate, DMG, glycine) by substitution method

Any other experiment related to subject

Referred Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. G. Marr and B.W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH206 B-T	Inorganic Chemistry-III Lab	CO1	3	1	-	-	2	-	-	-	2	2	2
		CO2	3	1	-	-	2	-	-	-	2	2	2
		CO3	3	1	-	-	2	-	-	-	2	2	2
		CO4	3	1	-	-	2	-	-	-	2	2	2

Course Title/Code	Organic Chemistry-III (CHH207B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To give basic knowledge of the organic molecules their behavior towards reacting materials	
Course Outcomes (COs)		Mapping
CO1	Able to prepare nitrogen containing functional group compounds and its chemical reactivity	Skill Development
CO2	Able to prepare sulphur containing functional group compounds and its chemical reactivity	Skill Development
CO3	Able to prepare polynuclear hydrocarbons and its chemical reactivity	Skill Development
CO4	Able to prepare heterocyclic compounds and Understand the formation of carbon-hetero atom multiple bond.	Skill Development
Prerequisites	Organic Chemistry-I & II	

SECTION A

Nitrogen containing functional groups

Preparation and important reactions of nitro and compounds, nitriles and isonitriles, Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

SECTION B

Sulphur containing compounds

Preparation and properties of thiols or mercaptans (physical and chemical properties), thioethers or sulphides: method of preparation, properties (reactions with alkyl halide, halogens, hydrolysis, oxidation etc.) mustard gas: preparation and properties. Aromatic sulphonic acids: nomenclature, method of preparation, physical properties, chemical properties (reaction of -OH of SO₃H group and reaction in which -SO₃H group replaced. Uses of sulphonic acids (benzenesulphonic acid, benzene sulphonyl chloride, Toluenesulphonic acid, Chloramine -T, sulphanilic acid, sulfanilamide: preparation and properties)

SECTION C

Polynuclear hydrocarbons

Polynuclear hydrocarbon or fused ring hydrocarbons: nomenclature

Naphthalene: structure, synthesis, properties (physical and chemical: sulfonation, acylation, nitration, halogenation, reduction, oxidation) and uses (naphthol, naphthylamines)

Anthracene: structure, synthesis, properties (physical and chemical: sulfonation, nitration, halogenation, reduction, oxidation) and uses (Anthraquinone, Alizarine).

Phenanthrene: structure, synthesis, properties (physical and chemical: nitration, acylation) and uses.

SECTION D

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.

Referred Books:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
5. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
6. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.

7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford Univ Press.
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Parakashan (2010).

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH207 B-T	Organic Chemistry -III	CO1	3	-	-	3	3	-	-	-	2	2	3
		CO2	3	-	-	3	3	-	-	-	2	2	3
		CO3	3	2	-	3	3	-	-	-	2	2	3
		CO4	3	2	-	3	3	-	-	-	2	2	3

Course Title/Code	Organic Chemistry-III LAB (CHH207B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	To skill students to identify the organic compounds from the unknown sample	
Course Outcomes (COs)		Mapping
CO1	Student will be able to identify the nitrogen, sulfur and chlorine containing organic functional groups	Skill Development
CO2	Student will be able to qualitatively analyse and identify the organic acid, phenols and carbonyl compounds	Skill Development
CO3	Student will be able to qualitatively analyse and identify the esters, hydrocarbons and carbohydrates	Skill Development
CO4	Student will be able to qualitatively analyse and identify the compounds containing nitrogen, sulphur and halogens	Skill Development
Prerequisites	Organic Chemistry-I & II Lab	

1. Functional group test for nitro, amine and amide groups.
2. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters)
3. **Any other experiment related to subject**

Referred 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)

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH207B -P	Organic Chemistry-III Lab	CO1	3	3	1	-	3	3	-	-	2	2	2
		CO2	3	3	1	-	3	3	-	-	2	2	2
		CO3	3	3	2	-	3	3	-	-	2	2	2
		CO4	3	3	2	-	3	3	-	-	2	2	2

Course Title/Code	POLYMER CHEMISTRY (CHH208B)	
Course Type	Core	
L-T-P Structure	4-0-0	
Credits	4	
Course Objective	To make student able to understand the practical aspects of kinetics of the reactions & different potentiometric titrations	
Course Outcomes (COs)		Mapping
CO1	Student will be able to the understand the emergence of Polymers	Skill Development
CO2	Student will be able to understand the To Understand the classification of polymeric materials	Skill Development
CO3	Understand thermal, mechanical, electrical properties of polymers	Employability
CO4	Student will be able to understand the To analyses microstructure of polymeric materials	Skill Development
Prerequisites	Nil	

SECTION A

Introduction to polymers

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers

Functionality & 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

SECTION B

Kinetics of polymerization

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization & Crystallinity

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

SECTION C

Nature & 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, Polydispersity index, Glass transition temperature (Tg) and determination of Tg, Factors affecting glass transition temperature (Tg).

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. Polymer degradation (thermal, mechanical, photo-degradation, oxidative and hydrolytic degradation)

SECTION D

Properties of polymers (physical, thermal, flow & mechanical properties)

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins- polystyrene poly (vinyl chloride), poly(vinyl acetate) and related polymers; acrylic polymers, polyamides and related polymers, Conducting polymers: Introduction, Band Theory of conductors, semiconductors and insulators, Band structure of conducting polymers, synthesis of conducting polymers by electrochemical and photochemical chemistry and applications

Reference Books:

1. R.B. Seymour & C.E. Carraher: Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York,
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.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.
6. M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1999.
7. H.R. Allcock, F.W. Lampe & J.E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall
8. F.W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984).
9. J.R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003).

0. P. Munk & T.M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons
0. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. JohnWiley & Sons (2005).
12. M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford Univ Press (2005).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH208 B	POLYMER CHEMISTR Y	CO1	1	-	1	-	-	-	-	-	-	-	1
		CO2	1	-	2	-	-	2	-	-	-	-	1
		CO3	1	-	-	-	1	-	-	-	1	-	1
		CO4	1	-	1	-	3	1	-	-	1	-	1

Course Title/Code	Industrial Chemistry (CHH209B)	
Course Type	Domain Elective	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To impart the knowledge of silicate industries To impart the knowledge and chemistry of cosmetics and perfumes To impart the knowledge and industrial applications of batteries, alloys and catalysts.	
Course Outcomes (COs)		Mapping
CO1	The chemistry of materials used in silicate industries	Skill Development
CO2	The chemistry of cosmetics and perfumes	Skill Development
CO3	The chemistry and industrial applications of batteries, alloys and catalysts	Skill Development & Employability
Prerequisites	B.Sc. with Chemistry as one of the Subject	

SECTION A

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass, Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre,

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

SECTION B

Chemistry of cosmetics & perfumes

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.

SECTION C

Batteries

Primary and secondary batteries, battery components and their role, Characteristics of Battery, Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery, Fuel cells, Solar cell and polymer cell

Alloys

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys, Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels

SECTION D

Catalysts & Catalysis

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation and regeneration of catalysts, Phase transfer catalysts, applications of zeolites as catalysts

Chemical Explosives

Origin of explosives properties in organic compounds, preparation and explosives properties of lead azide, PETN, cyclonite (RDX), Introduction to rocket propellants

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. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH209 B	Industrial Chemistry	CO1	3	2	2	2	2	3	2	2	2	2	2
		CO2	3	2	2	2	2	3	2	2	2	2	2
		CO3	3	3	3	3	2	3	2	2	2	2	2

Course Title/Code	ENVIRONMENTAL ETHICS & SUSTAINABLE DEVELOPMENT (CSH234)	
Course Type	Allied Elective	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	To describe, explain and analyze the sustainable development concerns and challenges.	
Course Outcomes (COs)		Mapping
CO1	Ability to develop an inter-disciplinary understanding of sustainable development concerns;	Skill Development
CO2	Ability to recognize the challenges of sustainable development; the opportunities and limits in meeting these challenges	Skill Development
CO3	Ability to defend or criticize the sustainability initiatives adopted by different enterprises.	Skill Development
Prerequisites (if any)		

Section A

Introduction to Sustainable Development: Definition of Sustainable Development; Triple Bottom Line, Components of TBL, Changing Perspective & Debates in Sustainable Development - Need

for Sustainable Development, Evolution of the concept of Sustainable Development: Stockholm Conference, The Brundtland Commission, Earth Summit, Agenda 21; Millennium Development Goals

Section B

Challenges to Sustainable Development and Sustainable Development Goals (SDGs): Challenges to Sustainable Development - Agriculture, Population & Food Security, Public Health and Nutrition, Education, Natural Resources (Forests, Energy, Water), Climate Change Sustainable Development Goals (SDGs) - Introduction, Challenges to SDGs, Indian Scenario.

Section C

Sustainability Strategies & Reporting: Sustainability Strategies & Reporting - Introduction, Rationale and Mechanisms, Key Principles, Sustainability Strategies Adopted by Different Enterprises – Case Studies

Section D

Sustainable Development and Contemporary Issues: Sustainable Consumption, Indigenous Knowledge, Gender Issues, Population & Sustainable Agriculture, Sustainable Tourism

Text and Reference Books

Environmental Management for Sustainable Development; C.J. Barrow; Routledge Publishers

1. Roberts, J.T., and Hite, A., 2000, From Modernization to Globalization - Perspectives on Development and Social Change, Blackwell Publishing
2. Sachs, J., 2004, Stages of Development, Speech at the Chinese Academy of Arts and Sciences
3. Giddings, B., Hopwood, B., and Geoff O'Brien, 2002, Environment, Economy and Society: Fitting Them Together into Sustainable Development, Published online in Wiley Inter Science (www.interscience.wiley.com). DOI: 10.1002/sd.199

List of Experiments/Activities

- Survey - Business and non-business students' perception towards TBL (based on the readings listed above); inferences on the basis of survey; <http://www.aabri.com/manuscripts/121249.pdf>
- Workshop based - Sustainable agriculture- Mushroom farming
- Workshop based - Back to nature - DIY composting bin
- Review - Sustainable Consumption in India: Challenges and Opportunities; Divesh Kumar, Praveen Goyal, ZillurRahman, Ishwar Kumar; IJMBS Vol. 1, Issue 3, September 2011; <http://www.ijmbs.com/13/devesh.pdf>
- Calculate Carbon Footprint/Ecological footprint
- Stimulus Activity (Piece of writing) - Sustainable Consumption
- CSR - Workshop for Village school children
- Simulation Activity - Challenges to Sustainable Development

- Case Studies - Sustainability initiatives @ TATA Motors, CAIRN INDIA, Mahindra & Mahindra, Subaru Isuzu, Disney, Novo Nordisk, etc

CO-

PO

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CHS234	Environmental Ethics & Sustainable Development	CO1	-	-	3	-	-	-	-	-	-	-	3
		CO2	-	-	3	-	-	-	-	-	-	-	2
		CO3	-	-	3	-	-	-	-	-	-	-	3

MAPPING

Course Title/Code	E-Waste: Environmental Problems and Management (ECS249)	
Course Type	Allied Elective	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	To describe, explain and analyze the environmental concerns and challenges.	
Course Outcomes (COs)		Mapping
CO1	Gain a better understanding and appreciation for the challenges related to waste management.	Skill Development
CO2	Create awareness about environmental impacts of e-waste.	Skill Development
CO3	Identify various components of e-waste	Skill Development
Prerequisites (if any)		

Section A

INTRODUCTION: E-Waste, Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of e-waste, Possible hazardous substances present in e-waste, Environmental and Health implications.

Section B

E-WASTE LEGISLATION: Regulatory regime for e-waste in India, The hazardous waste(Management and Handling) rules 2003, E- waste management rules 2015, Regulatory compliance including roles and responsibility of different stakeholders – producer, manufacturer, consumer etc., Proposed reduction in the use of hazardous substances (RoHS) & REACH, Extended producer responsibility (EPR).

Section C

END OF LIFE MANAGEMENT OF E-WASTE: Historic methods of waste disposal – dumping, burning, landfill; Recycling and recovery technologies – sorting, crushing, separation; Life cycle assessment of a product – introduction; Case study – optimal planning for electronic waste.

Section D

ENVIRONMENTALLY SOUND E-WASTE MANAGEMENT: Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, environmentally sound treatment technology for e-waste, Guidelines for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.

List of Experiments:

- Identify the hazardous materials present in printed circuit boards.
- Extraction of copper of printed circuit boards in etching solution.
- Demo of recycling process through videos.
- Extraction of precious metal from e Waste.
- Invited guest lecture.
- Field visit to a waste management initiative in NCR.
- Activity based learning: survey of the household practice of e-waste disposal and awareness.
- Case study – presentation and group discussion.

Text and Reference Books

Electronic Waste Management, R E Hester, R M Harrison, RSC publishing.

E Waste: Implications, Regulations and Management in India and current global practices,
RakeshJohri, TERI PRESS.

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
ECS249	E-Waste: Environmental Problems and Management	CO1	-	-	3	-	-	-	-	-	-	2	3
		CO2	-	-	3	-	-	-	-	-	-	2	2
		CO3	-	-	3	-	-	-	-	-	-	2	3

Course Title/Code	Cyber Crime & Laws (LWS323)	
Course Type	Domain elective	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	make students understand the concept of Cyber Crimes & Cyber Law and various aspects relating to it	
Course Outcomes (COs)		Mapping
CO1	To understand students the basic concept of Cyber Crimes & Cyber Law and its various aspects	Employability
CO2	Develop the ability to demonstrate problems arising out of online transactions and stimulate them to find solutions.	Employability
CO3	To develop the ability to clarify the Intellectual Property issues in the cyber space and the growth and development of the law in this regard.	Employability
CO4	To develop the ability to understand Information Technology Act, 2000.and Information Technology Amendment Act 2008	Employability
Prerequisites	Nil	

Section A

Unit 1: Cyber Crimes: Meaning, Categories & Kinds- (Contact Hours - 4)

A. Cyber Crime: Meaning & Categories

B. Nature of Cyber Crime, Cyber Crimes v. Conventional Crimes

C. Kinds of Cyber Crime- hacking, spamming, phishing, cyber stalking, cyber pornography, malware etc

Section B

Unit 2: Privacy Issues & Access Rights :- (Contact Hours -6)

A. Freedom of speech and expression in Cyberspace.

B. Right to Privacy and Right to Data Protection.

C. Access Rights

Section C

Unit 3: Cyber Space & Legal framework:- (Contact Hours -3)

A. Cyber Security

B. Cyber Space , Concept of Property in Cyber Space

C. Jurisdiction in Cyber Space

Section D

Unit 4: Information and Technology Act 2000 & IT Amendment Act 2008

A. Need of Cyber Law in India

B. Enactment & Scheme of the IT Act

C. Objectives of the IT Act 2000, Amendments to the Act

D. Justice Dispensation System for Cyber Crimes under IT Act

Tutorial activities 1 Hr/Week

Reference Books:

1. Cyber Law - Pavan Duggal

2. Cyber Crimes & Laws-Sushma Arora & Raman Arora-Taxmann's

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
LWS323	Cyber Crime & Laws	CO1	-	-	-	2	-	-	1	-	-	2	3
		CO2	-	-	-	2	-	-	1	-	-	2	3
		CO3	-	-	-	2	-	-	1	-	-	2	3
		CO4	-	-	-	2	-	-	1	-	-	2	3

Course Title/Code	Quantitative Aptitude-II (CDO204)	
Course Type	Allied Elective	
L-T-P Structure	1-1-0	
Credits	2	
Course Objective	To prepare students with the concepts of quantitative techniques required in aptitude test of various competitive exams & placements.	
Course Outcomes (COs)		Mapping
CO1	Students will be able to analyse various forms of data	Skill Development
CO2	Students will be able to solve complex problems based on arithmetic reasoning.	Skill Development
CO3	Students will be able to apply short tricks on complex problems of number system.	Skill Development
Prerequisites (if any)	QUANTITATIVE APTITUDE-I (CDO203)	

Unit 1: Number System

1.1 Factors and Multiples

1.2 Unit Digits & Cyclicity

1.3 Remainders

1.4 Factorials

1.5 Logarithm

Unit 2: Modern Mathematics

2.1 Permutation and Combination

2.1.1 Principal of counting and Basic formulas

2.1.2 Arrangements, Selection and Selection + Arrangement.

2.1.3 Linear/Circular arrangements, Digits and Alphabetic Problems and Applications.

2.2 Probability

2.2.1 Events and Sample Space, Basic Formulas.

2.2.2 Problems on Coins, Cards and Dices.

2.2.3 Conditional Probability, Bayes' Theorem and their Applications.

Unit 3: Data Analytics

3.1 Data Interpretation

3.1.1 Table and Bar graph

3.1.2 Line and Pie Charts

3.1.1 Mixed Charts and Caselets

3.1.2 Data Sufficiency

Unit 4: Area & Volume

4.1 Mensuration I- Areas

4.1.1 Different types of Triangles and their area and perimeter.

4.1.2 Different types of Quadrilateral and their area and perimeter.

4.1.3 Circumference and Area of Circle, Area of Sector and length of Sector.

4.1.4 Mixed Figures and their Applications.

4.2 Mensuration II- Surface Areas and Volumes

4.2.1 Problems on Cubes & Cuboids, Cone, Cylinder and Sphere.

4.2.2 Prism and Pyramid.

4.2.3 Mixed Figures and their Applications.

Unit 5: Logical Reasoning

5.1 Seating Arrangement

5.2 Ranking

5.3 Syllogism

5.4 Calendar

5.5 Ages & Numbers

Text Books/Reference Books:

A Modern Approach to Verbal & Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018

Instructions for paper setting: Fifty MCQ will be set in total. All questions will be compulsory. Each question will be of 1 mark. There will be no negative marking. Calculator will not be allowed.

TEXTBOOKS

Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2017

REFERENCE BOOKS

A Modern Approach to Verbal & Non Verbal Reasoning: R S Aggarwal, S Chand & Company Pvt Ltd, Edition 2018

CO-PO Mapping

Course Code	Course	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CDO204	Quantitative Aptitude-II	CO1	1	2	3	-	1	-	1	-	1	1	3
		CO2	1	2	3	-	1	-	1	-	1	1	3
		CO3	1	2	3	-	2	-	1	-	1	1	3

Course Title/Code	Mini Project-II (CHN210B)	
Course Type	Core	
L-T-P Structure	0-0-2	
Credits	2	
Course Objective	To skill students to identify the problem related to chemistry and environment and explore the it's solution	
Course Outcomes (COs)		Mapping
CO1	To apply theoretical knowledge and practical skills to a research project and on the collection and analysis of scientific data	Skill Development
CO2	Work independently and collaboratively with peers to bring the project to satisfactory completion	Skill Development
CO3	Communicate a scientific argument convincingly at a level and style appropriate to the audience	Employability
Prerequisites	Knowledge of Mini Project-I (CHN204B)	

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHN210 B	Mini Project-II	CO1	3	3	1	-	3	3	-	-	2	2	-
		CO2	3	3	1	-	3	3	-	-	2	2	-
		CO3	3	3	2	-	3	3	-	-	2	2	-
		CO4	3	3	2	-	3	3	-	-	2	2	-

Course Title/Code	Career Skills -I CDO205	
Course Type	Core	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	To prepare students for placements, Interviews	
Course Outcomes (COs)		Mapping
CO1	Students will be able to identify different categories of Aptitude.	Employability
CO2	Students will be able to solve aptitude problems based on Arithmetic Reasoning.	Employability
CO3	Students will be able to experiment with different short-tricks to solve problems in given time.	Employability
CO4	Students will be able to identify the nuances of teamwork and work collaboratively in teams	Employability
CO5	Students will be able to creatively solve problems	Employability
CO6	Students will be able to relate better with employability and apply the skillsets towards enhancing their employability skills	Employability
Prerequisites (if any)	N.A.	

Part A – Quantitative Aptitude
Unit 1: Arithmetic Aptitude I

- 1.1 Mixture & Alligation
 - 1.2 Number System 2
 - 1.2.1 Unit digit
 - 1.2.2 Remainders
 - 1.2.3 Factors
 - 1.2.4 Factorials
 - 1.3 Data Interpretation
- Unit 2: Reasoning
- 2.1 Number, Ranking & Time sequence Test
 - 2.2 Syllogism
 - 2.3 Logical Reasoning
 - 2.3.1 Seating Arrangement
 - 2.3.2 Linear and Circular arrangement puzzle
 - 2.3.3 Cross Variable puzzle
- Part B – Soft Skills
- Unit 3: Personality Development
- 3.1 Concept of personality
 - 3.2 Self awareness
 - 3.2.1 Different learning styles
 - 3.2.2 Areas of Self awareness
 - 3.2.3 Developing self-awareness
 - 3.3 Goal Setting
 - 3.3.1 Five principles of goal setting
 - 3.3.2 Setting “SMART” goals
 - 3.3.3 6P’s of goal setting
 - 3.3.4 SWOT analysis
 - 3.4.5 Short term & Long term goals
- Unit 4: Presentation Skills
- 4.1 Designing the presentation
 - 4.2 Audience and content analysis
 - 4.3 Delivering the presentation- Preparation, Practice, Performance
- Unit 5: Professional Communication
- 5.1 Email writing
 - 5.2 Diction and Speech Clarity
 - 5.3 LSRW & Introduction to verbal ability as an assessment tool for employability

CO-PO Mapping

Course Code	Course	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CDO2 05	Career Skills -I	CO1	1	-	-	-	-	1	-	-	-	-	-
		CO2	1	-	-	2	-	-	-	-	-	-	-
		CO3	1	-	-	-	-	1	-	-	-	-	-
		CO4	1	-	-	1	-	-	-	-	1	3	-
		CO5	1	-	-	1	-	1	-	-	1	3	-
		CO6	1	2	-	1	1	1	1	1	1	1	3

Semester-V

Course Code	Course Name	Offering Department	Course Type	Structure			Credits
				L	T	P	
CHH301B-T	PHYSICAL CHEMISTRY-IV	CH	CORE	3	1	0	4
CHH301B-P	PHYSICAL CHEMISTRY-IV LAB	CH	CORE	0	0	3	1.5
CHH302B-T	BIOMOLECULES & NATURAL PRODUCTS	CH	CORE	3	1	0	4
CHH302B-P	BIOMOLECULES & NATURAL PRODUCTS-LAB	CH	CORE	0	0	3	1.5
CHH303B-T	ANALYTICAL CHEMISTRY & SPECTROSCOPY	CH	CORE	3	1	0	4
CHH303B-P	ANALYTICAL CHEMISTRY & SPECTROSCOPY-LAB	CH	CORE	0	0	3	1.5
	DOMAIN SPECIFIC ELECTIVES						

CHS304B	CHEMISTRY IN AGRICULTUR E	CH	ELECTIVE	2	0	0	2
CHS305B							
CHS306B	FUEL CHEMISTRY						
CHN307B	NANOTECHN OLOGY			0	0	2	
	MINOR PROJECT						
CDO303	CAREER SKILLS-II	CDC	AUDIT	2	0	0	NIL
TOTAL (L-T-P) /CREDITS)				11/13	3	9	18.5

Course Title/Code	Physical Chemistry-IV (CHH301B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	To give an in-depth exposure of Quantum Chemistry and familiarize the students with various spectroscopic techniques like IR, Raman, NMR and ESR.	
Course Outcomes (COs)		Mapping
CO1	Familiarize with the concept of quantization and understand postulates of quantum chemistry.	Skill Development
CO2	Learn the qualitative treatment of simple harmonic oscillator along with energy calculations.	Skill Development
CO3	Work out the qualitative treatment of hydrogen and hydrogen like atoms.	Skill Development
CO4	Understand the concept of bonding in atoms and comparison of various bonding approaches.	Skill Development
CO5	Grasping the interaction of electromagnetic radiation with matter leading to the branch of spectroscopy. Familiarize and analyze molecular and vibrational spectra of molecules.	Employability
CO6	Explicit study of Raman, Electronic, NMR & ESR spectra of molecules to derive useful information about a molecule	Employability
Prerequisites	Physical Chemistry-I (CHH102B-T), Physical Chemistry-II (CHH201B-T) & Physical Chemistry-III (CHH301B-T)	

SECTION A

Quantum Chemistry-I

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, Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates

SECTION B

Quantum Chemistry-II

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

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H₂. Bonding and antibonding orbitals, Comparison of LCAO-MO and VB treatments of H₂ (only wave functions, detailed solution not required) and their limitations. 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

SECTION C

Molecular Spectroscopy-I

Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation, Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

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

SECTION D

Molecular Spectroscopy-II

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

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and pre-dissociation

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

Reference Books:

1. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi.
2. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001). House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
3. Kakkar, R. *Atomic & Molecular Spectroscopy: Concepts & Applications*, Cambridge University Press (2015).
4. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
5. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
6. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
7. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.*;
8. W.H. Freeman & Co.: New York (2003).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH301B-T	Physical Chemistry-IV	CO1	3	-	-	-	3	-	-	-	2	2	3
		CO2	3	-	-	-	3	-	-	-	2	2	3
		CO3	3	-	-	-	3	-	-	-	2	2	3
		CO4	3	-	-	-	3	-	-	-	2	2	3
		CO5	3	2	-	3	3	2	-	-	2	2	3
		CO6	3	2	-	3	3	2	-	-	2	2	3

Course Title/Code	Physical Chemistry-IV LAB (CHH301B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	To skill students in handling conductivity meter for various analysis and inculcate understanding of chemical kinetics by monitoring simple reactions for calculation of rate constant and activation energy.	
Course Outcomes (COs)		Mapping
CO1	Implementation of the basics of conductometry to derive useful information.	Skill Development
CO2	Demonstrate the conductometric titrations of various acid base mixtures and related calculations	Employability
CO3	Explore chemical kinetics of a chemical reaction and calculation of rate constant through different methods	Skill Development
CO4	Kinetic analysis of some saponification and hydrolysis reactions with the application of concepts learned in theory to derive important implications	Employability
Prerequisites	Physical Chemistry-I (CHH102B-P), Physical Chemistry-II (CHH201B-P) & Physical Chemistry-III LAB (CHH301B-P)	

Conductometry:

1. Determination of cell constant.
2. Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid.
3. 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.

Chemical Kinetics:

Study the kinetics of the following reactions.

1. Iodide-persulphate reaction (i) Initial rate method; (ii) Integrated rate method
2. Acid hydrolysis of methyl acetate with hydrochloric acid.
3. Saponification of ethyl acetate.
4. Comparison of the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate.
5. **Any other experiment related to subject**

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

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH301B -P	Physical Chemistry- IV Lab	CO1	3	3	3	3	3	3	-	-	2	2	2
		CO2	3	3	3	3	3	3	-	-	2	2	2
		CO3	3	3	3	3	3	3	-	-	2	2	2
		CO4	3	3	3	3	3	3	-	-	2	2	2

Course Title/Code	Biomolecules & Natural Products (CHH302B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	Students would be able to aware about primary metabolites such as carbohydrate, nucleic acid amino acids and Proteins and synthetic and natural dyes its synthesis, isolation, purification and structural elucidation and applications	
Course Outcomes (COs)		Mapping
CO1	Student will be able to describe structure and functions of DNA and RNA and propose synthesis of novel nucleotides	Skill Development
CO2	To identify structure of amino acids, and illustrate synthesis of proteins	Skill Development
CO3	To explain the structure and properties of carbohydrates and describe the reducing action of sugars	Skill Development
CO4	To differentiate between properties and applications of natural and synthetic dyes with their environmental impact	Skill Development
Prerequisites	Organic Chemistry I (CHH104B-T), Organic Chemistry II (CHH203B-T) & Organic Chemistry III (CHH207B-T)	

BIOMOLECULES & NATURAL PRODUCTS (CHH302B-T) SECTION A

Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides; Structure and synthesis of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides. Importance of nucleic acids in living system, Watson and crick model for DNA, Different types of DNA and RNA

SECTION B

Amino Acids, Peptides & Proteins

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

SECTION-C

Carbohydrates

Occurrence, classification and their biological importance, Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational

structures; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose.

SECTION-D

Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein;

Natural Dyes

Occurrence, colour and constitution, Classification, isolation, purification and properties, structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples,

Reference Books:

O. P. Agarwal, Chemistry of Natural Products, Vol-1, Goel Publishing House, 1997.

I. L. Finar, Organic Chemistry, Vol-2, 5th edition, Pearson education, London, 1975.

D. L. Nelson and M. M. Cox, Lehninger's Principles of Biochemistry 7th Edition, W. H. Freeman

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH30 2B-T	Biomolecules & Natural Products	CO1	-	-	-	1	1	-	-	-	-	-	1
		CO2	-	-	-	1	1	-	-	-	-	-	1
		CO3	-	-	-	1	1	-	-	-	-	-	1
		CO4	-	-	-	1	1	-	-	-	-	-	1

Course Title/Code	Biomolecules & Natural Products (CHH302B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credit	1.5	
Course Objective	Students familiarize in preparation, analysis and characterization of biomolecules and extraction of natural products	
	Course Outcomes (COs)	Mapping
CO1	Student will be able to describe structure and functions of DNA and RNA and propose synthesis of novel nucleotides	Skill Development
CO2	To identify structure of amino acids, and illustrate synthesis of proteins	Skill Development
CO3	To explain the structure and properties of carbohydrates and describe the reducing action of sugars	Skill Development
CO4	To differentiate between properties and applications of natural and synthetic dyes with their environmental impact.	Employability
Prerequisites	Organic Chemistry I Lab (CHH104B-P), Organic Chemistry II Lab (CHH203B-P) & Organic Chemistry III Lab (CHH207B-P)	

List of Experiments

1. Determination of Gluten in Wheat flour.
2. Quantitative determination of Glucose.
3. Synthesis of Phenyl Glucosazone from Glucose
4. Synthesis of Phenyl Glucosazone from Fructose
5. Isolation of starch from potato
6. Estimation of acetic acid strength in vinegar.
7. Identification of carbohydrates in a given organic sample.
8. Identification of carbohydrates in a given organic sample.
9. Synthesis of Methyl orange dye
10. Extraction of dye from the plant materials.

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH302B-P	Biomolecules & Natural Products Lab	CO1	2	1	-	1	1	-	-	-	-	1	-
		CO2	1	1	-	1	1	-	-	-	-	1	-
		CO3	1	1	-	1	1	-	-	-	-	1	-
		CO3	1	1	-	1	1	-	-	-	-	1	-

Course Title/Code	ANALYTICAL CHEMISTRY & SPECTROSCOPY (CHH303B-T)	
Course Type	Core	
L-T-P Structure	3-1-0	
Credits	4	
Course Objective	Students will be able to understand spectroscopy techniques and chromatography separation methods with the knowledge of interpreting data.	
	Course Outcomes (COs)	Mapping
CO1	To identify (by wavelength, wavenumber, or both) the region of the electromagnetic spectrum which is used in infrared (IR) spectroscopy and its application in various instrumental techniques.	Skill Development
CO2	To understand advanced spectroscopic techniques with interpretation.	Employability
CO3	To acquire the skills to evaluate strengths and limitations of different chromatographic separation and detection techniques with respect to sample properties and to specific analytical problems	Employability
CO4	To understand the various elemental analysis with knowledge of interpreting data.	Skill Development
Prerequisites	NIL	

SECTION A

Scope & Introduction to Analytical Chemistry

Qualitative and Quantitative analysis, Classification of analytical methods, Classical and Instrumental methods, Sampling, Accuracy and Precision concepts, Selection of a sampling method for analysis, Applications of analytical methods in various fields: Organic, Pharmaceuticals, Electronic and Environmental.

Chemical calculations of Expressing concentration of solutions –Normality, Molality, Molarity, Formality, inter-conversion between molality and molarity Mole fraction, Weight ratio, Volume ratio, Weight to volume ratio, ppb, ppm, millimoles, milliequivalents.

SECTION B

Spectroscopy

Introduction: General principles, introduction to absorption and emission spectroscopy, Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the born-oppenheimer approximation.

UV-Vis Spectroscopy: Electronic transition ($\sigma\text{-}\sigma^*$, $n\text{-}\sigma^*$, $\pi\text{-}\pi^*$ and $n\text{-}\pi^*$), relative positions of λ_{max} considering conjugative effect, steric effect, solvent effect, red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples). Application of Woodward Rules for calculation of λ_{max} 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 and trans isomers.

Applications of UV-Vis spectroscopy for identification of simple organic molecules

SECTION C

Separation Techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Role of computers in instrumental methods of analysis.

SECTION D

Physicochemical methods of analysis

Thermal methods of analysis: Theory of thermogravimetry Analysis (TGA), Theory of Differential thermal analysis (DTA), Theory of Differential Scanning Calorimetry (DSC), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture

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

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. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd.
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
8. Singh, J.; Ali, S.M.& Singh, J. Natural Product Chemistry, Prajati Prakashan (2010).
9. Kemp, W. Organic Spectroscopy, Palgrave.
10. Pavia, D.L. et al. Introduction to Spectroscopy 5th Ed. Cengage Learning India Ed. (2015).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CHH303B -T	ANALYTICAL CHEMISTRY & SPECTROSCOPY	CO1	2	1	1	2	2	2	1	-	2	2	1
		CO2	2	1	1	2	1	2	1	-	3	1	2
		CO3	2	2	1	1	1	1	1	-	2	2	1
		CO4	2	2	2	3	2	-	1	-	3	1	2

Course Title/Code	ANALYTICAL CHEMISTRY & SPECTROSCOPY (CHH303B-P)	
Course Type	Core	
L-T-P Structure	0-0-3	
Credits	1.5	
Course Objective	Students will be able to handle spectrophotometer and perform chromatography separation methods with the knowledge of interpreting data.	
	Course Outcomes (COs)	Mapping
CO1	To identify (by wavelength, wavenumber, or both) the region of the electromagnetic spectrum which is used in infrared (IR) spectroscopy and its application in various instrumental techniques.	Skill Development
CO2	To understand advanced spectroscopic techniques with interpretation.	Employability
CO3	To acquire the skills to evaluate strengths and limitations of different chromatographic separation and detection techniques with respect to sample properties and to specific analytical problems	Employability
CO4	To understand the various elemental analysis with knowledge of interpreting data.	Skill Development
Prerequisites	NIL	

1. Determination of the amount of oxalic acid & Sulphuric Acid in the given solution titrimetrically.
2. Determination of % composition of BaSO₄ and NH₄Cl in the given mixture gravimetrically.
3. Determination of R_f value of amino acids by Thin Layer Chromatography and Identification of given Amino Acid.
4. Separation of dyes in a given mixture by Thin Layer Chromatography.
5. Determination of Strength of Acetic Acid and Hydrochloric Acid in a given Mixture by Conductometric Titration using Strong Base NaOH.
6. To determine the λ_{\max} of solution of KMnO₄ using a Spectrophotometer and apply it to find out the concentration of given unknown solution.
7. **Any other experiment related to subject**

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CHH303B -P	ANALYTICAL CHEMISTRY & SPECTROSCOPY- LAB	CO1	2	1	1	2	2	2	1	-	2	2	1
		CO2	2	1	1	2	1	2	1	-	3	1	2
		CO3	2	2	1	1	1	1	1	-	2	2	1
		CO4	2	2	2	3	2	-	1	-	3	1	2

DOMAIN SPECIFIC ELECTIVES

Course Title/Code	Chemistry in Agriculture (CHS304B)	
Course Type	Core	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	Students would be able to learn basic knowledge of chemicals used in agriculture	
Course Outcomes (COs)		Mapping
CO1	Student will be able to explain the soil composition and its properties.	Skill Development
CO2	Students will be able to understand the application of fertilizer in agriculture.	Skill Development
CO3	Students will be able to understand the use of different types of pesticides, their characteristics and applications.	Skill Development
CO4	Students will be able to understand the preparation, properties and applications of plant growth promoters.	Employability
Prerequisites	Basic knowledge of Chemistry	

Section A

Soil Chemistry

Soil analysis, Composition of soil: Organic and Inorganic constituents. Soil acidity: buffering capacity of soils Cation exchange capacity. Absorption of cations and anions: availability of soil nutrients to plants.

Section B

Fertilizers in Agriculture

Different types of fertilizers. Significance of fertilizer in agriculture, Manufacture of the following fertilizers: NPK, Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. Biofertilizer: Introduction and significance

Section C

Pest control in Agriculture

Pesticides: Classification of pesticides with examples.

Insecticides: stomach poisons, contact insecticides, fumigants, manufacture and uses of insecticides. DDT, BHC(gammexane: conformation of gamma isomer) pyrethrin mention of aldrin, dieldrin, endrin and pentachlorophenel (and its Na salt) (structures excluded)

Biopesticides : Herbicides: 2,4-D and 2,4,5-T **Fungicides:** Bordeaux mixture, mention of lime sulphur.

Section D

Plant growth promoters

3-Indole Acetic Acid, Naphthalene Acetic Acid, Ethepon, Alar, Gibberlin, Cyclocel, Phosphon, dwarfing compound (CCC: 2-Chlorethyltrimethyl ammonium chloride). Defoliant: Methods of preparations, properties and applications

Reference Books:

1. R. Cremlyn,. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.
2. E. Stocchi, Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
3. G.T. Austin : shreve's Chemical Process Industries, 5th edition, Mc-Graw-Hill, 1984
4. B.A. Yagodin (Ed). Agricultural Chemistry, 2 Volumes, Mir Publishers (Moscow), 1976.

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHS304B	Chemistry in Agriculture	CO1	-	1	-	-	-	-	-	-	-	1	-
		CO2	-	1	-	-	-	-	-	-	-	1	-
		CO3	-	1	-	-	-	-	-	-	-	1	-
		CO4	-	1	-	-	-	-	-	-	-	1	-

Course Title/Code	Fuel Chemistry (CHS305B)	
Course Type	Core	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	Students would be able to learn basic knowledge of fuels and lubricants	
Course Outcomes (COs)		Mapping
CO1	Student will be able to explain the fundamentals of energy sources and properties of gaseous fuels	Skill Development
CO2	Students will be able to familiarized with the process of cracking and various processes involved in petroleum industry.	Skill Development
CO3	Students will be able to understand advantages and disadvantages of solid fuels, its processing at various industries.	Skill Development
CO4	Students will be able to understand classification and properties of lubricants	Skill Development
Prerequisites	Basic knowledge of Chemistry	

Section A

Fundamentals of Energy

Classification of energy resources (renewable and non-renewable), Consumption trend of primary and energy resources, Advantages and disadvantages of conventional energy sources, Classification of fuels, Calorific values determination,

Gaseous Fuel

LPG, CNG, LNG, bio-gas, gaseous fuels derived from biomass, fuel from waste, synthetic fuels (gaseous and liquids), Hydrogen, Producer gas and acetylene

Section B

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications, Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene

Section C

Solid fuels: Coal

Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal, Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Section D

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants, Properties of lubricants (viscosity index, cloud point, pore point) and their determination

Reference Books:

1. E. Stocchi, Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. P. C. Jain, M. Jain, Engineering Chemistry Dhanpat Rai & Sons, Delhi.
3. B. K. Sharma, H. Gaur, Industrial Chemistry, Goel Publishing House, Meerut (1996).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHS305B	Fuel Chemistry	CO1	-	1	-	-	-	-	-	-	-	1	-
		CO2	-	1	-	-	-	-	-	-	-	1	-
		CO3	-	1	-	-	-	-	-	-	-	1	-
		CO4	-	1	-	-	-	-	-	-	-	1	-

Course Title/Code	Nano Technology (CHS306B)	
Course Type	Elective	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	Outcome student will be able to understand the basic concept of nanoscience and nanotechnology.	
Course Outcomes (COs)		Mapping
CO1	To provide basic multidisciplinary education as well as specialization in one of the subdisciplines of nanoscience and nanotechnologies. Nanotechnology	Skill Development
CO2	To provide scientific knowledge of fundamental structures of chemical, physical and biological sciences in nanoscale	Skill Development
Prerequisites	Nil	

Section A

Fundamental of Nanotechnology

Nanotechnology: Definition and its principles, relationship and Nano scale (macro to micro to nano), overview of natural nanomaterial (bone, lotus leaf), role of chemistry at nanoscale. Nanomaterial as an alternatives to conventional materials, Application of nanomaterial in the

medicine and health care, environment, Information and communication technologies, consumer products

Section B

Nanoscale science and Classification of nanomaterials

Introduction to surface area to volume ratio and aspect ratio, Difference between surface area to volume ratio of bulk materials and nanomaterials (sphere, hollow sphere, rods, hollow rods, cubes and hollow cubes, Introduction to dimensional growth process, Classification of nanomaterials into 0D, 1D, 2D and 3D

Section C

Synthesis Techniques

Introduction to molecular self-assembly (MSA), Template synthesis, Sol-gel methods, Biological synthesis of Nanoparticles, Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents, Bacteria, fungi and plants as sources of reducing and capping agents and for biogenic synthesis of nanomaterials.

Section D

Characterization and application of nanomaterials

Instrumental techniques for characterization of nano particles i.e. Microscopy, spectroscopy, Dynamic light scattering, X-ray crystallography, Application of nanotechnology in medical science, catalytic industry, lubricants, water filtration, energy

References

1. Materials Science and Engineering –V. raghavan
2. Elements of Material Science and Engineering-H. Vanvlach (4th Edition)
3. Nanotechnology-S. K. Kulkarni (3rd Edition)

CO-PO Mapping

Course Code	Course	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CHS306 B	Nano Technology	CO1	3	3	3	-	-	-	-	-	2	1	-
		CO2	3	3	3	-	-	-	-	-	2	1	-

Course	Minor Project (CHN307B)
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Title/Code		
Course Type	Core	
L-T-P Structure	0-0-2	
Credits	1	
Course Objective	To skill students to identify the problem related to chemistry and environment and explore the it's solution	
Course Outcomes (COs)		Mapping
CO1	To apply theoretical knowledge and practical skills to a research project and on the collection and analysis of scientific data	Employability
CO2	Work independently and collaboratively with peers to bring the project to satisfactory completion	Skill Development
CO3	Communicate a scientific argument convincingly at a level and style appropriate to the audience	Skill Development
Prerequisites	Knowledge of Mini Project I (CHN204B) and Mini project II (CHN210B)	

CO-PO Mapping

_Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHN307B	Minor Project	CO1	3	3	1	-	3	3	-	-	2	2	-
		CO2	3	3	1	-	3	3	-	-	2	2	-
		CO3	3	3	2	-	3	3	-	-	2	2	-
		CO4	3	3	2	-	3	3	-	-	2	2	-

Course Title/Code	Career Skills II – CDO303	
Course Type	Core	
L-T-P Structure	2-0-0	
Credits	1	
Course Objective	To prepare students for placements, Interviews	
Course Outcomes (COs)		Mapping
CO1	Students will be able to analyze various forms of data.	Employability
CO2	Students will be able to solve complex problems based on arithmetic reasoning.	Employability
CO3	Students will be able to apply short tricks on complex problems of the number system.	Employability
CO4	Students will be able to enhance and expand word knowledge by fostering word consciousness.	Employability
CO5	Students will be able to construct simple and complex sentences accurately and develop reading skills & build verbal reasoning skills.	Employability
CO6	Students will be able to enhance their ability to ace interviews, participate effectively and confidently in a Group Discussion	Employability
Prerequisites		

Part A – Quantitative Aptitude
Unit 1: Geometry and Mensuration

1.1 Geometry

1.1.1 Basic geometry & Theorems, Lines & Angles

1.1.2 Polygons, Triangle and Quadrilaterals

1.1.3 Circles

1.2 Mensuration I- Areas

1.2.1 Different types of Triangles and their area and perimeter.

1.2.2 Different types of Quadrilateral and their area and perimeter.

1.2.3 Circumference and Area of Circle, Area of Sector and length of Sector.

1.2.4 Mixed Figures and their Applications.

1.3 Mensuration II- Surface Areas and Volumes

1.3.1 Problems on Cubes & Cuboids, Cone, Cylinder and Sphere.

1.3.2 Prism and Pyramid.

1.3.3 Mixed Figures and their Applications.

Unit 2: Algebra

2.1 Linear & Quadratic equations

2.2 Mathematical inequalities

2.3 Maximum & Minimum Values

2.4 Integral Solutions

Unit 3: Verbal Reasoning

3.1 Cubes & Dice

3.2 Inserting Missing Characters

3.3 Clocks

Part B - Employability Enhancement & Verbal Ability

Unit 4: Communication Accuracy

4.1 Relevance of Verbal Ability and preparatory guidelines

4.2 Functional Grammar – Subject Verb Agreement

4.3 Tenses – Perfect, Simple, Continuous

4.4 Common Errors and rectification

Unit 5: Word Power Building Skills

5.1 Words: Antonyms, Synonyms, Verbal Analogies

5.2 Compound words: Homophones, Homonyms, Word Families

5.3 Root Word Technique for Prefixes & Suffixes

5.4: Word Power: 7 Tips for Learning New Words

5.5 Practice Vocabulary Exercises

Unit 6: Reading & Writing Skills

6.1 Objectives of Reading, Definition & Types of Reading & Importance of Reading

6.2 Reading Techniques: SW3R, Active Reading, Detailed, Speed

6.3 Practice Exercises: Short & Medium Passages
3.1 Writing: Introduction of Writing Skills, Objectives

of enhancing Writing Skills & Types of Writing

6.4 Sentences, Phrases, Types of Sentences, Parts of Sentences

6.5 Paragraph Writing: Construction, Linkage & Cohesion

Text Books/Reference Books:

1. Quantitative Aptitude for Competitive Examinations: R S Aggarwal, S Chand & Company PvtLtd, Edition 2017
2. A Modern Approach to Verbal; Non Verbal Reasoning: R S Aggarwal, S Chand Company Pvt Ltd, Edition 2018
3. Verbal Ability and Reading Comprehension: MVN Enterprises

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CD O303	CAREER SKILLS II	CO1	1	-	-	-	-	1	-	-	-	-	-
		CO2	1	-	-	2	-	-	-	-	-	-	-
		CO3	1	-	-	-	-	1	-	-	-	-	-
		CO4	1	-	-	1	-	-	-	-	1	3	-
		CO5	1	-	-	1	-	1	-	-	1	3	-
		CO6	1	2	-	1	1	1	1	1	1	3	1

Semester-VI

Course Code	Course Name	Offering Department	Course Type	Structure			Credits
				Deptt./Allied Core/Elective / Audit	L	T	
CHH308B/ CHH309B	FOOD CHEMISTRY/ INSTRUMENTAL METHOD OF CHEMICAL ANALYSIS	CH	ELECTIVE	3	1	0	4
CHH310B/ CHH311B	CHEMICALS & ENVIRONMENT /CLINICAL & PHARMACEUTICAL CHEMISTRY	CH	ELECTIVE	3	1	0	4
CHH312B	MAJOR PROJECT	CH	CORE	0	0	0	8
CDO305	CAREER SKILLS-III	CH	AUDIT	2	0	0	NIL
TOTAL (L-T-P) /CREDITS)				8	2	0	16

Course Title/Code	Food Chemistry (CHH308B)	
Course Type	Core	
L-T-P Structure	3-0-0	
Credits	4	
Course Objective	The student learn about the basic knowledge in Food Chemistry, modern trends in the food industry and the food analysis	
	Course Outcomes (COs)	Mapping
CO1	To gain knowledge about basic definitions involved in food chemistry and determination of health by understanding about balanced diet.	Skill Development
CO2	Discuss the basics of food constituents their functions and classifications.	Skill Development
CO3	Differentiate food and food additives, identify types of additive, its purpose and functions	Skill Development
CO4	Identify the importance of nutrients, balanced diet, intentional and un-intentional food additives.	Skill Development
Prerequisites	Biomolecules and natural Product	

FOOD CHEMISTRY (CHH308 B)

SECTION-A

Introduction

Basic definitions of food– nutrition – health – nutritional status – malnutrition – under nutrition – over nutrition; functions of food (physiological, social and psychological) – food groups (cereal grains and products, pulses and legumes, milk and meat products, fruits and vegetables, fats and sugar); basic concept of a balanced diet. Determinants of health; food preparation - objectives and methods of cooking (moist heat method – boiling – steaming - pressure cooking – stewing; combination – braising; dry heat – frying – baking – roasting - grilling or broiling) – effects of cooking (color – texture – nutrients).

SECTION-B

Constituents of foods

Proteins – functions & classification (on the basis of – functions – size, shape and solubility – location); amino acids (essential – non-essential); formation of peptides (body synthesis – food derived); food sources of proteins; consequences of deficiency of proteins.

Carbohydrates – functions & classification (monosaccharides – disaccharides – oligosaccharides – polysaccharides); food sources; consequences of inadequate intake; introduction and functions of dietary fibers

Lipids – functions & classification (simple – compound – derived); introduction of fatty acids – degree of saturation; food sources; consequences of inadequate intake

SECTION C

Foods & Food Additives

Vitamins – general functions & basic classification (fat & water soluble); general functions; food sources and consequences of inadequate intake.

Minerals – general functions & basic classification (major – trace); general food sources; utilization and consequences of inadequate intake of calcium and iron.

Water – functions; components of body fluids (intra- and extra-cellular); water balance – water intake (liquid– solids– metabolic); water output (lungs–skin); water imbalance – dehydration (causes & prevention) – water intoxication-

SECTION D

Nutrition & Balanced Diet Nutrition

Food additives – Definition, types intentional and unintentional, functions – beneficial & unlawful intentions, general principles for the use of additives, artificial sweeteners – saccharin, cyclamate, aspartame; flavor/taste enhancers – monosodium glutamate (MSG); Preservatives and food preservation – reasons of food spoilage – principle of food preservation – methods - heat (pasteurization – boiling – canning) – cold – dehydration. Special food – Introduction of mushroom and spirulina

Reference Books:

Swaminathan M. Advanced Text Book on Food and Nutrition, volume I and II Printing and Publishing CO., Ltd., Bangalore. 1993.

Swaminathan M. Text Book on Food chemistry, Printing and Publishing CO., Ltd., Bangalore. 1993.

Norman N. Potter , Food science, CBS publishers and distributors, New Delhi. 1994.

Lillian Hoagoland Meyer, Food Chemistry, CBS publishers and distributors, New Delhi.1994.

Owen R Fennema, Food Chemistry, Marcel Decker Inc., New York. 1996.

Srilakshmi B., Food Science, New age International Pvt. Ltd. Publishers, III ed. 2003.

Siva Sankar B., Food Processing and Preservation. Prentice – Hall of India Pvt. Ltd., New Delhi. 2002.

Ramakrishnan S., Prasannam K.G and Rajan R –Principles. Text book of medical biochemistry. Orient Longman Ltd. III ed. 2001.

Shakuntala Manay N. and Shadaksharaswamy M. FOODS: Facts and Principles. New Age International Pvt. Ltd. Publishers, II ed. 2002.

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH308B	Food Chemistry	CO1	-	2	-	-	-	-	-	-	1	1	-
		CO2	-	2	-	-	-	1	-	-	1	1	-
		CO3	-	2	-	-	-	-	-	-	1	1	-
		CO4	-	2	-	-	-	-	-	-	1	1	-

Course Title/Code	Instrumental Methods of Chemical Analysis (CHH309B)	
Course Type	Core	
L-T-P Structure	3-0-0	
Credits	4	
Course Objective	To impart knowledge on various spectroscopic techniques like UV-Vis and IR. To make the student understand various chromatographic techniques of separation	
	Course Outcomes (COs)	Mapping
CO1	To identify (by wavelength, wavenumber, or both) the region of the electromagnetic spectrum which is used in infrared (IR) spectroscopy and its application in various instrumental techniques.	Skill Development
CO2	To understand advanced spectroscopic techniques with interpretation .	Skill Development
CO3	To acquire the skills to evaluate strengths and limitations of different chromatographic separation and detection techniques with respect to sample properties and to specific analytical problems	Employability
CO4	To understand the various elemental analysis with knowledge of interpreting data.	Employability
Prerequisites	Nil	

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS (CHH309 B)

SECTION A

Introduction to Spectroscopic Methods of Analysis

Qualitative & Quantitative Analysis

Treatment of analytical data, including error analysis, Classification of analytical methods and the types of instrumental methods, Consideration of electromagnetic radiation

Infrared Spectroscopy

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), and interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR), Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

SECTION B

Atomic Spectroscopy

Emission, absorption, fluorescence and photoacoustic Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).

SECTION C

Separation Techniques

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

SECTION D

Mass Spectroscopy

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

Reference Books:

D.A. Skoog, F.J. Holler & S. Crouch (ISBN 0-495-01201-7) Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.

Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, 7th ed, IBH Book House, Ndl.

P. W. Atkins, J. D. Paula, Physical Chemistry, 10th Ed., Oxford University Press (2014).

R. Kakkar, Atomic and Molecular Spectroscopy: Concepts and Applications. Cambridge University Press, 2015.

G. W. Castellan, Physical Chemistry 4th Ed., Narosa (2004).

C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy 4thEd. TMH New Delhi

B. C. Smith, Infrared Spectral Interpretations: A Systematic Approach. CRC Press, 1998.

W. J. Moore, Physical Chemistry Orient Blackswan, 1999.

D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, Cengage Learning India.

H. H. Willard, L. L. Merritt, J. Dean, F. A. Settoe, Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmon

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHH309B	Instrumental Methods of Chemical Analysis	CO1	-	1	2	-	-	2	-	-	-	1	-
		CO2	-	1	2	-	-	2	-	-	-	1	-
		CO3	-	1	2	-	-	2	-	-	-	1	-
		CO4	-	1	2	-	-	2	-	-	-	1	-

Course Title/Code	Chemicals & Environment (CHS310B)	
Course Type	Core	
L-T-P Structure	3-0-0	
Credits	4	
Course Objective	The student is expected to learn about the production process of industrial chemical and their impact on environment and human health, metal toxicity and its remediation process, Atmospheric composition and air pollution and its control measures and Chemistry of water and wastewater treatment processes.	
Course Outcomes (COs)		Mapping
CO1	To Demonstrate knowledge of chemical principles of fundamental environmental processes in air, water, and soil.	Skill Development
CO2	Discuss the production process of industrial chemical and their impact on environment and human health.	Skill Development
CO3	Explain Atmospheric composition and air pollution and its control measures.	Skill Development
CO4	Describe water purification and waste treatment processes and the practical chemistry involved	Skill Development
Prerequisites	Nil	

SECTION A

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.

SECTION B

METALS AND ENVIRONMENT

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology, Heavy metals - Chemical speciation – Speciation of Hg & As, Bioaccumulation, biomagnification, metal remediation by physical, chemical and biological methods

SECTION C

ENVIRONMENT AND ITS SEGMENTS

Ecosystems: Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere

Atmosphere: Structure and composition of atmosphere, Lapse rate (Environmental and Adiabatic lapse rate), inversion phenomenon and its classification, Cloud formation and CCN mechanism, Photochemical smog, mechanism of ozone depletion, Global warming and green-house gases, National Ambient Air Quality Standards and Air quality Index

SECTION D

WATER POLLUTION

Chemistry of water its physical and chemical properties, Water quality parameters, DO sag curve, Concept of BOD and COD

WATER PURIFICATION METHODS

Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange).

Reference Books:

E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.

R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.

J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.

K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.

S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

S.E. Manahan, Environmental Chemistry, CRC Press (2005).

G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).

A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHS310B	Chemicals & Environment	CO1	-	1	-	-	1	-	-	-	-	1	-
		CO2	-	1	-	-	1	-	-	-	-	1	-
		CO3	-	1	-	-	1	-	-	-	-	1	-
		CO4	-	1	-	-	1	-	-	-	-	1	-

Course Title/Code	Clinical & Pharmaceutical Chemistry(CHS311B)	
Course Type	Core	
L-T-P Structure	3-0-0	
Credits	4	
Course Objective	The student is expected to learn about composition and properties of disinfectants, antiseptics, important drugs, their mode of actions, enzymes and body fluids	
	Course Outcomes (COs)	Mapping
CO1	To gain knowledge about various reagents, separation, estimation, variables and specifications of drug samples	Skill Development
CO2	Discuss the basic structure, metabolism, and analytical methods of amino acids and proteins	Skill Development
CO3	Explain about enzymatic activity, its mechanism, identification and classification of enzymes.	Skill Development
CO4	Describe glucose metabolism, methods of its measurement and its functionalities	Skill Development
Prerequisites	Nil	

SECTION A

Basic Principles and Practices

Reagents, Chemicals, Reference Materials, Water Specifications, basic separation techniques, laboratory mathematics and calculations, concentrations, dilutions, types of samples, sample procession, sample variables, Reference values and method of their determination

SECTION B

Amino Acids and Proteins

Basic Structure, Metabolism, Essential & Nonessential Amino Acids, Amino Acid Analysis, Proteins: Catabolism and Nitrogen Balance, Nitrogen Content, Charge and Isoelectric Point. Plasma Proteins: Prealbumin (Transthyretin), Albumin, Globulins. Other proteins of importance: Myoglobin, Troponin (cTn), Brain Natriuretic Peptide and N-Terminal–Brain, Natriuretic Peptide, Fibronectin, Cystatin C, Amyloid. **Total protein abnormalities:** Hypoproteinemia, Hyperproteinemia. Methods of analysis: Total Nitrogen, Total Proteins, Fractionation, Identification, and Quantitation of Specific Proteins, Serum Protein Electrophoresis, High-Resolution Protein Electrophoresis. Proteins in other body fluids: Urinary Protein, Cerebrospinal Fluid Proteins

SECTION C

Enzymes

General properties and definitions, enzyme classification and nomenclature, Enzyme kinetics: Catalytic Mechanism of Enzymes, Factors That Influence Enzymatic Reactions, Measurement of Enzyme Activity, Calculation of Enzyme Activity, Measurement of Enzyme Mass, Enzymes as

Reagents. Enzymes of clinical significance: Creatine Kinase, Lactate Dehydrogenase, Aspartate Aminotransferase, Alanine Aminotransferase, Alkaline Phosphatase, Acid Phosphatase, Amylase, Lipase, Glucose-6-Phosphate Dehydrogenase, Drug-Metabolizing Enzymes

SECTION D

Carbohydrates & Electrolytes

Glucose Metabolism, Regulation of Carbohydrate Metabolism. Hyperglycemia, hypoglycemia (Genetic Defects in Carbohydrate Metabolism), Methods of Glucose Measurement, Self-Monitoring of Blood Glucose, Glucose Tolerance and 2-Hour Postprandial Tests, Glycosylated Hemoglobin/Hemoglobin A1c, Ketones, Microalbuminuria

Water: Osmolality. The electrolytes: Sodium, Potassium, Chloride, Bicarbonate, Magnesium, Calcium, Phosphate, Lactate. Anion gap, electrolytes and renal function

Reference Books:

1. O. Le Roy, Natural and synthetic organic medicinal compounds, Ealemi., 1976.
2. B. L. Oser, Hawk's physiological chemistry, 14th edition, Tata-McGraw – Hill Publishing Co.Ltd, 1965
3. O. Kleiner, J. Martin, Bio-Chemistry, Prentice-Hall

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHS311B	Clinical & Pharmaceutical Chemistry	CO1	-	1	-	-	-	-	-	-	1	1	-
		CO2	-	1	-	-	-	-	-	-	1	1	-
		CO3	-	1	-	-	-	-	-	-	1	1	-
		CO4	-	1	-	-	-	-	-	-	1	1	-

Course Title/Code	Major project (CHN312B)	
Course Type	Core	
L-T-P Structure	0-0-8	
Credits	8	
Course Objective	To skill students to identify the problem related to chemistry and environment and explore the it's solution	
Course Outcomes (COs)		Mapping
CO1	To apply theoretical knowledge and practical skills to a research project and on the collection and analysis of scientific data	Skill Development
CO2	Work independently and collaboratively with peers to bring the project to satisfactory completion	Skill Development
CO3	Communicate a scientific argument convincingly at a level and style appropriate to the audience	Employability
Prerequisites	Knowledge of Mini Project I (CHN204B)/ Mini project II (CHN210B)/ Minor Project (CHN307B)	

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CHN312 B	Major Project	CO1	3	3	1	-	3	3	-	-	2	2	-
		CO2	3	3	1	-	3	3	-	-	2	2	-
		CO3	3	3	2	-	3	3	-	-	2	2	-
		CO4	3	3	2	-	3	3	-	-	2	2	-

Course Title/Code	Career Skills III – CDO305	
Course Type	Core	
L-T-P Structure	2-0-0	
Credits	2	
Course Objective	To prepare students for placements, Interviews	
Course Outcomes (COs)		Mapping
CO1	Recognize problem based on Modern Mathematics and Algebra	Employability
CO2	Solve basic to moderate level problems based on Mensuration and Geometry.	Employability
CO3	Calculate solution to logical reasoning.	Employability
CO4	Get proficient in resume building and drafting effective cover letters.	Employability
CO5	Enhance their ability to write, read, comprehend and communicate effectively to increase the productivity of business.	Employability
CO6	Prepare for placements and manage interviews effectively.	Employability

Part A – Quantitative Aptitude

Unit 1 : Permutation and Combination

1.1 Principal of counting and Basic formulas

- 1.2 Arrangements, Selection and Selection + Arrangement.
 1.3 Linear/Circular arrangements, Digits and Alphabetic Problems and Applications.

Unit 2 : Probability

- 2.1 Events and Sample Space, Basic Formulas.
 2.2 Problems on Coins, Cards and Dices.
 2.3 Conditional Probability, Bayes' Theorem and their Applications.

Unit 3: Verbal & Non-Verbal Reasoning

- 3.1 Calendar
 3.2 Puzzle Test
 3.3 Non-Verbal Reasoning

Part B - Employability Enhancement

Unit 4: Professional Writing

- 4.1. Profiling on Social Sites: LinkedIn, Facebook, Instagram
 4.2. Cover Letter/Emails
 4.3. Resume Writing

Unit 5: Group Discussions

- 5.1. Do's and Dont's of a Group Discussion
 5.2. Roles played in a Group Discussion
 5.3. Tips for Cracking a Group Discussion

Unit 6: Managing Interviews

- 6.1. Developing the employability mindset
 6.2. Preparing for Self -Introduction
 6.3. Researching the employer
 6.4. Portfolio Management
 6.5. Answering Questions in an Interview

CO-PO Mapping

Course Code	Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CD O305	CAR EER SKI LLS -III	CO1	1	-	-	-	-	1	-	-	-	-	-
		CO2	1	-	-	2	-	-	-	-	-	-	-
		CO3	1	-	-	-	-	1	-	-	-	-	-
		CO4	1	-	-	1	-	-	-	-	1	3	-
		CO5	1	-	-	1	-	1	-	-	1	3	-
		CO6	1	2	-	1	1	1	1	1	1	1	3

Manav Rachna University
Department of Chemistry
Mapping of Course Outcomes with Program Outcomes
Program: BSc. (H) Chemistry

SEMESTER I												
Subject code	Subject Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MAH110B	FUNDAMENTAL OF MATHEMATICS	0	0	0	2	0	0	0	2	0	3	2
MAH105B	STATISTICAL MATHEMATICS	0	0	0	2	0	0	0	2	0	3	2
PHH106B-T	ESSENTIALS OF PHYSICS	3	2	2	0	3	0	0	0	2	2	3
PHH106B-P	ESSENTIALS OF PHYSICS LAB	3	3	3	3	3	3	0	0	2	2	2
HLS102	COMMUNICATIVE ENGLISH	0	0	0	1	0	0	0	3	0	0	1
CSH105B-T	PROGRAMMING FOR PROBLEM SOLVING	3	3	3	0	0	0	0	0	3	3	3
CSH105B-P	PROGRAMMING FOR PROBLEM SOLVING LAB	3	3	3	0	0	0	0	0	3	3	3
CHH101B-T	GREEN CHEMISTRY	3	2	0	3	3	0	0	0	2	2	3
CHH101B-P	GREEN CHEMISTRY LAB	3	2	0	3	3	0	0	0	2	2	2
SEMESTER II												
CHH102B-T	PHYSICAL CHEMISTRY-I	3	3	2	3	2	2	2	0	3	2	2
CHH102B-P	PHYSICAL CHEMISTRY-I LAB	2	2	2	3	2	3	1	0	3	2	1
CHH103B-T	INORGANIC CHEMISTRY-I	2	0	0	2	0	0	0	0	0	0	1
CHH103B-P	INORGANIC CHEMISTRY-I LAB	2	1	0	1	0	0	0	0	0	0	0
CHH104B-T	ORGANIC CHEMISTRY-I	3	2	0	3	3	0	0	0	2	2	3
CHH104B-P	ORGANIC CHEMISTRY-I LAB	3	2	0	3	3	0	0	0	2	2	3
CHH137	ENVIRONMENTAL SCIENCE	0	0	0	0	0	0	2	3	1	3	0
Semester III												
CHH201B-T	PHYSICAL CHEMISTRY-II	3	2	2	3	2	0	1	0	3	2	2
CHH201B-P	PHYSICAL CHEMISTRY-II LAB	1	3	2	1	1	1	0	0	2	2	2
CHH202B-T	INORGANIC CHEMISTRY-II	3	2	0	0	0	0	0	1	2	3	0
CHH202B-P	INORGANIC CHEMISTRY-II LAB	3	0	0	0	3	0	0	0	0	2	1
CHH203B-T	ORGANIC CHEMISTRY-II	3	0	2	3	3	0	0	2	2	2	3
CHH203B-P	ORGANIC CHEMISTRY-II LAB	3	1	0	2	2	0	0	0	2	2	2
EDS288	APPLIED PSYCHOLOGY	2	2	0	0	2	0	1	0	1	1	2
EDS289	APPLIED PHILOSOPHY	2	2	0	0	2	0	1	0	1	1	2
EDS290	APPLIED SOCIOLOGY	2	2	0	0	2	0	1	0	1	1	2
MCS231	BASICS OF ECONOMICS	2	2	0	0	2	0	1	0	1	1	2
MCS232	INTRODUCTION TO FINANCE	2	2	0	0	2	0	1	0	1	1	2
CDO203	QUANTITATIVE APTITUDE-I	1	2	3	0	2	0	1	0	1	1	3
CHN204B	MINI PROJECT-I	3	3	2	0	3	3	0	0	2	2	0
FLS101	SPANISH	1	1	0	0	1	0	1	0	1	1	1
FLS102	GERMAN	1	1	0	0	1	0	1	0	1	1	1
FLS103	FRENCH	1	1	0	0	1	0	1	0	1	1	1
Semester IV												
CHH205B-T	PHYSICAL CHEMISTRY-III	2	2	2	3	2	2	1	0	3	2	2
CHH205B-P	PHYSICAL CHEMISTRY- III LAB	2	2	2	3	2	2	1	0	3	2	2
CHH206B-T	INORGANIC CHEMISTRY- III	3	0	2	2	2	0	0	0	0	0	3
CHH206B-P	INORGANIC CHEMISTRY- III LAB	3	1	0	0	2	0	0	0	2	2	2
CHH207B-T	ORGANIC CHEMISTRY- III	3	2	0	3	3	0	0	0	2	2	3
CHH207B-P	ORGANIC CHEMISTRY- III LAB	3	2	0	3	3	0	0	0	2	2	3
CHH208B	POLYMER CHEMISTRY	1	0	2	0	3	2	0	0	1	0	1
CHH209B	INDUSTRIAL CHEMISTRY	3	3	3	3	2	3	2	2	2	2	2
CHS234	ENVIRONMENT & SUSTAINABLE DEVELOPMENT	0	0	3	0	0	0	0	0	0	0	3
ECS249	E-WASTE MANAGEMENT	0	0	3	0	0	0	0	0	0	2	3
LWS323	CYBER CRIME & LAWS	0	0	0	2	0	0	1	0	0	2	3
CDO204	QUANTITATIVE APTITUDE-II	1	2	3	0	1	0	1	0	1	1	3
CHN210B	MINI PROJECT-II	3	3	2	0	3	3	0	0	2	2	0
CDO203	CAREER SKILLS-I	1	2	0	2	1	1	1	1	1	3	1
Semester V												
CHH301B-T	PHYSICAL CHEMISTRY-IV	3	2	0	3	3	2	0	0	2	2	3
CHH301B-P	PHYSICAL CHEMISTRY-IV LAB	3	3	3	3	3	3	0	0	2	2	2
CHH302B-T	BIOMOLECULES & NATURAL PRODUCTS	0	0	0	1	1	0	0	0	0	0	1
CHH302B-P	BIOMOLECULES & NATURAL PRODUCTS-LAB	2	1	0	1	1	0	0	0	1	0	0
CHH303B-T	ANALYTICAL CHEMISTRY & SPECTROSCOPY	2	2	2	3	2	2	1	0	3	2	2
CHH303B-P	ANALYTICAL CHEMISTRY & SPECTROSCOPY-LAB	2	2	2	3	2	2	1	0	3	2	2
CHS304B	CHEMISTRY IN AGRICULTURE	0	1	0	0	0	0	0	0	0	1	0
CHS305B	FUEL CHEMISTRY	0	1	0	0	0	0	0	0	0	1	0
CHS306B	NANOTECHNOLOGY	3	3	3	0	0	0	0	0	2	1	0
CHN307B	MINOR PROJECT	3	3	2	0	3	3	0	0	2	2	0
CDO303	CAREER SKILLS-II	1	2	0	2	1	1	1	1	1	3	1
Semester V												
CHH308B	FOOD SCIENCE	0	2	0	0	0	1	0	0	1	1	0
CHH309B	INSTRUMENTAL METHOD OF CHEMICAL ANALYSIS	0	1	2	0	0	2	0	0	0	1	0
CHH310B	CHEMICALS & ENVIRONMENT	0	1	0	0	1	0	0	0	0	1	0
CHH311B	CLINICAL & PHARMACEUTICAL CHEMISTRY	0	1	0	0	0	0	0	0	1	1	0
CHH312B	MAJOR PROJECT	3	3	2	0	3	3	0	0	2	2	0
CDO305	CAREER SKILLS-III	1	2	0	2	1	1	1	1	1	3	1