FACULTY OF APPLIED SCIENCES

DEPARTMENT OF CHEMISTRY

BSc(H) Chemistry

Scheme-B

With Effect From 1st July 2019

B.Sc. (Hons.) Chemistry

Chemistry is one of the branches of science dealing with the structure and behavior of nature with molecular perspective to understand scientific reasoning. The course includes many concepts, such as Nano chemistry, supramolecular chemistry, quantum chemistry, biological chemistry etc. Chemistry is fast moving from being a descriptive field to an exact science, a transition that will increasingly require input from all branches of science. Apart from chemistry, students will also be able to learn Physics, Mathematics and other subjects in this course. In addition, the well-equipped teaching and research laboratories will facilitate the students to develop experimental, analytical and conceptual skills and build their interest in the field of research.

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

PROGRAM OBJECTIVES

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

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

PROGRAM OUTCOMES

After completion of the program, the students will:

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

MANAV RACHNA UNIVERSITY FARIDABAD

DEPARTMENT OF CHEMISTRY

BSc(H) Chemistry (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	Number of Credits
MAH 110-B/ MAH 105-B	Fundamentals of Mathematics/ Statistics-I	MA	Hard	Allied Core	3	1	0	0	4	4
PHH 106 B-T	Essentials of Physics	PH	Hard	Allied Core	3	1	0	0	4	4
PHH 106 B-P	Essentials of Physics-Lab	PH	Practical	Allied Core	0	0	2	0	2	1
HLS 102	Communicative English	HUM	Soft Course	Allied Core	1	0	2	0	3	2
CSH105 B-T	Programming for Problem Solving Using C	CST	Hard	Allied Core	2	1	0	0	3	3
CSH105 B-P	Programming for Problem Solving Using C -Lab	CS	Practical	Allied Core	0	0	2	0	2	1
CHH101 B-T	Green Chemistry	CH	Hard	Core	3	1	0	0	4	4
CHH101 B-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	Number of Credits
CHH 102 B-T	Physical Chemistry-I	CH	Hard	Core	3	1	0	0	4	4
CHH 102 B	Physical Chemistry-I-Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH 103 B-T	Inorganic Chemistry-I	CH	Hard	Core	3	1	0	0	4	4
CHH 103 B-P	Inorganic Chemistry-I-Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH 104 B-T	Organic Chemistry-I	CH	Hard	Core	3	1	0	0	4	4
CHH 104 B-P	Organic Chemistry-I-Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH-135-B	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 (CHN-106-B): 2 CREDITS

SEMESTER-3

Subject code	Subject Name	Offering Department	Course nature (Hard/ Soft/ NTCC)	Course type (Core/ Elective etc)	L	T	P	O	Contact hours per week	Number of Credits
CHH 201 B-T	Physical Chemistry II	**CH**	**Hard**	**Core**	**3**	**1**	**0**	**0**	**4**	**4**
CHH 201 B-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**
CHH 202 B-P	Inorganic Chemistry II-Lab	**CH**	**Practical**	**Core**	**0**	**0**	**3**	**0**	**3**	**1.5**
CHH 203 B-T	Organic Chemistry II	**CH**	**Hard**	**Core**	**3**	**1**	**0**	**0**	**4**	**4**
CHH 203 B-P	Organic Chemistry II-Lab	**CH**	**Practical**	**Core**	**0**	**0**	**3**	**0**	**3**	**1.5**
Odd Semester Open Electives	**Education:** Applied Psychology, **Environment:** Environment and Sustainable Development **Management:** Basics of Economics **LAW:** Constitutional law **Mini Project-I (CHN 204 B)**		**Soft/** **NTCC**	**Elective**	**2** **0**	**0** **0**	**0** **0**	**0** **2**	**2** **0**	**2**
	Foreign Language: German / Spanish / French	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 code	Subject Name	Offering Department	Course nature (Hard/ Soft/ NTCC)	Course type (Core/ Elective etc)	L	T	P	O	Contact hours per week	Number of Credits
CHH 205 B-T	Physical Chemistry III	CH	Hard	Core	3	1	0	0	4	4
CHH 205 B-P	Physical Chemistry III-	CH	Practical	Core	0	0	3	0	3	1.5
CHH 206 B-T	Inorganic Chemistry III	CH	Hard	Core	3	1	0	0	3	4
CHH 206 B-P	Inorganic Chemistry III – Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH 207 B-T	Organic Chemistry III	CH	Hard	Core	3	1	0	0	3	4
CHH 207 B-P	Organic Chemistry III – Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH 208 B / CHH209 B	Polymer Chemistry / Industrial Chemistry	CH	Hard	Core	3	1	0	0	3	4
Even Semester Open Electives	Education: Applied Philosophy **Management:** Introduction to Finance, **Law:** IPR, **Technology:** E-Waste Management **Mini Project-II**, (CHN 210 B)		Soft/ NTCC	Elective	2 0	0 0	0 0	0 2	2 0	2
	Total (L-T-P-O/Contact hours/Credits)				**14 / 12**	**1**	**9**	**3/ 5**	**24/ 22**	**22.5**

SEMESTER-5

Subject code	Subject Name	Offering Department	Course nature (Hard/ Soft/ NTCC)	Course type (Core/ Elective etc)	L	T	P	O	Contact hours per week	Number of Credits
CHH 301 B-T	Physical Chemistry IV	CH	Hard	Core	3	1	0	0	4	4
CHH 301 B-P	Physical Chemistry IV- Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH 302 B-T	Biomolecules & Natural Products	CH	Hard	Core	3	1	0	0	3	4
CHH 302 B-P	Biomolecules & Natural Products – Lab	CH	Practical	Core	0	0	3	0	3	1.5
CHH 303 B-T	Analytical Chemistry & Spectroscopy	CH	Hard	Core	3	1	0	0	3	4
CHH 303 B-P	Analytical Chemistry & Spectroscopy- Lab	CH	Practical	Core	0	0	3	0	3	1.5
Domain Specific Elective	Chemistry in Agriculture (CHS 304 B) / Fuel Chemistry (CHS 305 B) / Nano Technology (CHS 306 B)/ **Minor Project (CHN 307 B)**	CH	Soft/ NTCC	Core Elective	2 0	0 0	0 0	0 2	0 2	2
	Total (L-T-P-O/Contact hours/Credits)				**11/ 09**	**3**	**9**	**2**	**19/ 21**	**22.5**

SEMESTER-6

Subject code	Subject Name	Offering Department	Course nature (Hard/ Soft/ NTCC)	Course type (Core/ Elective etc)	L	T	P	O	Contact hours per week	Number of Credits
CHH 313 B / CHH-314-B	Food Chemiatry / Instrumental Methods of Chemical Analysis	CH	Hard	Elective	3	1	0	0	3	4
CHH-315-B / CHH-316-B	Chemicals & Environment / Clinical & Pharmaceutical Chemistry	CH	Hard	Elective	3	1	0	0	3	4
CHO-317-B	Major Project	CH	NTCC	Core	0	0	0	8	2	8
	Total (L-T-P-O/Contact hours/Credits)				**6**	**2**	**2**	**8**	**8**	**16**

** Student going for Industrial training can opt elective courses in semester 6 as equivalent MOOC course.
** Departmental Core elective subjects will be conducted only when 25% of the students register for particular course.
** Major project will be evaluated by report submission and oral examination.

* Student may opt equivalent MOOC course to map the credits of odd and even semester basket of skill enhancement.

Semester	Classroom Contact hours	Non-teaching Outcome hrs	Credits
First Semester	**23**	**0**	**20**
Second Semester	**23**	**2**	**22.5**
Summer Training	**NA**	**NA**	**2**
Third Semester	**19-21**	**0—2**	**18.5**
Fourth Semester	**19-21**	**0—2**	**18.5**
Fifth Semester	**22-24**	**0—2**	**22.5**
Sixth Semester	**8**	**10**	**16**
Total	**128 to 134**	**12 to 18**	**120**

SEMESTER-1

Course Title/ Code	**Fundamentals of Mathematics (FOM)- MAH110B (For Students not have maths in 10+2)**
Course Type:	Core (Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To equip the students with the concepts of Differentiation, Integration, Ordinary differential equations and Partial differential equations.
Learning Outcomes	The students would be able to apply the concepts of theory of Differentiation, Integration, Ordinary differential equations and Partial differential equations required for solving the mathematical problems and their applications.
Pre-requisites	Basic Knowledge of Mathematics.

	Sections	**Weightage**
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	**100%**

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.

Course Title/ Code	**STATISTICS – I (MAH105B)** **((For Students have maths in 10+2))**
Course Type:	Core (Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To equip the students with the concepts of Measures of Central Tendency, Measures of Dispersion, Skewness, Moments & Kurtosis and Correlation & Regression Analysis.
Learning Outcomes	The students would be able to apply the concepts of Measures of Central Tendency, Measures of Dispersion, Skewness, Moments & Kurtosis and Correlation & Regression Analysis required for solving the mathematical problems and their applications.
Pre-requisites	NA

	Sections	**Weightage**
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	**100%**

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.

Course Title/ Code	**ESSENTIALS OF PHYSICS (PHH106B) T & P**
Course Type:	Core (Departmental/Allied)
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Objectives	To apply the concepts of physics to: 1) different optical phenomena 2) devices based on these phenomena, lasing in gases and solids 3) quantum mechanics and its applications 4) develop and analyze electromagnetic wave equations in different media
Learning Outcomes:	Students will have the Ability to: 1) produce and Analyze the Interference Pattern Due to Division of Amplitude 2) produce required Quality Spectrum and analyze it Using Appropriate Diffraction Grating. 3) measure the Concentration/Purity of Optically Active Materials Using Optical Devices. 4) explain the Construction, Working and Applications of Lasers. 5) solve problem of one dimensional and three dimensional problems using concepts of Quantum Mechanics. 6) to apply electromagnetic wave equations for different media and find out different parameters
Pre-requisite	Student has knowledge of physics upto 10+2 standard

Syllabus	**Sections**	**Weightage**
	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	**100%**

ESSENTIALS OF PHYSICS (PHH106 B-T)

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

Polaization 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

ESSENTIALS OF PHYSICS-LAB (PHH106 B-T)

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

Course Title/ Code	**COMMUNICATIVE ENGLISH (HLS102)**
Course Type:	Core (Allied)
Course Nature:	SOFT
L-T-P-O Structure	(1-0-2-0)
Objectives	1. To equip the students with effective communication skills. 2. To deal extensively with the requirements of Industry. 3. To equip students with the nuances of technical writing. 4. To bridge the gap between college and work-place 5. To understand the genres of English Literature
Outcome	After completion of course students would be able: • To learn about communication process and ways to make communication effective by giving attention to all elements involved. • To understand the value of verbal communication as well as non-verbal aspects of communication in making inter personnel communication effective and intrapersonnel communication insightful. • To gain confidence by enhancing their abilities to articulate their ideas. • To able to scan, skim and revise documents for fruitful reading and comprehension. • To acquire better writing skills in formal communication.
Pre-requisite	Basic knowledge of English

COMMUNICATIVE ENGLISH (HLS102)

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 Correspondenc. 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.

Course Title/ Code	**Programming for Problem Solving Using C(CSH105 B) T & P**
Course Type	Core (Departmental)
Course Nature	Hard
L-T-P-O Structure	(2-1-2-0)
Objectives	Students are able to construct a program of moderate complexity from a specification
Outcome	
Pre-requisite	Basic knowledge of computer operations

	Sections	**Weightage**
Syllabus	A	25%
	B	25%
	C	25%
	D	25%
	TOTAL	**100%**

PROGRAMMING FOR PROBLEM SOLVING USING C (CSH105 B-T)

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, CUnit, GIT, SCRUM, MAKE. Dynamic Memory Allocation.

PROGRAMMING FOR PROBLEM SOLVING USING C (CSH105 B-P)

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 Conepts :

I. Statements
II. Functions
III. Arrays
IV. Structures
V. Pointers
VI. 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

Course Title/ Code	GREEN CHEMISTRY (CHH 101 B) T & P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-2-0)
Objectives	Students are able to demonstrate the necessity and viability of the methods of green chemistry
Outcome	• Recognise the impact of green chemistry on human health and the environment. • Demonstrate the knowledge of the twelve principles of Green Chemistry which they can apply to a range of work places for a safer, less toxic and healthier environment.
Pre-requisite	Basic knowledge of Chemistry

GREEN CHEMISTRY (CHH 101 B-T)

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: Comparision 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 CO_2, 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, H_2O_2, 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.

GREEN CHEMISTRY-LAB (CHH 101 B-P)

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

SEMESTER-2

Course Title/ Code	PHYSICAL CHEMISTRY-I (CHH 102 B) T &P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to make the students understand the different states of matter and various laws governing the properties of solid, liquid and gaseous state. Emphasis will also be on the basic concept of ionic equilibrium and its applications.
Outcome	After the completion of the course, students will be able to, • Learn the states of matter in detail. • Laws governing the solid, liquid and gaseous state. • Have deep understanding methods to study the solid, liquid and gaseous state. • Concept of ionic equilibria and its applications.
Pre-requisite	Studied Physical Chemistry in 10+2 level

PHYSICAL CHEMISTRY-I (CHH 102 B-T)

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, vanderwaals 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 rationalindices, 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.

PHYSICAL CHEMISTRY-I LAB (CHH 102 B-T)

1. **Surface tension measurements using stalagmometer.**
   (a). Determine the surface tension by (i) drop number (ii) drop weight method.
   (b). Study the variation of surface tension with different concentration of detergent solutions. Determine CMC
2. **Viscosity measurement using Ostwald's viscometer.**
   (a). Determination of co-efficient of viscosity of an unknown aqueous solution.
   (b). Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar of PVA.
   (c). Study the variation of viscosity with different concentration of sugar solutions.
3. **Solid State:**
   (a). Indexing of a given powder diffraction pattern of a cubic crystalline system.
4. **pH metry:**
   (a). Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.
   (b). Preparation of buffer solutions of different pH values (i). Sodium acetate-acetic acid (ii). Ammonium chloride-ammonium hydroxide
   (c). pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.
   (d). Determination of dissociation constant of a weak acid.
5. **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. 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).

Course Title/ Code	**INORGANIC CHEMISTRY-I (CHH 103 B) T&P**
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to make the students understand the basic concept of atom and atomic structure, periodic properties of elements and chemical bonding.
Outcome	After the completion of the course, students will be able to, 1. Learn basic concept of atom and its structure in detail. 2. Arrangement of electrons in atom. 3. Concept of s, p, d and f orbitals and their shape using. 4. Understand nature of chemical bonding and concept of molecular orbitals.
Pre-requisite	Basic knowledge of Inorganic Chemistry upto 10+2 level

INORGANIC CHEMISTRY-I (CHH 103 B-T)

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.

INORGANIC CHEMISTRY-I LAB (CHH 103 B-T)

A. Titrimetric Analysis

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

B. Acid-Base Titrations

Principles of acid-base titrations to be discussed.

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

C. Oxidation-Reduction Titrimetry

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

i. Estimation of Fe(II) and oxalic acid using standardized KMnO4solution
ii. Estimation of oxalic acid and sodium oxalate in a given mixture.
iii. 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.

Course Title/ Code	ORGANIC CHEMISTRY-I (CHH 104 B) T&P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to have an understanding the structure and bonding in organic chemistry, electronic displacements, stereochemistry and chemistry of aliphatic and aromatic hydrocarbons
Outcome	After the completion of the course, students will be able to, • Know the basic concepts of organic chemistry. • Understand the basics of reaction mechanism. • Stereochemistry and optical isomerism in organic compounds. • Understand the chemistry of aliphatic and aromatic hydrocarbons.
Pre-requisite	Basic knowledge of organic chemistry upto 10+2 level

ORGANIC CHEMISTRY-I (CHH-104-B-T)
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; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

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

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.

ORGANIC CHEMISTRY-I LAB (CHH 104 B-P)

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water
3. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

7. Detection of extra elements
8. Organic Preparations
   a. Bromination of acetanilide / aniline / phenol
   b. 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)

Course Title/ Code	**Environmental Science (CHH 137 B)**
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(2-0-0-2)
Objectives	1. To make the student identify the areas of environmental degradation 2. To make the student identify the impact of environmental degradation on the surroundings 3. To enable student apply the concept of sustainable development in real life. 4. To help the student to correlate his/her field with various aspects of environment
Outcome	Student will be able to 1. understand the environmental degradation and its surroundings 2. apply the concept of sustainable development 3. correlate field of work with various aspects of environments
Pre-requisite	Nil

ENVIRONMENTAL SCIENCE (CHH-137-B)

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

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
g) Role of an individual in conservation of natural resources.
h) 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:
    a. Forest ecosystem
    b. Grassland ecosystem
    c. Desert ecosystem
    d. 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-sports 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 :-
    a. Air pollution
    b. Water pollution
    c. Soil pollution
    d. Marine pollution
    e. Noise pollution
    f. Thermal pollution

g. 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

SEMESTER-3

Course Title/ Code	PHYSICAL CHEMISTRY-II (CHH 201 B) T &P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	**1.** To develop in depth understanding of thermodynamic laws and their application. **2.** To derive relationship between various equilibrium constants **3.** To derive relation between colligative properties **4.** To understand concept of order and molecularity **5.** To impart depth in kinetics of the reaction
Outcome	After the completion of the course, students will be able to, • Understand the basic concept of chemical thermodynamics and the laws governing. • Learn the basics of systems of variable compositions. • Learn the concept of chemical equilibrium. • Learn solution and colligative properties.
Pre-requisite	Physical Chemistry I

PHYSICAL CHEMISTRY-II (CHH 201 B-T)

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 mono molecular 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)

PHYSICAL CHEMISTRY II LAB- (CHH201 B-P)

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).

Course Title/ Code	INORGANIC CHEMISTRY II (CHH 202 B) T&P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to make the students understand the basic concept of s & p block elements and the concept of metallurgy.
Outcome	After the completion of the course, students will be able to, • Understand general principles of metallurgy. • Understand general characteristics and chemical properties of s & p block elements. • Learn chemical and physical properties of hydrides, oxides, oxo and halides of various groups. • Understand preparation, properties, structures of borazines, silicates, silicons, phosphonitrilic halides, interhalogens and pseudohalogen compounds and clatherate compounds of nobel gases.
Pre-requisite	Inorganic Chemistry-I

INORGANIC CHEMISTRY II (CHH 202 B-T)

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:

(a). General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group.
(b). Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
(c). 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.
(d). 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:

- Phosphonitrilic halides $\{(PNCl_2)_n$ where n = 3 and 4$\}$
- Oxides: oxides of phosphorus, sulphur and chlorine
- Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids 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

INORGANIC CHEMISTRY II LAB (CHH 202 B-P)

A. Iodo/Iodimetric Titrations

i. Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically)
ii. Estimation of antimony in tartar-emetic iodimetrically

B. Complexometric titrations using disodium salt of EDTA

i. Estimation of Mg^{2+}, Zn^{2+}
ii. Estimation of Ca^{2+}

C. Inorganic Preperations

i. Cuprous Chloride, Cu_2Cl_2
ii. Manganese(III) phosphate, $MnPO_4.H_2O$
iii. Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (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.

Course Title/ Code	ORGANIC CHEMISTRY II (CHH 203 B) T & P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to make the students understand the basic concept of some of the functional group chemistry, their methods of synthesis and chemical reactions.
Outcome	After the completion of the course, students will be able to, • Perform inter-conversions of various functional groups in organic chemistry. • Learn the carbon-carbon bond formations, redox reactions with mechanistic understanding. • Understand the stereo chemical aspect of reaction mechanism. • Learn the properties, synthesis and chemical reactions of halogen and/or oxygen containing functional groups in organic chemistry
Pre-requisite	Organic Chemistry-I

ORGANIC CHEMISTRY II (CHH 203 B) T & P

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; SNAr, 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 effecting it, Ring substitution reactions, Reimer Tiemann and Kolbe's Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

***Ethers and Epoxides*:** Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4

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 Meerveing Pondorf Verley reduction. , reduction by LiAlH4 & NaBH4,
Active methylene compounds; Keto-enol tautamerism, 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

ORGANIC CHEMISTRY II LAB (CHH 203 B-P)

A. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.

B. Organic preparations:

i. 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).
ii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
iii. Selective reduction of meta dinitrobenzene to m-nitroaniline.
iv. Hydrolysis of amides and esters.
v. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
vi. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
vii. 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

SEMESTER-4

Course Title/ Code	PHYSICAL CHEMISTRY-III (CHH 205 B) T &P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to 1. develop in depth understanding of phase equilibria in one,two, phases, azeotropic mixtures. 2. develop concept of thermodynamic third law and its applications. 3. understand concept in electrochemical cells 4. To impart depth in surface chemistry
Outcome	After the completion of the course, students will be able to, • Learn basic concept of phase equilibria and their applications. • Understand the qualitative and quantitative aspects of electrochemical cells. • Understand the nature of adsorption and their qualitative analysis. • Learn analytical concepts of various reactions through potentiometric titrations.
Pre-requisite	Physical Chemistry I & Physical Chemistry II

PHYSICAL CHEMISTRY-III (CHH 205 B –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—Hitorfs 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 SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers, Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation), 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 Publicating 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).

PHYSICAL CHEMISTRY III-LAB (CHH 205 B-P)

1. Phase Equibria:

i. 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.

ii. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.

iii. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.

iv. Study the equilibrium of at least one of the following reactions by the distribution method:

(a) $I_2(aq) + I^-(aq) \rightarrow I_3^-(aq)$

(b) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n^{2+}$

2. Potentiometry:

i. Perform the following potentiometric titrations: i. 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:

ii. 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).

Course Title/ Code	INORGANIC CHEMISTRY III (CHH 206 B) T& P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to make the students understand the coordination chemistry, study of d block elements, actinides and lanthanides.
Outcome	After the completion of the course, students will be able to, • Learn coordination chemistry of transition metal complexes. • Understand the chemistry of d-block elements. • Understand chemistry of lanthanides and actinides. • Learn the basics of inorganic reaction mechanism
Pre-requisite	Inorganic Chemistry I & Inorganic Chemistry II

INORGANIC CHEMISTRY III (CHH 206 B-T)

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 octaherdral and tetrahedral complexes, measurement of 10 Dq (Δo), 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

INORGANIC CHEMISTRY III- LAB (CHH 206 B-P)

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 acetylacetone, 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

Course Title/ Code	ORGANIC CHEMISTRY III (CHH 207 B) T & P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	The objective of the course is to make the students understand the properties, synthesis and chemical reactions of nitrogen containing functional groups, polynuclear hydrocarbons, heterocyclic compounds and alkaloids.
Outcome	After the completion of the course, students will be able to, • learn preparations, properties and chemical reactivity of nitrogen containing functional groups, • learn preparations, properties and chemical reactivity of sulphur containing functional groups, • learn preparations, properties and chemical reactivity of polynuclear hydrocarbons, heterocyclic compounds Understand the formation of carbon-hetero atom multiple bond.
Pre-requisite	Organic Chemistry I & Organic Chemistry II

ORGANIC CHEMISTRY III (CHH 207 B-T)

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 mercatans (physical and chemical properties), thioethers or sulphides: method of preparation, propreties (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 SO_3H group and reaction in which $–SO_3H$ group replaced. Uses of suphonic acids (benzenesulphonic acid, benzene suphonyl chloride, Toluenesulphonic acid, Chloramine –T, sulphanilic acid, sulfanilamide: preparation and properties)

SECTION C

Polynuclear hydrocarbons

Polynuclear hydrocarbon or fused ring hydrocarbons: nomenclature

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

Anthracene: structure, synthesis, properties (physical and chemical: sufonation, 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).

ORGANIC CHEMISTRY III-LAB (CHH 207 B-P)

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)

Course Title/ Code	**POLYMER CHEMISTRY (CHH 208 B)**
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	To make the students 1. aware of the emergence of Polymers 2. understand the classification of Polymeric materials 1. Understand thermal, mechanical, electrical properties of polymers 2. analyses microstructure of polymeric materials
Outcome	Student will be able to 1. understand the basics of polymers 2. understand the thermal mechanical properties of polymers and its applications
Pre-requisite	Nil

POLYMER CHEMISTRY (CHH 208 B)

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.

Crystalization & 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).
10. P. Munk & T.M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons
11. 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).

Course Title/ Code	**INDUSTRIAL CHEMISTRY (CHH 209 B)**
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	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.
Outcome	Students will be able to understand 1. the chemistry of materials used in silicate industries 2. the chemistry of cosmatics and perfumes 3. the chemistry and industrial applications of batteries, alloys and catalysts
Pre-requisite	Basic knowledge of Chemistry

INDUSTRIAL CHEMISTRY (CHH 209 B)

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 andexamples) 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).

SEMESTER-5

Course Title/ Code	PHYSICAL CHEMISTRY-IV (CHH 301 B) T &P
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	1. To give an in-depth exposure of Quantum Chemistry 2. To familiarize the students with various spectroscopic techniques like IR, Raman, NMR and ESR.
Outcome	After the completion of the course, students will be able to, • Learn basic concept of Quantum Chemistry and their applications • Able to understand the concept of various spectroscopic techniques • Learn analytical concepts of various spectroscopic techniques
Pre-requisite	Physical Chemistry I, Physical Chemistry II & Physical Chemistry III

PHYSICAL CHEMISTRY-IV (CHH 301B-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 H_2^+. Bonding and antibonding orbitals, Comparison of LCAO-MO and VB treatments of H_2 (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 (BeH_2, H_2O) molecules, Qualitative MO theory and its application to AH_2 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).

PHYSICAL CHEMISTRY IV- LAB (CHH 301 B-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).

Course Title/ Code	**BIOMOLECULES & NATURAL PRODUCTS (CHH 302 B) T&P**
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	Make student 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
Outcome	Explain the structures of biomolecules (carbohydrates, proteins, enzymes, lipids and nucleic acids) and their role in life related processes. The basic types of molecules included are carbohydrates, proteins, enzymes, lipids and nucleic acids.
Pre-requisite	Organic Chemistry I, Organic Chemistry II & Organic Chemistry III

BIOMOLECULES & NATURAL PRODUCTS (CHH 302 B-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:

1. O. P. Agarwal, Chemistry of Natural Products, Vol-1, Goel Publishing House, 1997.
2. I. L. Finar, Organic Chemistry, Vol-2, 5th edition, Pearson education, London, 1975.
3. D. L. Nelson and M. M. Cox, Lehninger´s Principles of Biochemistry 7th Edition, W. H. Freeman

BIOCHEMISTRY & NATURAL PRODUCTS-LAB (CHH 302 B-P)

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 given organic sample.
8. Identification of carbohydrates in given organic sample.
9. Synthesis of Methyl orange dye
10. Extraction of dye from the plant materials.

Course Title/ Code	**ANALYTICAL CHEMISTRY & SPECTROSCOPY (CHH303-B) T&P**
Course Type:	Domain Core
Course Nature:	Hard
L-T-P-O Structure	(3-1-3-0)
Objectives	1. To calculate concentration terms and their inter-conversion 2. To understand basic principles of UV-Vis spectra & analyze spectra 3. To impart the knowledge of separation techniques and physicochemical analysis
Outcome	Student will be able to 1. Understand basic knowledge of UV-Vis spectra & analyze spectra 2. Understand the basic knowledge of separation techniques and physicochemical analysis
Pre-requisite	Nil

ANALYTICAL CHEMISTRY AND SPECTROSCOPY (CHH 303 B-T)

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 molarityMole fraction, Weight ratio, Volume ratio, Weight to volume ratio, ppb, ppm, millimoles, milliequivalents.

SECTION B

Spectroscopy

Intoduction: Gerneral 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 (σ-σ^*, n-σ^*, π-π^* and n-π^*), relative positions of λmax 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 λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis 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).

ANALYTICAL CHEMISTRY AND SPECTROSCOPY LAB (CHH303 B-P)

1. Determination of the amount of oxalic acid & Sulphuric Acid in the given solution titrimetrically.
2. Determination of % composition of $BaSO_4$ and NH_4Cl in the given mixture gravimetrically.
3. Determination of Rf 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 λmax of solution of $KMnO_4$ using a Spectrophotometer and apply it to find out the concentration of given unknown solution.
7. **Any other experiment related to subject**

DOMAIN SPECIFIC ELECTIVES:

Course Title/ Code	**CHEMISTRY IN AGRICULTURE (CHS 304 B)**
Course Type:	Domain Elective
Course Nature:	Soft
L-T-P-O Structure	(2-0-0-0)
Objectives	To provide basic knowledge of chemicals used in agriculture
Outcome	Student will be able to understand the basic reactions properties and uses of chemicals in agriculture
Pre-requisite	Basic knowledge of Chemistry

CHEMISTRY IN AGRICULTURE (CHS 304 B)

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). Defoliants: 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.

Course Title/ Code	FUEL CHEMISTRY (CHS 305 B)
Course Type:	Domain Elective
Course Nature:	Soft
L-T-P-O Structure	(2-0-0-0)
Objectives	To provide basic knowledge of fuels and lubricants
Outcome	Student will be able to understand the basic reactions properties and uses of fuels and lubricants
Pre-requisite	Basic knowledge of Chemistry

FUEL CHEMISTRY (CHS 305 B)

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).

Course Title/ Code	NANO TECHNOLOGY (CHS 306 B)
Course Type:	Domain Elective
Course Nature:	Soft
L-T-P-O Structure	(2-0-0-0)
Objectives	To provide basic multidisciplinary education as well as specialization in one of the subdisciplines of nanoscience and nanotechnologies. nanotechnology To provide scientific knowledge of fundamental structures of chemical, physical and biological sciences in nanoscale
Outcome	Student will be able to understand the basic concept of nanoscience and nanotechnology.
Pre-requisite	Nil

NANO TECHNOLOGY (CHS 306 B)

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)

SEMESTER-6

Course Title/ Code	FOOD CHEMISTRY (CHH308 B)
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	1.To provide the basic knowledge in Food Chemistry and modern trends in the industry. 2.To provide the knowledge to the students in the food analysis
Outcome	Student will be able to understand the chemistry behind the foods and food industry. Student will be able to analyses the food content
Pre-requisite	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:

1. Swaminathan M. Advanced Text Book on Food and Nutrition , volume I and II Printing and Publishing CO., Ltd., Bangalore. 1993.
2. Swaminathan M. Text Book on Food chemistry, Printing and Publishing CO., Ltd., Bangalore. 1993.
3. Norman N. Potter , Food science, CBS publishers and distributors, New Delhi. 1994.
4. Lillian Hoagoland Meyer, Food Chemistry, CBS publishers and distributors, New Delhi.1994.
5. Owen R Fennema, Food Chemistry, Marcel Decker Inc., New York. 1996.
6. Srilakshmi B., Food Science, New age International Pvt. Ltd. Publishers, III ed. 2003.
7. Siva Sankar B., Food Processing and Preservation. Prentice – Hall of India Pvt. Ltd., New Delhi. 2002.
8. Ramakrishnan S., Prasannam K.G and Rajan R –Principles. Text book of medical biochemistry. Orient Longman Ltd. III ed. 2001.
9. Shakuntala Manay N. and Shadaksharaswamy M. FOODS: Facts and Principles. New Age International Pvt. Ltd. Publishers, II ed. 2002.

Course Title/ Code	**INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS (CHH309 B)**
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	1. To impart knowledge on various spectroscopic techniques like UV-Vis and IR 2. To make the student understand various chromatographic techniques of separation
Outcome	Student will be able to 1. understand the various spectroscopic techniques like UV-Vis & IR 2. understand various chromatographic techniques of separation
Pre-requisite	Analytical Chemistry & Spectroscopy

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 photoaccoustic 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, photoaccoustic, 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:

1. D.A. Skoog, F.J. Holler & S. Crouch (ISBN 0-495-01201-7) Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
2. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, 7th ed, IBH Book House, Ndls.
3. P. W. Atkins, J. D. Paula, Physical Chemistry, 10th Ed., Oxford University Press (2014).
4. R. Kakkar, Atomic and Molecular Spectroscopy: Concepts and Applications. Cambridge University Press, 2015.
5. G. W. Castellan, Physical Chemistry 4th Ed., Narosa (2004).
6. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy 4thEd. TMH New Delhi
7. B. C. Smith, Infrared Spectral Interpretations: A Systematic Approach. CRC Press, 1998.
8. W. J. Moore, Physical Chemistry Orient Blackswan, 1999.
9. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, Cengage

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

Course Title/ Code	CHEMICALS & ENVIRONMENT (CHH 310 B)
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	After going through the course the student is expected to learn about 1. The production process of industrial chemical and their impact on environment and human health. 2. The impact of metal toxicity and its remediation process. 3. Atmospheric composition and air pollution and its control measures. 4. Chemistry of water and wastewater treatment process.
Outcome	Student will be able to 1. Understand the processes of industrial chemicals and its impact on environment 2. Understand toxicity and remediation process
Pre-requisite	Nil

CHEMICALS & ENVIRONMENT (CHH 310 B)

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:

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

Course Title/ Code	**CLINICAL & PHARMACEUTICAL CHEMISTRY (CHS 311 B)**
Course Type:	Domain Elective
Course Nature:	Hard
L-T-P-O Structure	(3-1-0-0)
Objectives	After going through the course the student is expected to learn about 1. The disinfectants and antiseptics. 2. The important drugs and the mode of actions. 3. Enzymes & Body fluids
Outcome	Student will be able to understand 1. About chemistry and uses of disinfectant, antiseptic. 2. About drugs and mode of action 3. About enzymes and body fluids
Pre-requisite	Nil

CLINICAL & PHARMACEUTICAL CHEMISTRY (CHS 311 B)

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 of India (P) Ltd, New Delhi, 1974.