

MAHENDRA ARTS & SCIENCE COLLEGE

(AUTONOMOUS)

(Affiliated to Periyar University)

[Accredited by NAAC "A" Grade & Recognized u/s 2(f) and 12(B) of the UGC act 1956]

KALIPPATTI – 637 501.



BACHELOR OF SCIENCE

SYLLABUS FOR B.Sc. Chemistry

OUTCOME BASED EDUCATION - CHOICE BASED CREDIT SYSTEM

**FOR THE STUDENTS ADMITTED FROM
THE ACADEMIC YEAR 2019 – 2020 ONWARDS**

**MAHENDRA ARTS & SCIENCE COLLEGE
(Autonomous)
(Affiliated to Periyar University)**

Department of Chemistry

B.Sc. Chemistry Degree Programme

I- PREAMBLE

Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The developments in chemistry during last few decades are phenomenal. It is also seen that these developments are crossing the traditional vertical boundaries of scientific disciplines. New branches of chemistry are emerging and gaining importance, such as bioorganic chemistry, materials chemistry, nano - chemistry, computational chemistry, etc. A chemist cannot isolate himself from other disciplines. Thus, after a long span of more and more specialization in graduate syllabi, a symbiotic interdisciplinary approach now seems to be more relevant. The practice of Chemistry over a span of more than a century has also created concomitant and perhaps unavoidable impacts of human environment. The chemical industry is now pressurized from both the government and the society to develop eco - friendly processes and products which will reduce waste and prevent toxic substances from entering the environment. The principles and applications of chemistry should be learnt on this background.

II- PROGRAMME OBJECTIVES

- ❖ To learn the applications of chemical agents to provide goods and services for human community by materials processing.
- ❖ To pursue higher education and research in reputed institute at National and International level.
- ❖ To understand the impact of chemistry on basic human needs such as Agriculture, Industry, Medicine, Environment etc.
- ❖ To enrich the knowledge of students on current scenario in chemistry.
- ❖ To work as entrepreneurs and technologist with strong ethics and practical skills.

III- PROGRAMME OUTCOMES

1. Graduates will gain and apply knowledge of Chemistry, Science and Technology concepts to solve problems related to field of Chemistry.
2. Graduates will be able to decide and apply appropriate tools and techniques in chemical manipulation.
3. Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in chemistry practices.
4. Graduates will be able to undertake any responsibility as an individual and as a team in a multidisciplinary environment.
5. Graduates will have thorough knowledge in sciences and will also be ready to engage themselves in lifelong learning.

IV- REGULATIONS

These regulations shall take effect from the academic year 2019-2020, i.e., for students who are to be admitted to the first year of the programme during the academic year 2019-20 and thereafter.

1. Eligibility for Admission:

A candidate who has passed the Higher Secondary examination of Tamilnadu Higher Secondary Board or an examination of some other board accepted by the syndicate as equivalent there to with Chemistry and Physics and any one of the following subjects namely Maths, Botany, Zoology or Biology shall be eligible for admission into B.Sc., programme in Chemistry. However non Mathematics candidates have to take Allied subjects other than Mathematics.

2. Duration of the Programme:

The candidates shall complete all the courses of the programme in 3 years from the date of admission. The programme of study shall consist of six semesters and a total period of three years with a minimum of 142 credits. The programme of study will comprise the course according to the syllabus.

3. Programme of Study:

The programme of study for the UG degree has been divided into the following five categories:

Part I : Tamil / Other Languages.

Part II : English Language.

Part III : Core Courses, Elective Courses and Allied Courses.

Part IV : Skill Enhancement Courses, Non-Major Elective Course, Enhancement Compulsory Courses.

Part V : Value added Courses and Extension Activity.

4. Examinations

The programme of study shall be based on semester pattern with Internal Assessment under Choice Based Credit System.

The examinations for all the papers consist of both Internal (Continuous Internal Assessment - CIA) and External (End Semester) theory examinations. The theory examinations shall be conducted for three hours duration at the end of each semester. The candidates failing in any subjects(s) will be permitted to appear for the same in the subsequent semester examinations.

V- STRUCTURE OF THE PROGRAMME

SEMESTER : I

Part	Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
				L	P		Int.	Ext.	Total
I	LANGUAGE COURSE-I	Tamil – I	M19UFTA01	5	-	3	25	75	100
		French – I	M19UFHI01						
		Hindi – I	M19UFFR01						
II	LANGUAGE COURSE-II	English – I	M19UFTE01	5	-	3	25	75	100
III	CORE COURSE-I	General Chemistry-I	M19UCH01	7	-	5	25	75	100
III	ALLIED COURSE-I	Allied-I - Mathematics-I	M19UMAA01	5	-	4	25	75	100
		Allied-I - Biochemistry-I	M19UBCA01						
III	CORE PRACTICAL -I	Practical-I – Inorganic Volumetric Analysis	M19UCHP01	-	3	3	40	60	100
III	ALLIED PRACTICAL -I	Allied Practical-I- Mathematics	M19UMAAP01	-	3	-	-	-	-
		Allied Practical-I- Biochemistry	M19UBCAP03						
V	ENHANCEMENT COMPULSORY COURSE	Value Education – Yoga	M19UVE01	2	-	2	25	75	100
Total				24	6	20	165	435	600

SEMESTER: II

Part	Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
				L	P		Int.	Ext.	Total
I	LANGUAGE COURSE-I	Tamil – II	M19UFTA02	5	-	3	25	75	100
		French – II	M19UFHI02						
		Hindi – II	M19UFFR02						
II	LANGUAGE COURSE-II	English – II	M19UFTE02	5	-	3	25	75	100
III	CORE COURSE-II	General Chemistry-II	M19UCH02	7	-	5	25	75	100
III	ALLIED COURSE-II	Allied-II - Mathematics-II	M19UMAA02	5	-	4	25	75	100
		Allied-II - Biochemistry-II	M19UBCA02						
III	CORE PRACTICAL –II	Practical-II - Organic and Inorganic preparation	M19UCHP02	-	3	3	40	60	100
III	ALLIED PRACTICAL –I	Allied Practical-I- Mathematics	M19UMAAP01	-	3	3	40	60	100
		Allied Practical-I- Biochemistry	M19UBCAP03						
V	ENHANCEMENT COMPULSORY COURSE	Environmental studies	M19UES01	2	-	2	25	75	100
Total				24	6	23	205	495	700

SEMESTER: III

Part	Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
				L	P		Int.	Ext.	Total
I	LANGUAGE COURSE-I	Tamil – III	M19UFTA03	5	-	3	25	75	100
		French – III	M19UFHI03						
		Hindi – III	M19UFFR03						
II	LANGUAGE COURSE-I	English – III	M19UFTE03	5	-	3	25	75	100
III	CORE COURSE-III	General Chemistry-III	M19UCH03	6	-	5	25	75	100
III	ALLIED COURSE-III	Allied-III - Physics-I	M19UPHA03	4	-	4	25	75	100
III	CORE PRACTICAL –III	Practical-III - Inorganic Qualitative Analysis	M19UCHP03	-	3	3	40	60	100
III	ALLIED PRACTICAL –II	Allied Practical-II- Physics	M19UPHAP03	-	3	-	-	-	-
IV	SEC- I	SEC-I - Food and Nutrition	M19UCHS01	2	-	2	25	75	100
IV	NMEC-I	NMEC-I		2	-	2	25	75	100
Total				24	6	22	190	510	700

SEMESTER: IV

Part	Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
				L	P		Int.	Ext.	Total
I	LANGUAGE COURSE-I	Tamil – IV	M19UFTA04	5	-	3	25	75	100
		French – IV	M19UFHI04						
		Hindi – IV	M19UFFR04						
II	LANGUAGE COURSE-II	English – IV	M19UFTE04	5	-	3	25	75	100
III	CORE COURSE-IV	General Chemistry-IV	M19UCH04	6	-	5	25	75	100
III	ALLIED COURSE-IV	Allied-IV - Physics-II	M19UPHA04	4	-	4	25	75	100
III	CORE PRACTICAL –IV	Practical-IV – Organic Estimation & Physical Constant	M19UCHP04	-	3	3	40	60	100
III	ALLIED PRACTICAL –II	Allied Practical-II- Physics	M19UPHAP03	-	3	3	40	60	100
IV	SEC- II	SEC-II - Industrial Chemistry	M19UCHS02	2	-	2	25	75	100
IV	NMEC-II	NMEC-II		2	-	2	25	75	100
V	EXTENSION ACTIVITIES	Extension Activities	M19UEX01	-	-	1	-	-	-
Total				24	6	26	230	570	800

SEMESTER: V

Part	Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
				L	P		Int.	Ext.	Total
III	CORE COURSE-V	Inorganic Chemistry-I	M19UCH05	6	-	5	25	75	100
III	CORE COURSE-VI	Organic Chemistry-I	M19UCH06	6	-	5	25	75	100
III	CORE COURSE-VII	Physical Chemistry-I	M19UCH07	5	-	5	25	75	100
III	ELECTIVE COURSE-I	Elective-I		5	-	4	25	75	100
III	CORE PRACTICAL -V	Practical-V - Organic Analysis	M19UCHP05	-	3	3	40	60	100
III	CORE PRACTICAL -VI	Practical-VI - Physical Chemistry Experiments	M19UCHP06	-	3	3	40	60	100
IV	SEC- III	SEC-III - Pharmaceutical Chemistry	M19UCHS03	2	-	2	25	75	100
Total				24	6	27	205	495	700

SEMESTER: VI

Part	Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
				L	P		Int.	Ext.	Total
III	CORE COURSE-VIII	Inorganic Chemistry-II	M19UCH08	6	-	5	25	75	100
III	CORE COURSE-IX	Organic Chemistry-II	M19UCH09	6	-	5	25	75	100
III	CORE COURSE-X	Physical Chemistry-II	M19UCH10	6	-	5	25	75	100
III	ELECTIVE COURSE-II	Elective-II		5	-	4	25	75	100
III	CORE PRACTICAL -VII	Practical-VII - Inorganic Estimation	M19UCHP07	-	5	3	40	60	100
IV	SEC- IV	SEC-IV - Green Chemistry	M19UCHS04	2	-	2	25	75	100
Total				25	5	24	165	435	600

Summary of Credits, Hours and Mark Distribution

Part	Course Name	No. of Credits						Total Credits	Total Hours	No. of Courses	Max. Marks
		I	II	III	IV	V	VI				
I	Language – I	3	3	3	3	-	-	12	20	4	400
II	Language – II	3	3	3	3	-	-	12	20	4	400
III	Core	5	5	5	5	15	15	50	63	10	1000
	Core Practical	3	3	3	3	6	3	21	23	7	700
	Elective	-	-	-	-	4	4	8	8	2	200
	Allied	4	4	4	4	-	-	16	18	4	400
	Allied Practical	-	3	-	3	-	-	6	12	2	200
IV	SEC	-	-	2	2	2	2	8	8	4	400
	NMEC	-	-	2	2	-	-	4	4	2	200
	Enhancement Compulsory Courses	2	2	-	-	-	-	4	4	2	200
	Extension Activities	-	-	-	1	-	-	1	-	1	-
Total		20	23	24	26	27	24	142	180	42	4100

ALLIED SUBJECTS FOR B.Sc. CHEMISTRY STUDENTS

Semester	Course Title	Course Code
I	Allied-I - Mathematics-I	M19UMAA01
	Allied-I - Biochemistry-I	M19UBCA01
II	Allied-II - Mathematics-II	M19UMAA02
	Allied-II - Biochemistry-II	M19UBCA02
	Allied Practical-I – Mathematics	M19UMAAP01
	Allied Practical-I – Biochemistry	M19UBCAP03
III	Allied-III - Physics-I	M19UPHA03
IV	Allied-IV - Physics-II	M19UPHA04
	Allied Practical-II - Physics	M19UPHAP03

ALLIED SUBJECTS OFFERED FOR OTHER MAJOR STUDENTS

Semester	Course Title	Course Code
III	Allied-III - Chemistry-I	M19UCHA03
IV	Allied-IV - Chemistry-II	M19UCHA04
	Allied Practical-II – Chemistry	M19UCHAP03

ELECTIVE SUBJECTS FOR B.Sc. CHEMISTRY STUDENTS

Semester	ELECTIVE – I	
	Course Title	Course Code
V	Analytical Chemistry	M19UCHE01
	Polymer Chemistry	M19UCHE02
	Chromatography Technique	M19UCHE03
	Material Science	M19UCHE04
ELECTIVE – II		
	Course Title	Course Code
VI	Dairy Chemistry	M19UCHE05
	Spectroscopy	M19UCHE06
	Bio-Inorganic Chemistry	M19UCHE07
	Corrosion Science	M19UCHE08

SKILL ENHANCEMENT COURSES

Semester	Course Title	Course Code
III	SEC-I - Food and Nutrition	M19UCHS01
IV	SEC-II - Industrial Chemistry	M19UCHS02
V	SEC-III - Pharmaceutical Chemistry	M19UCHS03
VI	SEC-IV - Green Chemistry	M19UCHS04

NON - MAJOR ELECTIVE COURSES [FOR OTHER DEPARTMENTS]

Semester	Course Title	Course Code
III	NMEC-I - Applied Chemistry	M19NCH01
	NMEC-I - Agro Industrial Chemistry	M19NCH02
IV	NMEC-II - Food Chemistry	M19NCH03
	NMEC-II - Biological Chemistry	M19NCH04

VI- SCHEME OF EXAMINATION

1. Question Paper Pattern for Theory Examination

Time: Three Hours

Maximum Marks: 75

Part A: (10 x 1 = 10)

Answer ALL Questions

(Objective Type - Two Questions from each unit)

Part B: (5 x 2 = 10)

Answer ALL Questions

(One Question from each unit)

Part C: (5 x 5 = 25)

Answer ALL Questions

(One Question from each unit with internal choice)

Part D: (3 x 10 = 30)

Answer Any Three out of Five Questions

(One Question from each unit)

2. Question Paper Pattern for Practical Examination

QUESTION PATTERN

Practical	:	50 Marks
Viva Voce	:	05 Marks
Record	:	05 Marks

Total	:	60 Marks

3. Distribution of Marks:

The following are the distribution of marks for external and internal for End Semester Examinations and Continuous Internal Assessment and passing minimum marks for Theory / Practical of UG programmes.

ESE	EA Total	Passing Minimum for EA	CIA Total	Passing Minimum for CIA	Total Marks Allotted	Passing Minimum for ESE
Theory	75	30	25	10	100	40
Practical	60	24	40	16	100	40

The following are the Distribution of marks for the Continuous Internal Assessment in Theory / Practical courses of UG programme.

THEORY

EVALUATION OF INTERNAL ASSESSMENT

Test : 15 Marks
Assignment : 05 Marks
Attendance : 05 Marks

Total : 25 Marks

The Passing minimum shall be 40% (10 Marks) out of 25 Marks.

PRACTICAL

EVALUATION OF INTERNAL ASSESSMENT

Test 1 : 15 Marks
Test 2 : 15 Marks
Record : 10 Marks

Total : 40 Marks

The Passing minimum shall be 40% (16 Marks) out of 40 Marks.

4. Passing Minimum:

The Candidates shall be declared to have passed the examination if he/she secures not less than 40 marks in total (CIA mark + Theory Exam mark) with minimum of 30 marks in the End Semester Theory Examinations.

The Candidates shall be declared to have passed the examination if he/she secures not less than 40 marks in total (CIA mark + Practical Exam mark) with minimum of 24 marks in the End Semester Practical Examinations.

5. Submission of Record Note Books for Practical Examination:

Candidates appearing for practical examinations should submit a bonafide record note books prescribed for practical examinations. The candidates failed to submit the record book shall not be permitted to appear for the practical examinations.

VII- NOTE

a) SWAYAM / MOOC – Free Online Education

SWAYAM / MOOC is an instrument for self-actualisation providing opportunities for a life-long learning. Here the student can choose from hundreds of courses, virtually every course taught at the college level, offered by the best teachers in India and elsewhere.

The students can choose an online SWAYAM / MOOC course during their period of study which will earn an extra credit and it will be transferred to the academic records of the students.

b) Add-on courses

Students are provided with additional courses during their course of study right from the First year. Students are free to choose the courses. On successful completion of each course, the students will gain one extra credit.

SEMESTER - I

CORE COURSE-I	B.Sc. Chemistry	2019-2020
M19UCH01	GENERAL CHEMISTRY-I	
Credits: 5		

Objectives

This course gives knowledge on atomic structure, electronic configuration, periodic properties, Thermodynamics, hybridization, gaseous state, Volumetric analysis and organic reaction intermediates.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Impart essential theoretical knowledge on atomic structure, electronic structure.	K1
CO2	Sketch the periodic properties and Hydrogen.	K4
CO3	Understand the gaseous and liquid state.	K2
CO4	Know the concept of resonance effect, intermediate structure and stability.	K3
CO5	Apply the Lab safety measures and learn the principles of volumetric analysis.	K4

UNIT I

Atomic structure: Rutherford model - Bohr model - Hydrogen atom spectra - de Broglie's concept - dual nature, Quantum numbers - Wave mechanical concept of atom - Schrodinger's wave equation (derivation not needed) - significance of Ψ and Ψ^2 - Eigen functions and Eigen values - shapes of different orbitals - Differences between an orbit and orbital.

Electronic Structure: Pauli's Exclusion principle and its application - Hund's rule - its basis and applications - stability of half filled and fully - filled orbitals - Aufbau principle and its limitations. Heisenberg's uncertainty principle - Division of elements in periodic table (s, p, d and f blocks).

UNIT II

Atomic properties: Atomic radius - Covalent radius - van der Waals radius - Ionic radius and their periodic trends. Ionisation Energy - Electron affinity - Electronegativity: Determination- Pauling, Mulliken-Jaffe, Allred - Rochow methods.

Hydrogen: Electronic structure, position in the periodic table, abundance, preparation and properties, isotopes, ortho and para hydrogen.

UNIT III

Gaseous state: Concept of ideal and real gases, gas laws, Postulates of kinetic theory of gases (no derivation). Maxwell's distribution of molecular velocities (Derivation not needed). Types of molecular velocities - mean, most probable and root mean square velocities - Interrelationships. Collision diameter, Collision frequency, mean free path and collision number. Viscosity of gases.

Classical Thermodynamics: Maxwell's relations and thermodynamic equations of state - applications in the evaluation of $C_p - C_v$ for solids and for vanderwaals gases, $C_p - C_v$ in terms of coefficient of expansion and coefficient of compressibility - Relation between C_p and C_v .

UNIT IV

Structure and shape of organic molecules: Classification and nomenclature of organic compounds, IUPAC systems. Hybridization, sp^3 hybridization in alkane (methane), sp^2 hybridization in alkenes (ethylene) and sp hybridization in alkynes (ethyne).

Electronic Displacement Effects: Inductive effect, Electromeric effect, Resonance and Hyper conjugation. Reactive Intermediates: Carbocations, Carbanions, free radicals, carbenes and nitrenes (Structure and stability).

UNIT V

Handling of chemicals: Safety and hygiene in chemical laboratory - storage and handling of chemicals, handling of acids, ethers, toxic and poisonous chemicals, antidots - first aid procedure.

Volumetric analysis: Molarity, molality, normality and mole fraction: Definition - Primary and Secondary standards: Definition and examples. Acid-base, redox, iodometric, iodimetric and complexometric titrations: Theories. Calibration of pipette, burette and standard flask. Weighing principle in chemical balance.

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Concise Inorganic Chemistry	J.D. Lee,	John Wiley	2014
2	Basic Inorganic Chemistry	F.A. Cotton & G. Wilkinson	John Wiley 3 rd Edn.	1994
3	Physical Chemistry	P.W. Atkins	Oxford University Press	2017
4	Physical Chemistry	G.W. Castellan	Narosa Publishing House	1990
5	Organic Chemistry	B.Y. Paula	Pearson Education, New Delhi.	2013

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Principle of Inorganic Chemistry	B.R. Puri, L.R. Sharma, K.C. Kalia	Milestone Publishers	2017
2	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	Sulan Chandans Son.	2013
3	Advanced Inorganic Chemistry	Gurdeep Raj	Krishna Prakashan Media (P) Ltd.	2014
4	Modern Inorganic Chemistry	Satya Prakash S.	S. Chand and Company Ltd.	2003
5	Selected Topics in Inorganic Chemistry	U. Malik, G.D. Tuli, R.D. Madan	S. Chand and Company Ltd.	2010
6	Text book of Organic Chemistry	P.L. Soni	Sulan Chand & Son.	2012
7	Advanced Organic Chemistry	ArunBhal, B.S. Bahl	S. Chand and Company Ltd.	2012
8	Principles of Physical Chemistry	B.R. Puri, L.R. Sharma, M.S. Pathania	Vishal Publisher	2012
9	Physical Chemistry	Kundu an d Jain	S. Chand	2003

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - I

CORE PRACTICAL-I	B.Sc. Chemistry	2019-2020
M19UCHP01	INORGANIC VOLUMETRIC ANALYSIS	
Credits: 3		

Course Outcomes

On the successful completion of the course, student will be able to

1. Learn the techniques of volumetric analysis.
2. Acquire the quantitative skills in volumetric analysis.
3. Estimate the amount of metal ion and metal in the given solutions.

A double titration involving the making up of the solution to be estimated and the preparation of standard solution.

Acidimetry and Alkalimetry

1. Estimation of NaOH (Standard- Na_2CO_3 , Link-HCl)
2. Estimation of Oxalic acid (Standard- Oxalic acid, Link-NaOH)

Permanganometry

1. Estimation of Oxalic acid (Standard- Oxalic acid, Link- KMnO_4)
2. Estimation of Ferrous ion (Standard – FAS, Link- KMnO_4)

Dichrometry

1. Estimation of Ferrous ion (Standard- FAS, Link- $\text{K}_2\text{Cr}_2\text{O}_7$)
2. Estimation of Ferric ion using external indicator method (Standard- $\text{K}_2\text{Cr}_2\text{O}_7$)

Iodometry

1. Estimation of $\text{K}_2\text{Cr}_2\text{O}_7$ (Standard - $\text{K}_2\text{Cr}_2\text{O}_7$, Link- $\text{Na}_2\text{S}_2\text{O}_3$)

Complexometry

1. Estimation of Zinc (Standard - ZnSO_4 , Link- EDTA)
2. Estimation of Magnesium (Standard - MgSO_4 , Link- EDTA)

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's Text book of quantitative inorganic analysis	J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham	4 th Ed, ELBS/Longman, England	1986
2.	Experimental Inorganic Chemistry	W.G. Palmer	Van Nostrand Reinhold Co., London	1972
3.	Vogel's Text book of macro and semimicro qualitative Inorganic analysis	G. Svehla	Orient Longman, VI Edition.	1987

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R.Kulandaivelu	Sultan Chand & sons, New Delhi, 2 nd Edn.	1997
2.	Inorganic Semimicro Qualitative analysis.	V.V. Ramanujam	National Publishing Co	1971
3.	Advanced Experimental Chemistry.	J.N. Gurtu and R. Kapoor	S. Chand and Co.	1987

SEMESTER - II

CORE COURSE-II	B.Sc. Chemistry	2019-2020
M19UCH02	GENERAL CHEMISTRY-II	
Credits: 5		

Objectives

On accomplishment of this course the students should have understood chemical bonding, hydrides, solid state, Liquid state, organic reaction mechanism and aromaticity.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Acquire knowledge on bonding and bonding theories.	K1
CO2	Learn the hydrides and alkali metals.	K2
CO3	Categorize the reaction mechanisms in organic chemistry.	K4
CO4	Study the types of aromaticity in organic compounds.	K3
CO5	Understand and study the crystalline structure of solids.	K2

UNIT I

Bonding: Ionic bond - Lattice energy. Covalent bond - Fajans Rule - Polarisation - partial ionic character of a covalent bond. Hydrogen bonding - Intermolecular & Intramolecular Hydrogen bonding and consequences.

Bonding Theories: VB theory - MO theory - Basic principles of bonding and antibonding orbitals. Comparison of VB & MO Theories - Applications of MO theory to H₂, He₂, N₂ & O₂ molecules. VSEPR theory of simple inorganic molecules - BeCl₂, SiCl₄, PCl₅, SF₆, IF₇, XeF₆, BF₃ & H₂O.

UNIT II

Hydrides and Metallic hydrides: Hydrides - Classification- Types of hydrides - Preparation properties, structure and uses. Metallic hydrides: Preparation, properties, structure and uses. Complex hydrides: Preparation properties, structure and uses.

Alkali metals and Alkaline Earth metals: Alkali metals - Introduction, reaction with water, halides, oxides and hydroxides, salts of oxo-acids, organometallic compounds and biological importance. Alkaline Earth metals: Introduction, halides, oxides and hydroxides, salts of oxo-acids, organometallic compounds biological importance of Mg^{2+} and Ca^{2+} .

UNIT III

Aliphatic nucleophilic substitution: SN_1 , SN_2 and SN_i reactions – mechanism and stereochemistry. Relative reactivity of ethyl, isopropyl, tertiary butyl, vinyl and benzyl halides

Elimination reactions: Mechanisms of E_1 and E_2 reactions- Hofmann and Saytzeff rule. Comparison between substitution and elimination reaction.

UNIT IV

Aromaticity: Aromatic hydrocarbons and aromaticity - resonance in benzene - delocalised cloud in benzene – aromaticity - Huckel's $(4n+2)$ rule and its simple applications.

Electrophilic substitution reactions in aromatic compounds: General mechanism – Nitration, Halogenation, Sulphonation, Friedel - Crafts acylation and alkylation. Orientation and reactivity in monosubstituted benzene - nuclear and side chain halogenation. Polynuclear aromatic hydrocarbons - naphthalene, anthracene - isolation, synthesis, properties and uses.

UNIT V

The Solid State: Difference between crystalline and amorphous solids - isotropy and anisotropy - interfacial angles - symmetry in crystal systems - elements of symmetry - space lattice and unit cell - Bravais lattices - Law of rational indices - Miller indices - X ray diffraction - Bragg's equation - Experimental methods structures of NaCl, CsCl and ZnS.

Liquid state: Liquid crystals - types, theories of liquid crystals, applications.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Concise Inorganic Chemistry	J.D. Lee,	John Wiley	2014
2	Thermodynamics for chemists	S. Glasstone	Affiliated East West press, New Delhi	1960
3	Principles of industrial analysis	D.A. Skoog, F. James Hollar and T.A. Niemanns	Thomson Books Cole, 5 th edition, Singapore.	2004
4	Essentials of Nuclear chemistry	H.J. Arnikar	New Age International	2011
5	Advanced Organic Chemistry, Vol. 1 and 2	F. A. Carey and R. Sundberg	Springer US	2008

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	Sulan Chand & Son	2013
2	Modern Inorganic Chemistry	S. Satya Prakash	S. Chand and Company Ltd.	2003
3	Selected Topics in Inorganic Chemistry	W.U. Malik, G.D. Tuli, R.D. Madan	S. Chand and Company Ltd.	2010
4	Instrumental methods of chemical analysis	B.K. Sharma	Goel publication, 5 th Edition. Meerut.	1996
5	Text book of Organic Chemistry	P.L. Soni	Sulan Chand & Son	2012
6	Advanced Organic Chemistry	ArunBhal, B.S. Bahl	S. Chand and Company Ltd.	2012

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - II

CORE PRACTICAL-II	B.Sc. Chemistry	2019-2020
M19UCHP02	PRACTICAL-II - ORGANIC AND INORGANIC PREPARATION	
Credits: 3		

Course Outcomes

1. To enable the students to learn the methods of preparing inorganic and organic compounds.
2. To acquire the qualitative skills in preparation.
3. Students will become familiar with safe-handling of chemical reactions.

A. Inorganic Preparations

1. Preparation of potash alum
2. Preparation of ferrous ammonium sulphate.
3. Preparation of potassium trioxalato chromate (III)
4. Preparation of tetrammine copper (II) sulphate.
5. Preparation of Microcosmic salt.

B. Organic Preparations

Preparation of following Organic compounds:

1. Salicylic acid from methyl salicylate or ethyl benzoate
2. Benzoic acid from benzaldehyde.
3. m-Dinitro benzene from nitro benzene.
4. Osazone from glucose.
5. p-Bromoacetanilide from acetanilide.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's qualitative Inorganic analysis	G. Svehla	Orient Longman, VI Edition,	1987
2.	Inorganic Semimicro Qualitative analysis.	V.V. Ramanujam	National Publishing Co	1971
3.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R .Kulandaivelu	Sultan Chand & sons, New Delhi. 2 nd Edn.	1997

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's Text book of quantitative inorganic analysis	J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham	ELBS/Longman, England, 4 th Edn.	1986
2.	Experimental Inorganic Chemistry	W.G. Palmer	Van Nostrand Reinhold Co., London	1972
3.	An advanced course in practical Inorganic Chemistry	D.N. Grindley	Butterworths	1964

SEMESTER - III

CORE COURSE -III	B.Sc. Chemistry	2019-2020
M19UCH03	GENERAL CHEMISTRY-III	
Credits: 5		

Objectives

On fulfillment of this course the students should have understood Transition, Boron group and Carbon group elements, Stereoisomerism in organic chemistry and Thermodynamics first and second Law.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn transition elements and the principles of qualitative analysis.	K1
CO2	Study the characteristics of boron and carbon group elements	K2
CO3	Analyze stereo nature and confirmations.	K3
CO4	Understand thermodynamic first laws and its application.	K3
CO5	Understand thermodynamic second laws and thermodynamic functions.	K3

UNIT I

Transition Elements: Position in the Periodic Table - General characteristics of d-block elements – an objective study of the properties expected.

Principles of Qualitative analysis: Basic principles of inorganic semi micro analysis. Principle involved in Na_2CO_3 extract preparation, Common ion effect, Solubility product and their applications in Qualitative analysis. Separation of cations into Groups.

UNIT II

Boron group: Diborane and hydrogen compounds of the other elements, metal borides, halides of B, Al, Ga, In and Tl, oxides, oxo-acids, oxo-anions and hydroxides of boron; nitrogen derivatives of boron.

Carbon group: Allotropy of elements, Intercalation compounds of graphite, hydrides, carbides and silicides, halides; oxides and oxo-acids of carbon; oxides and oxo-acids and hydroxides of Si, Ge, Sn and Pb; Silicones; Sulfides; Cyanogen, its derivatives and silicon nitride.

UNIT III

Stereoisomerism: Types, Geometrical Isomerism, Cis-Trans and Z-E isomerisms, Optical isomerism, Chirality, Optical activity, Measurement of optical activity, Concept of enantiomerism, diastereomerism, Configurational nomenclature, D-L, R-S, erythro - threo conventions - meso and d, l - forms of tartaric acid. Concepts of racemization and resolution concepts of anomerization and epimerization, Walden Inversion - Asymmetric synthesis - stereoselective and stereospecific reactions.

UNIT IV

Terminology of Thermodynamics: Thermodynamic equilibrium - Nature of work and heat Law of conservation of energy - first law of thermodynamics - Internal energy - Enthalpy of a system - Heat capacity of a system - Expansion of an ideal gas - work done in reversible isothermal expansion - work done in reversible isothermal compression - work done in reversible adiabatic expansion - Joule-Thomson effect, Joule-Thomson coefficient - Inversion temperature - zeroth law of thermodynamics - Absolute temperature scale - Kirchoff's equation.

UNIT V

Second law of Thermodynamics: Need for the law, Different statements of II law, Heat engine, Carnot's cycle and its efficiency, Thermodynamic scale of temperature, Entropy as a state function, Entropy as a function of P, V and T, Entropy change in phase change, Entropy of mixing, Entropy as a criterion of spontaneous and equilibrium processes in isolated systems, Gibbs function(G), Helmholtz function(A) as thermodynamic quantities, ΔA and ΔG as criteria for thermodynamic equilibrium and spontaneity, Their advantage over entropy change-variation of ΔA and ΔG with P, V and T, Gibbs Helmholtz equations and their applications.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Inorganic Chemistry: Principles, Structure and Reactivity	J. E. Huheey	Harper and Row, 3 rd Edn.	1983
2	Thermodynamics for chemists	S. Glasstone	Affiliated East West press, New Delhi	1960
3	Solid state chemistry	N.B. Hannay	Prentice-Hall	1967
4	New Directions in Solid State Chemistry	C.N.R. Rao and J. Gopalakrishnan	Cambridge University Press	1997
5	Advanced Organic Chemistry, Vol. 1 and 2	F.A. Carey and R. Sundberg	Springer US	2008

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	Sulan Chand & Son	2013
2	Modern Inorganic Chemistry	S. Satya Prakash	S. Chand and Company Ltd.	2003
3	Introduction to solids	L.V. Azroff	Mc Graw Hill, New York	2009
4	Principles of Organic Chemistry	M.K. Jain	Vishal publishing Co.	2017
5	Text book of Organic Chemistry	P.L. Soni	Sulan Chandans Son	2012
6	Advanced Organic Chemistry	Arun Bhal, B.S. Bahl	S. Chand and Company Ltd.	2012

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - III

CORE PRACTICAL-III	B.Sc. Chemistry	2019-2020
M19UCHP03	PRACTICAL-III - INORGANIC QUALITATIVE ANALYSIS	
Credits: 3		

Course Outcomes

1. To enable the students to understand the techniques of semi micro qualitative analysis of inorganic salt mixtures.
2. To create an awareness on eco-friendly approach in qualitative analysis.
3. Students become familiar with elimination of interfering acid radicals.

Semi-micro Qualitative Analysis

1. Analysis of a mixture-I containing two cations and two anions (of which one is interfering type).
2. Analysis of a mixture-II containing two cations and two anions (of which one is interfering type).
3. Analysis of a mixture-III containing two cations and two anions (of which one is interfering type).
4. Analysis of a mixture-IV containing two cations and two anions (of which one is interfering type).
5. Analysis of a mixture-V containing two cations and two anions (of which one is interfering type).
6. Analysis of a mixture-VI containing two cations and two anions (of which one is interfering type) Acid radicals.
7. Analysis of a mixture-VII containing two cations and two anions (of which one is interfering type).
8. Analysis of a mixture-VIII containing two cations and two anions (of which one is interfering type).
9. Analysis of a mixture-IX containing two cations and two anions (of which one is interfering type).
10. Analysis of a mixture-X containing two cations and two anions (of which one is interfering type).

Acid radicals:

Simple acid radicals: Nitrate, Sulphate, Bromide, Iodide and Carbonate.

Interfering acid radicals: Phosphate, Oxalate, Borate and fluoride.

Basic Radicals:

Group I : Lead

Group II : Copper, Cadmium, Bismuth

Group III : Cobalt, Nickel, Manganese

Group IV : Barium, Strontium

Group V : Magnesium, Ammonium

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's qualitative Inorganic analysis	G. Svehla	Orient Longman, VI Edition,	1987
2.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R. Kulandaivelu	Sultan Chand & sons, New Delhi, 2 nd Edn.	1997
3.	Inorganic Semimicro Qualitative analysis.	V.V. Ramanujam	National Publishing Co	1971

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's Text book of quantitative inorganic analysis	J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham	ELBS/Longman, England,4 th Edn.	1986
2.	Experimental Inorganic Chemistry	W.G. Palmer	Van Nostrand Reinhold Co., London	1972
3.	An advanced course in practical Inorganic Chemistry	D.N. Grindley	Butterworths	1964

SEMESTER - IV

CORE COURSE-IV	B.Sc. Chemistry	2019-2020
M19UCH04	GENERAL CHEMISTRY- IV	
Credits: 5		

Objectives

In this course the students should have understood Halogens and Noble Gases, Nanochemistry, Radioactivity, Aliphatic amines, Diazonium compounds and Carbonyl compounds.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Know the characteristics of halogens and noble gases.	K1
CO2	Understand the importance of nanochemistry and applications.	K2
CO3	Aware of radioactivity and its application.	K3
CO4	Acquire knowledge on amine compounds in organic chemistry.	K2
CO5	Correlate the reactions of Carbonyl Compounds.	K4

UNIT I

Peculiarities of fluorine - Hydrides, oxides and oxy acids of halogens. Structure, preparation, and hydrolysis of inter halogen compounds. Pseudohalogens - chemical reactions. Position of noble gases in the periodic table - Isolation from atmosphere - general Characteristics- Structure and shape of xenon compounds – XeF_2 , XeF_4 , XeF_6 , XeO_3 and XeOF_4 .

UNIT II

Nanochemistry: Nanotechnology – fundamental principles, nano particles – definition – size relationship. Nano particles of metals, semiconductors and oxides. Synthesis of Nano sized compounds – reduction methods, solgel method and chemical vapour deposition method. Properties – optical and electrical properties. Nano clusters – carbon nano tubes, Application of nano chemistry in various field.

UNIT III

Nuclear forces - Exchange theory and nuclear fluid theory. Natural radioactivity - modes of decay - Geiger Nuttal rule. Units of radioactivity - Kinetics of radioactive disintegration - Half life and average life - Radioactive equilibrium - Numerical problems. Mass defect and binding energy - Artificial transmutation and artificial radioactivity.

Application of radioactive isotopes - C-14 dating, rock dating - Numerical problems - isotopes as tracers - study of reaction mechanism (ester hydrolysis), radio diagnosis and radiotherapy. Nuclear reactors - common features: moderators, coolant control materials, reactor shielding - uses.

UNIT IV

Aliphatic amines - separation of amines by Hinsberg's & Hofmann methods - preparation and properties of dimethyl amine, trimethyl amine, (ethylene diamine and hexamethylene diamine). Derivatives of aniline - acetanilide, N-methyl aniline & N, N - dimethylaniline - preparation and properties.

Diazonium compounds - diazotisation mechanism - diazonium ion as a weak electrophile preparation and synthetic uses of diazo acetic ester & diazomethane.

UNIT V

Carbonyl compounds: Introduction, general mechanism for nucleophilic acyl substitution. Relative reactivity of carbonyl compounds - Reactions of carbonyl compounds with carbon, hydrogen, nitrogen and oxygen nucleophiles like Grignard reagents, HCN, Lithium aluminium hydrides, sodium boro hydride, addition of water, addition of primary & secondary amines, addition of alcohol - stereochemistry of nucleophilic addition(RE & SI face) - reactions of α , β - unsaturated carbonyl compounds.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Inorganic Chemistry: Principles, Structure and Reactivity	J. E. Huheey	Pearson Education India, 4 th Edn.	2006
2	Inorganic Chemistry	D. F. Shriver, P.W. Atkins, C.H. Langford	ELBS, 2 nd Edn.	1995
3	Physical chemistry	R. A. Alberty, R. J. Silbey	Wiley, 4 th Edn.	2006
4	Physical Chemistry	W.J. Moore	Orient Longman, London	1972
5	Advanced Organic Chemistry	J. March and M Smith	John-Wiley and sons, 7 th Edn.	2015

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	Sulan Chand & Sons.	2013
2	Modern Inorganic Chemistry	S. Satya Prakash	S. Chand and Company Ltd.	2003
3	Principles of Physical Chemistry	B.R. Puri, L.R. Sharma, M.S. Pathania	Vishal Publishers, 47 th Edn.	2017
5	Text book of Organic Chemistry	P.L. Soni	Sulan Chandans & Son, 29 th Edn.	2012
6	Advanced Organic Chemistry	ArunBhal, B.S. Bahl	S. Chand and Company Ltd.	2012

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - IV

CORE PRACTICAL-IV	B.Sc. Chemistry	2019-2020
M19UCHP04	PRACTICAL-IV - ORGANIC ESTIMATION & PHYSICAL CONSTANT	
Credits: 3		

Course Outcomes

On the successful completion of the course, student will be able to

1. Know the fundamental strategies of organic estimation.
2. Estimate the amount of organic compound in the given solutions.
3. Learn the determination of physical constants of organic compounds.

ORGANIC ESTIMATIONS

1. Estimation of Phenol.
2. Estimation of Aniline.
3. Estimation of Glycine.
4. Estimation of Ascorbic acid (Vitamin C).
5. Estimation of Saponification value of Oil.

DETERMINATION OF PHYSICAL CONSTANTS

Determination of boiling and melting points by semi micro method (at least 10 different organic compounds).

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Organic Chemistry – Lab manual	N.S. Gnanapragasam and G. Ramamurthy	S. Viswanathan Co. Pvt. Ltd	1998
2.	Vogel's Textbook of Practical Organic Chemistry,	B.S. Furniss, A.J.Hannaford, P.W.Smith, A.R.Tatchell	ELBS /Longman, London, 7 th Edn.	1984
3.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu	Sultan Chand & sons, New Delhi, 2 nd Edn.	1997

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Text book of Practical Organic Chemistry	Vogel	ELBS/Longman, England, 4 th Edn.	1986
2.	Organic Chemistry Lab Manual	Ganapragasm and Ramamurthy	S. Vishwanathan Printers and Publishers (P) Ltd., Chennai, 2 nd Edn.	2007
3.	Advanced Experimental Chemistry.	J.N. Gurtu and R. Kapoor	S. Chand and Co.	1987

SEMESTER - V

CORE COURSE-V	B.Sc. Chemistry	2019-2020
M19UCH05	INORGANIC CHEMISTRY – I	
Credits: 5		

Objectives

This course gives knowledge on Coordination Compounds, Theories of bonding in complexes, Lanthanide and Actinide Elements, Acid base concepts and non aqueous solvents.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the basic concepts, classification, nomenclature and isomerism in Coordination chemistry	K1
CO2	Understand the theories of bonding in complexes.	K2
CO3	Gain knowledge on reactions and applications of coordination compounds.	K3
CO4	Discuss the chemistry of Lanthanides & actinide series	K4
CO5	Learn about acids and base concept, HSAB theory and non aqueous solvents	K2

UNIT I

Coordination Chemistry: Definition of the terms - Classification of ligands - Nomenclature of mononuclear and polynuclear complexes - chelating ligands and chelates - Examples - chelate effect - explanation. Werner's theory - Sidgwick's theory - Effective Atomic Number concept.

Isomerism in complexes-Structural Isomerism - types. Stereoisomerism - Geometrical isomerism in 4 and 6 coordinated complexes. Optical isomerism in 4 and 6 coordinated complexes

UNIT II

Theories of bonding in complexes - Valence Bond Theory - Postulates - Hybridisation and geometries of complexes - Outer orbital and inner orbital octahedral complexes. Square planar and tetrahedral complexes - VB Theory and magnetic properties of complexes - limitations of VB Theory.

Crystal Field Theory: Postulates – d orbital splitting in octahedral, tetrahedral and square planar complexes - strong and weak ligands - Spectrochemical series - High spin and low spin complexes - CF Theory and magnetic properties of complexes - Crystal Field Stabilisation Energy (CFSE) and its uses - Calculation of CFSE values of d^1 to d^{10} Octahedral and Tetrahedral complexes - CF theory and colour of complexes - limitations of CF theory - comparison between VBT and CFT.

UNIT III

Substitution reaction in square planar complexes – Trans effect – Trans effect series – uses of Trans effect – polarization theory and π - bonding theory.

Application of coordination compounds in Quantitative and Qualitative analysis - complexometric titrations - principles and type of titrations using EDTA - EDTA and its applications - Estimation of metal hardness on water.

UNIT IV

Lanthanides: Introduction, occurrence, separation, oxidation states and general chemistry including electronic structure, colour and spectra, lanthanide contraction, magnetic properties and coordination complexes.

Actinides: Introduction, isolation and general chemistry including electronic structure, color and spectra, actinide contraction, magnetic properties. Comparison of lanthanides and actinides.

UNIT V

Bronsted acids and bases: Bronsted acid, periodic trends in Bronsted acidity, polyoxo compound formation; Lewis acids and bases: definitions, strengths, representative Lewis acids, heterogeneous acid-base reactions, HSAB principle, theories of HSAB and super acids.

Non-aqueous solvents - physical properties of a solvent, types of solvents and their general characteristics. Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2 - Comparison.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Inorganic Chemistry: Principles, Structure and Reactivity	J. E. Huheey	Harper and Row, 4 th Edn.	2013
2	Inorganic Chemistry	D. F. Shriver, P.W. Atkins, C.H. Langford	ELBS, 2 nd Edn.	1995
3	Physical chemistry	R.A. Alberty, R.J. Silbey	Wiley	2006
4	Inorganic Chemistry	G.L. Miessler, D.A. Tarr	Pearson Education	2004

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	Sulan Chandans Son	2013
2	Modern Inorganic Chemistry	S. Satya Prakash	S. Chand and Company Ltd.	2003
3	Advanced Inorganic Chemistry	Gurdeep Raj	Krishna Prakashan Media(P) Ltd.	2014
5	Selected Topics in Inorganic Chemistry	U. Malik, G.D. Tuli, R.D. Madan	S. Chand and Company Ltd.	2010
6	Concise Coordination Chemistry	R. Gopalan, V. Ramalingam	Vikas Publishing house	2008

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - V

CORE COURSE-VI	B.Sc. Chemistry	2019-2020
M19UCH06	ORGANIC CHEMISTRY-I	
Credits: 5		

Objectives

On accomplishment of this course the students should have understood Heterocyclic compounds, Carbohydrates, Amino acids and Proteins, Nucleic acid, Organometallic compounds, Organic sulphur compounds and Carboxylic acids.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about Chemistry of Heterocyclic compounds	K1
CO2	Summarise the concept of Carbohydrates	K2
CO3	Acquire the knowledge of Amino acids, Proteins and Nucleic acid	K3
CO4	Illustrate about Organometallic compounds and Organic sulphur compounds	K4
CO5	Know the idea of carboxylic acid and Acids derivatives	K3

UNIT I

Chemistry of five and six – membered aromatic heterocycles with one hetero atom - Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic fused and bridged heterocycles – aromaticity.

Synthesis and reactions of pyrrole, furan, thiophene, pyridine, indole, quinoline and isoquinoline.

UNIT II

Saccharides: Classification, configuration of aldoses and ketoses, reactions of monosaccharides like oxidation, reduction and osazone formation (phenyl hydrazone)

Stereochemistry of glucose, cyclic structure of mono saccharides, formation of glycosides, determination of ring size, di-saccharides and polysaccharides.

UNIT III

Amino acids – Classification – methods of synthesis of amino acids – reactions of amino acids (with reference to glycine) – Action of heat on amino acids – Peptide linkage and polypeptide formation – Determination of structure of polypeptide – Partial hydrolysis method and terminal residue hydrolysis method.

Proteins – classification – colour reactions – Properties of proteins – Primary, secondary and tertiary structure of proteins. DNA bases, Nucleosides and nucleotides, nucleic acids, helical forms of DNA.

UNIT IV

Preparation and reactions of diethyl zinc and methyl lithium – preparation and uses of organo tin compounds and mercury compounds – TEL.

Preparation and properties of thioalcohols and thioethers. Preparation and uses of sulphonal, mustard gas, sulphone and s-benzyl thiouronium salts.

UNIT V

Structure of carboxylic acid and carboxylate anion – Relative strengths of monocarboxylic acids – effect of substituents on acidity – preparation, properties and synthesis of citric acid – Action of heat on alpha, beta and gamma hydroxy acids – Action of heat on dicarboxylic acid (Blanc's rule) – Preparation and uses of NBS.

Acid derivatives– nucleophilic acyl substitution (acid and base catalysed), Mechanism of esterification and ester hydrolysis (acidic and alkaline) – synthesis of ester by Tischenko reaction.

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Advanced Organic Chemistry, Part A: Structure and Mechanisms.	F. A. Carey and R. A. Sundberg	Springer, New York, 5 th Edn.	2007
2	Advanced Organic Chemistry	J. March and M Smith	John-Wiley and sons, 7 th Edn.	2015
3	Organic Chemistry. Vol-2	I. L. Finar	Pearson Education Asia, 6 th Edn.	2004
4	Heterocyclic Chemistry	T. L. Gilchrist	Pearson, 3 rd Edn.	2005
5	Organic Chemistry	B.Y. Bruice	Pearson Education, New Delhi,	2013

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Organic Chemistry	P.L. Soni	Sulan Chand & Son.	2012
2	Advanced Organic Chemistry	ArunBhal, B.S. Bahl	S. Chand and Company Ltd.	2003
3	Principles of Organic Chemistry	M.K. Jain	Vishal publishing Co.	2017
4	Organic Chemistry	Wade	Pearson Education, 8 th Edn.	2016
5	Heterocyclic Chemistry	J. A. Joule and K. Mills	John-Wiley, 5 th Edn.	2010
6	Organic Chemistry	P. Y. Bruice	Pearson Education, 7 th Edn.	2013

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - V

CORE COURSE-VII	B.Sc. Chemistry	2019-2020
M19UCH07	PHYSICAL CHEMISTRY-I	
Credits: 5		

Objectives

On fulfillment of this course the students should have understood Catalysis, Adsorption, Chemical Kinetics and Photochemistry.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about catalysis and their catalytic reactions	K1
CO2	Know about basics of adsorption.	K2
CO3	Understand the concept of Chemical Kinetics and determine the rate law from initial rate.	K2
CO4	Get the principles of Collision theory of reaction rates and to use Arrhenius equation to calculate rate constant, activation energy, and frequency factor.	K3
CO5	Illustrate different photochemical processes and their kinetics.	K4

UNIT I

General characteristics of catalytic reactions, acid – base catalysis, enzyme catalysis, mechanism and kinetics of enzyme catalyzed reactions, Michaelis-Menten equation, effect of temperature on enzyme catalysis, Heterogeneous catalysis, pH dependence of rate constants of catalyzed reactions.

UNIT II

Definition of adsorption, adsorbents and adsorbates. Adsorption of gases on solids. Classification of adsorptions with examples. Differences between kinds of adsorptions. Adsorption isotherms, derivation of Langmuir's and BET adsorption isotherms. Adsorption from solutions. Gibb's adsorption isotherm.

UNIT III

Rate of a reaction, order of a reaction, rate law and the mechanism, factors affecting reaction rates, molecularity, derivation of rate constant of a second order reaction - Determination of the rate constant of a second order reaction - Derivation of rate constant of a third order reaction - Derivation of half-life periods for second and third order reactions. Effect of temperature on reaction rates - Derivation of Arrhenius equation - concept of activation energy - determination of Arrhenius frequency factor and energy of activation.

UNIT IV

Collision theory of reaction rates - Derivation of rate constant of a bimolecular reaction from collision theory-Failures of CT. Lindemann theory of Unimolecular reactions. Theory of Absolute Reaction Rates - Thermodynamic derivation of rate constant for a bimolecular reaction based on ARRT- comparison between ARRT and CT. Significance of free energy of activation and entropy of activation.

UNIT V

Consequences of light absorption - Jablonski diagram - non radiative transitions - radiative transitions - Grotthus-Draper law - Stark Einstein law of photochemical equivalence - Quantum efficiency, quantum yield. Energy transfer in photochemical reactions - photosensitization - Photosynthesis in plants - Chemiluminescence - fluorescence and phosphorescence - lasers - uses of lasers. Photochemical reactions - Kinetics of hydrogen - bromine reaction - decomposition of HI.

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Kinetics and Mechanism	R.G. Frost and Pearson	Wiley New York	1961
2	Chemical Kinetics	G.M. Harris	D.C. Heath and Co.	1966
3	Chemical Kinetics	K.J. Laidlar	Harper and Row, New York	1987
4	Physical Chemistry	P.W. Atkins	Oxford University Press, 7 th Edn.	2009
5	Physical Chemistry	G.W. Castellan	Orient Longmann	1990
6	Catalysis	U. Hanefeld, L. Lefferts	Wiley	2018

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Principles of Physical Chemistry	B.R. Puri, L.R. Sharma, M.S. Pathania	Shoban Lal, Nagin Chand & Co, 23 rd Edn.	1993
2	Physical Chemistry	Kundu and Jain	S. Chand	2003
3	Kinetics and Mechanism of Chemical Transformations	J. Rajaram and J.C. Kuriakose	Macmillan India Ltd	1993
4	Introduction to Heterogeneous catalysis	R. Prins, A. Wang, X. Li	Wspc (Erope)	2016

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - V

CORE PRACTICAL-V	B.Sc. Chemistry	2019-2020
M19UCHP05	PRACTICAL-V- ORGANIC ANALYSIS	
Credits: 3		

Course Outcomes

On the successful completion of the course, student will be able to

1. Acquire knowledge about the analysis of simple organic compounds.
2. Create awareness on eco-friendly approach in the analysis.

Analysis of simple Organic compounds

- a. Characterization of functional groups
- b. Confirmation by preparation of solid derivatives / characteristic colour reactions

Note:

1. Mono-functional compounds are given for analysis. In case of bifunctional compounds, students are required to report any one of the functional groups.
2. Each student is expected to do the analysis of at least 10 different organic substances.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Organic Chemistry – Lab manual	N.S. Gnanapragasam and G. Ramamurthy	S. Viswanathan Co. Pvt. Ltd	1998
2.	Vogel's Textbook of Practical Organic Chemistry,	B.S. Furniss, A.J.Hannaford, P.W.Smith, A.R.Tatchell	ELBS /Longman, London, 7 th Edn.	1984
3.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R. Kulandaivelu	Sultan Chand & sons, New Delhi, 2 nd Edn.	1997

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Text book of Practical Organic Chemistry	Vogel	ELBS/Longman, England, 4 th Edn.	1986
2	Organic Chemistry Lab Manual	Ganapragasm and Ramamurthy	S. Vishwanathan Printers and Publishers (P) Ltd., Chennai, 2 nd Edn.	2007
3	Advanced Experimental Chemistry.	J.N. Gurtu and R. Kapoor	S. Chand and Co.	1987

SEMESTER - V

CORE PRACTICAL-VI	B.Sc. Chemistry	2019-2020
M19UCHP06	PRACTICAL-VI - PHYSICAL CHEMISTRY EXPERIMENTS	
Credits: 3		

Course Outcomes

On the successful completion of the course, students will be able to

1. Understand the concepts of physical chemistry experiments.
2. Do the physical chemistry experiments.
3. Learn the fundamentals of conductometric and potentiometric titrations.
4. Understand the method of determination of critical solution temperature, transition temperature and rate constant.

EXPERIMENTS

1. Determination of molecular weight by Cryoscopic method (Rast Method).
2. Construction of phase diagram for the given two component system (Naphthalene-Biphenyl) and determination of eutectic temperature and eutectic composition.
3. Determination of critical solution temperature of phenol – water system and determination of electrolyte concentration (NaCl) using phenol – water system.
4. Determination of transition temperature of a hydrated salt (sodium thiosulphate, sodium acetate) by thermometric method.
5. Determination of rate constant for the reaction of acid catalysed hydrolysis of an ester (methyl acetate or ethyl acetate) and comparison of given acids A and B by the kinetics study.
6. Determination of rate constant for the reaction between persulphate and KI and study the kinetics.
7. Determination of the strength of given HCl solution by titrating with standard strong NaOH solution by conductometrically.

8. Determination of the strength of given KCl solution by titrating with standard AgNO₃ solution by conductometrically.

9. Determination of the strength of given FAS solution by titrating with standard KMnO₄ solution by potentiometrically.

10. Determination of the strength of given HCl solution by titrating with standard strong NaOH solution by potentiometrically.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Advanced Experimental Chemistry, Vol I.	J.N. Gurtu and Kapoor	R. S. Chand & Co. Ltd., New Delhi.	1980
2.	College Practical Chemistry	V.K. Ahluwalia, Sunitha Dhingra and Adarsh Gulate	Universities Press (India) Pvt Ltd.	2008
3.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R. Kulandaivelu	Sultan Chand & sons, New Delhi, 2 nd Edn.	1997

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Findlay's Practical Physical Chemistry	B.P. Levitt	Longman, London, 9 th Edn.	1985
2.	Experimental Physical Chemistry	F. Daniels	McGraw Hill, New York, 7 th Edn.	1970
3.	Practical Physical Chemistry	A. Findlay	7 th Ed., London, Longman,	1959

SEMESTER - VI

CORE COURSE-VIII	B.Sc. Chemistry	2019-2020
M19UCH08	INORGANIC CHEMISTRY-II	
Credits: 5		

Objectives

On accomplishment of this course the students should have understood nitrogen and oxygen group, Organometallic Chemistry, Bio-inorganic Chemistry and metallic bond.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn the preparation, properties and structure of nitrogen and oxygen group.	K1
CO2	Understand the Chemistry of Organometallic compounds and Structure & bonding of some important Organometallic compounds	K2
CO3	Students understand the various types of Organometallic reactions and catalysis.	K2
CO4	Students understand the bioactivity of proteins, enzymes, metals, vitamins, hemoglobin and myoglobin.	K3
CO5	Conclude the concept of Solid State and properties, theory, type of semiconductors, & defects of Solid.	K4

UNIT I

Nitrogen group: Differences between nitrogen and rest of the family members - A comparative study on hydrides, halides and oxides of nitrogen group elements. Structure and basic character of ammonia. Oxyacids of nitrogen (HNO_2 , HNO_3) and phosphorous (H_3PO_3 , H_3PO_4 and $\text{H}_4\text{P}_2\text{O}_7$). Preparation, properties and structure of hydrazine.

Oxygen group: Structure and allotropy of elements- preparation, properties and structure of ozone, oxides and oxyacids of Sulphur. Halides and oxyhalides of Sulphur, Thionic acids, thionyl chloride, permono and perdisulphuric acid. Biologically important sulphur compounds – sulphur bridged Molybdenum dimeric complexes.

UNIT II

Compounds with transition metal to carbon bonds: Classification of ligands, nomenclature, eighteen electron rule; transition metal carbonyls: range of compounds and structure, bonding, vibrational spectra, preparation, reactions; transition metal organometallics: square planar complexes, metal alkyls, metal alkylidenes, metal alkylidyne and cyclopentadienyl complexes; Structure and bonding: metal-olefin bond and arene metal bond.

UNIT III

Organometallic reactions and catalysis: oxidative addition, reductive elimination, insertion, hydride elimination, abstraction; olefin hydrogenation, hydroformylation, Wacker process, Ziegler-Natta polymerisation, cyclooligomerisation, olefin isomerisation, olefin metathesis, Monsanto acetic acid synthesis, Fischer-Tropsch process, hydrosilylation.

UNIT IV

Metal ion in biology and their vital role in the active site, Structure and functions of Metallo proteins and enzymes. Ion transport mechanism in cell membrane – Na and K pumps-Ionophores – Structures and characteristic features of Haemoglobin and myoglobin – VitaminB12

UNIT V

Metallic bond: Metallic properties, band theory of metals; semiconductors: n- and p-type semiconductors-superconductors. Imperfections in solids- Schotky defect, Frenkel defect, Metal excess defect, metal deficiency defect and line defects.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Inorganic Chemistry: Principles, Structure and Reactivity	J.E. Huheey	Pearson, 5 th Edn.	2006
2	Inorganic Chemistry	D.F. Shriver, P.W. Atkins, C.H. Langford	ELBS, 2 nd Edn.	1995
3	Inorganic Chemistry	G. Sharpe	Addison-Wesley, 3 rd Edn.	2002
4	Inorganic Chemistry	G.L. Miessler, D.A. Tarr	Pearson Education	2008
5	Advanced Inorganic Chemistry	F.A. Cotton, G. Wilkinson	John Wiley, 6 th Edn	2007

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	SulanChand & Son	2013
2	Modern Inorganic Chemistry	S. Satya Prakash	S. Chand and Company Ltd.	2003
3	Advanced Inorganic Chemistry	Gurdeep Raj	Krishna Prakashan (P) Ltd.	2014
5	Selected Topics in Inorganic Chemistry	U. Malik, G.D. Tuli, R.D. Madan	S. Chand and Company Ltd.	2010
6	Concise Coordination Chemistry	R. Gopalan, V. Ramalingam	Vikas Publishing house	2008
7	A New Concise Inorganic Chemistry	J. D. Lee	Wiley, 5 th Edn.	2014
8	Bio-Inorganic Chemistry	R.W. Hay	Ellis, Horwood, Reprint	1991

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - VI

CORE COURSE-IX	B.Sc. Chemistry	2019-2020
M19UCH09	ORGANIC CHEMISTRY-II	
Credits: 5		

Objectives

On successful accomplishment of this course the students should have understood Substitution reactions, Elimination Reactions, Molecular Rearrangement, Oxidation and Reduction, Alkynes and C-C bond formation.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Acquire knowledge on alkene and alkane.	K1
CO2	Obtain the knowledge of Molecular Rearrangement and naming reactions	K2
CO3	Sketch the concept of Oxidation and Reduction	K3
CO4	Illustrate Alkynes and C-C bond formation	K4
CO5	Understand the mechanisms of some organic reactions	K2

UNIT I

Alkanes: Preparation Method: Wurtz method, Kolbe's method and reduction of alkyl halides. Physical and chemical properties of alkanes, Mechanism of free radical substitution in alkanes, Halogenation and reactivity.

Alkenes: Properties of alkenes, Electrophilic and Free radical addition. Addition reactions of alkenes with mechanism, addition of hydrogen, halogens, hydrogen bromide - Markownikoff's rule - peroxide effect, sulphuric acid, water, BH_3 , O_3 , hydroxylation with KMnO_4 .

UNIT II

Benzidine, Pinacol, Benzilic acid, Favorskii, Wolff, Hofmann, Curtius, Schmidt, Lossen, Beckman, Dienone phenol, Fries, Demyanov, Baeyer - Villiger, Claisen, Cope and Wagner - Meerwein Rearrangement.

UNIT III

Oxidation: With Cr and Mn compounds; with peracids and other peroxides; with periodic acid, $\text{Pb}(\text{OAc})_4$, $\text{Hg}(\text{OAc})_2$ and SeO_2 .

Reduction: Catalytic hydrogenation; metal hydride, dissolving metal and hydrazine based reductions. Cram-Felkin-Anh model.

UNIT IV

Alkynes - Acidity of alkynes - Addition of hydrogen - Hydroboration - Hydrohalogenation - Addition of hypohalous acid, Hydration - addition of water with HgSO_4 catalyst - Addition of alcohols and carboxylic acids - oxidation with KMnO_4 - Ozonolysis - formation of acetylides.

UNIT V

C-C Bond Formation: Mechanism of Acyloin, Aldol, Stobbe, Claisen, Knoevenagel and Benzoin condensations, Darzen's glycidic ester synthesis; Dieckmann reactions, Wittig reaction, Diels-Alder and ene reactions, Reformatsky reaction. Acetoacetic ester and malonic ester synthesis. Acylation reactions. Enamine reactions. Gattermann aldehyde synthesis. Michael and Mannich reactions.

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Advanced Organic Chemistry, Part A: Structure and Mechanisms.	F. A. Carey and R. A. Sundberg	Fifth edition, Springer, New York	2007
2	Organic Chemistry	Clayden, Greeves, Warren	Oxford, 2 nd Edn.	2012
3	Advanced Organic Chemistry	J. March and M Smith	John-Wiley and sons, 7 th Edn.	2015
4	Organic Chemistry Vol-2	I. L. Finar	Pearson Education Asia, 6 th Edn.	2004
5	Organic Chemistry	P.Y. Bruice	Pearson Education, New Delhi, 7 th Edn.	2013

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Text book of Organic Chemistry	P.L. Soni	Sulan Chandans Son	2012
2	Advanced Organic Chemistry	ArunBhal, B.S. Bahl	S. Chand and Company Ltd.	2012
3	Principles of Organic Chemistry	M.K. Jain	Vishal publishing Co.	2017
4	Organic Chemistry	Wade	Pearson Education, 6 th Edn.	2016
5	Organic Chemistry	Morrison and Boyd	Pearson Education, New Delhi. 7 th Edn.	2014
6	Organic Chemistry	P. Y. Bruice	Pearson Education, 7 th Edn.	2013

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - VI

CORE COURSE -X	B.Sc. Chemistry	2019-2020
M19UCH10	PHYSICAL CHEMISTRY-II	
Credits: 5		

Objectives

On fulfillment of this course the students should have understood Phase rule and Electro Chemistry principles and applications.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Conquer the concept of phase rule and component systems	K1
CO2	Understand the principle of electrochemistry	K2
CO3	Learn about theory of strong electrolytes	K3
CO4	Get the knowledge of Galvanic cells, Reversible and Irreversible cells	K2
CO5	Illustrate the information about concentration cells	K4

UNIT I

Definition of terms- Derivation of phase rule - One component systems - H₂O system, Sulphur system – explanation using Clausius - Clapeyron equation - supercooling and sublimation. Two component systems - solid liquid equilibria - reduced phase rule – simple eutectic systems - Ag-Pb only. Efflorescence-deliqescence. CST-phenol water system. Effect of impurities on CST.

UNIT II

Electro chemistry: Metallic and electrolytic conductance – Definitions of specific, equivalent and molar conductances – Relations between them – measurement of conductance and cell constant. Variation of conductance with dilution – Qualitative explanation – Strong and weak electrolytes. Migrations of ions – transport number – determination by Hittorf and moving boundary methods – Kohlrausch's law – applications – calculation of equivalent conductance for weak electrolytes and determination of transport number.

Applications of conductance measurements – Oswalds dilution law, Degree of dissociation of weak electrolytes – Conductometric titrations.

UNIT III

Theory of strong electrolytes – Debye – Huckel – Onsager theory – verification of Onsager equation – Wein and Debye – Falkenhagen effect. Activity and activity co-efficients of strong electrolytes – ionic strength.

pH scale, Buffer solution – Henderson's equations – uses of Buffers including living systems – common ion effect – solubility product principle – relation to solubility – Applications in qualitative and quantitative analysis.

UNIT IV

Galvanic cells – Reversible and Irreversible cells – EMF and its measurement – Weston Standard cell – types of reversible single electrodes – standard Hydrogen electrode – calomel electrode – Derivation of Nernst equation both for emf of cells and single electrode potentials – Nernst theory for single electrode potential – standard reduction potentials – electro chemical series – significance.

Application of emf measurements – Application of Gibbs – Helmholtz equation to galvanic cells – calculation of thermodynamic quantities – pH using hydrogen, quinhydrone and glass electrodes – potentiometric titrations.

UNIT V

Concentration cells with and without transference – LJP expression – applications of concentrations cells – valency of ions – solubility product – activity coefficient.

Storage cells – Lead storage battery – Lithium ion battery, mechanism of charging and discharging, Fuel cells: hydrogen – oxygen cell – polarization – over voltage - decomposition voltage.

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Physical Chemistry	P.W. Atkins	Oxford University Press, 7 th Edn.	2009
2	Physical Chemistry	G.W. Castellan	Orient Longmann	1990
3	Introduction to Electrochemistry	S. Glasstone	Van Nostr and Co., Inc., New York	1996

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Principles of Physical Chemistry	B.R. Puri, L.R. Sharma, M.S. Pathania	Shoban Lal, Nagin Chand & Co, 23 rd Edn.	1993
2	Physical Chemistry	Kundu and Jain	S. Chand	2003
3	Physical Chemistry	G.M. Barrow	McGraw-Hill, International Student Edition, New Delhi	1973

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - VI

CORE PRACTICAL-VII	B.Sc. Chemistry	2019-2020
M19UCHP07	PRACTICAL-VII - INORGANIC ESTIMATION	
Credits: 3		

Course Outcomes

On the successful completion of the course, students will be able to

1. Learn the techniques of gravimetric analysis.
2. Acquire knowledge on gravimetric estimation.
3. Understand the techniques of colorimetry experiments

A. GRAVIMETRIC ANALYSIS

1. Estimation of Barium as Barium sulphate
2. Estimation of Barium as Barium chromate
3. Estimation of Lead as Lead chromate
4. Estimation of Calcium as Calcium oxalate
5. Estimation of Iron as Iron (III) oxide.
6. Estimation of Nickel as Nickel-DMG complex.

B. COLORIMETRY

1. Estimation of Iron(II)
2. Estimation of Copper (II)
3. Estimation of Nickel (II)

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's qualitative Inorganic analysis	G. Svehla	Orient Longman, VI Edition.	1987
2.	Inorganic Semimicro Qualitative analysis.	V. V. Ramanujam	National Publishing Co.	1971
3.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu	New Delhi, Sultan Chand & sons, 2 nd Edn.	1997

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's Text book of quantitative inorganic analysis	J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham	ELBS/Longman, England, 4 th Edn.	1986
2.	Experimental Inorganic Chemistry	W.G. Palmer	Van Nostrand Reinhold Co., London	1972
3.	An advanced course in practical Inorganic Chemistry	D.N. Grindley	Butterworths	1964

SEMESTER - III

ALLIED COURSE – III	B.Sc. Chemistry	2019-2020
M19UCHA03	ALLIED-III - CHEMISTRY-I	
Credits: 4		

Objectives

On accomplishment of this course the students should have understood acid, base, buffer solution, pH, radioactivity, vitamins, cleaning agents, plastics, paint and varnish.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the basic concepts of acid base, Buffer solution and pH	K2
CO2	Acquire knowledge about radioactivity and isotopes	K1
CO3	Illustrate Vitamins and some biological related materials	K4
CO4	Sketch about different plastics and its uses	K3
CO5	Extract the preparation of paint and varnish	K4

UNIT I

Acid and Base: Theories of Acids and Bases – Arrhenius Theory – Lowry – Bronsted Theory – Lewis Theory – Advantages of Lewis Theory – pH and pOH – Definition – Numerical problems – Indicator – Definition and Examples only – Buffer solution – Definition – Types of buffer solution with examples – Application of pH in Industries.

UNIT II

Nuclear Chemistry: Natural radioactivity - radioactive series - Group displacement law. Nuclear Binding energy, mass defect-Calculations. Nuclear Fission and Nuclear Fusion-differences – Stellar energy.

Applications of radioisotopes - C-14 dating, rock dating - agriculture - industry and medicine.

UNIT III

Biological Chemistry: Vitamins – Fat and Water soluble vitamins and their functions.

Chemistry of Soaps and Detergents: Cleaning action of soap – Difference between soaps and detergents - Laboratory preparation of soaps, shampoos & detergents.

UNIT IV

Plastics: Definition - Polymerization – Definition – Types of polymerization – Types of plastics– Differences – Mechanical properties of plastics – Advantages of plastics over traditional materials (Wood and Metal) - Polymers in Surgery – Biomaterials – Definition – Biomedical uses of Polyurethane, PVC, Polypropylene and Polyethylene.

UNIT V

Paint and Varnish: Paint – Definition – Components of Paints and their functions – Varnish – Definition – Preparation of Oil Varnish – Differences between Paint and Varnish – Special Paints – Luminescent Paints, Fire Retardant Paints, Aluminium Paints and Distemper.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1	Principle of Inorganic Chemistry	B.R. Puri, L.R. Sharma, K.C. Kalia	Vallabh Publications	2004
2	Text book of Inorganic Chemistry	P.L. Soni, M. Katyal	Sulan Chandans Son	1986
3	Applied Chemistry	Krishnamurthy N., Jayasubramanian K and Vallinayagam	Prentice Hall of India, New Delhi	1990
4	Chemistry in Everyday Life	Gem Mathew G. D.	Vishal Publishing	2011

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1	Concise Inorganic Chemistry	J.D. Lee	Blackwell Science, 5 th Edn.	1996
2	Chemistry in Everyday Life	Gem Mathew G D	Vishal Publishing	2014
3	Organic Chemistry	P. Y. Bruice	Pearson Education, 7 th Edn.	2013
4	Engineering Chemistry	S. S. Dara	S. Chand & Company	1992

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	S
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	M	S	S	M	M
CO5	M	S	S	S	M

S- Strong; **M**-Medium.

SEMESTER - IV

ALLIED COURSE - IV	B.Sc. Chemistry	2019-2020
M19UCHA04	ALLIED-IV - CHEMISTRY-II	
Credits: 4		

Objectives

This course provides knowledge in water, fuel, cement, glass, rubber, drugs and batteries.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the chemistry of water.	K2
CO2	Explain the fuel types and its composition	K1
CO3	Study the manufacture of the cements, glass, rubber	K2
CO4	Relate the importance of drugs	K3
CO5	Device solar cell and batteries	K4

UNIT I

Chemistry of water: Importance of water – Sources of water – Impurities of water – Hardness of water and its types – Effect of Hardness – Methods of removing hardness of water (Softening of Hard water) – Practically calculating Total Hardness, Temporary Hardness and Permanent hardness of water sample.

UNIT II

Fuels: Coal – Stages of Carbonization and classification of coal Estimation of moisture, volatile matter and ash content of a given sample of coal. Petroleum – Refining - Fractional distillation of crude oil – Gasoline – Octane number – Knocking – Cracking – Leaded Petrol. Natural Gas – Liquefied Petroleum Gas (LPG).

UNIT III

Industrial Chemistry: Cement – Raw materials – Manufacture of Portland cement and Setting of cement. Definition – Manufacture of Glass – Varieties of Glass – Optical Glass, Windshield Glass and Photo chromatic Glass. Rubber – Vulcanization and Uses of rubber. Rocket Propellant – Solid, liquid and gas propellants.

UNIT IV

Pharmaceutical Chemistry: Drugs: Classification based on chemical nature, source and target organ. Anaesthesia: types, examples of Anaesthetics - Antiseptics & Disinfectants - Antibiotics: Uses and examples. Preservatives, Antioxidants, Semi-micro qualitative analysis of tablets.

UNIT V

Energy Sources: Primary Battery – Definition and example – Construction, Working and Uses of Dry cell – Secondary Battery – Definition and example – Construction, Working and Uses of Lead-acid Storage Cell – Nonconventional Energy Sources – Solar Cell – Definition – Principle, Construction, Working and Uses. Corrosion: Methods of prevention.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1	A Text book of Pharmaceutical Chemistry	Jeyashre Ghosh	Tata McGraw Hill Publishing, New Delhi.	1993
2	Applied Chemistry	Krishnamurthy N., Jayasubramanian K., Vallinayagam	Prentice Hall of India, New Delhi	1990
3	Chemistry in Everyday Life	Gem Mathew G. D.	Vishal Publishing	2011
4	Principles of Physical Chemistry	B. R. Puri, R. Sharma and M. S. Pathania	S. Chand	2003

REFERENCES BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Physical Chemistry	P. W. Atkins	Oxford University	2009
2.	Engineering Chemistry	S. S. Dara	S. Chand & Company	1992
3.	Industrial Chemistry	B. K. Sharma	Goel Publishing House	2014
4.	Engineering Chemistry	Shikha Agarwal	Cambridge University Press	2016

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	S
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	M	S	S	M	M
CO5	M	S	S	S	M

S- Strong; **M**-Medium.

SEMESTER - IV

ALLIED PRACTICAL-II	B.Sc. Chemistry	2019-2020
M19UCHAP03	ALLIED PRACTICAL-II - CHEMISTRY	
Credits: 3		

Course Outcomes

On the successful completion of the course, student will be able to

1. Learn the techniques of volumetric analysis.
2. Acquire the quantitative skills in volumetric analysis.
3. Estimate the amount of substance in the given solutions.
4. Acquire knowledge about the analysis of simple organic compounds.

A double titration involving the making up of the solution to be estimated and the preparation of standard solution.

A. Inorganic Volumetric Estimation

Acidimetry and Alkalimetry

1. Estimation of NaOH (Standard- Na_2CO_3 , Link-HCl)
2. Estimation of Oxalic acid (Standard- Oxalic acid, Link-NaOH)

Permanganometry

1. Estimation of Oxalic acid (Standard- Oxalic acid, Link- KMnO_4)
2. Estimation of Ferrous sulphate (Standard - FAS, Link- KMnO_4)

Iodometry

1. Estimation of $\text{K}_2\text{Cr}_2\text{O}_7$ (Standard - $\text{K}_2\text{Cr}_2\text{O}_7$, Link- $\text{Na}_2\text{S}_2\text{O}_3$)

Complexometry

1. Estimation of Magnesium (Standard - MgSO_4 , Link- EDTA)

B. Analysis of simple Organic compounds

a. Characterization of functional groups (Acid, phenols, aldehyde, ketone, esters, nitro compounds, primary amine, amide, aliphatic diamide and monosaccharides).

b. Confirmation by preparation of solid derivatives / characteristic colour reactions.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's qualitative Inorganic analysis	G. Svehla	Orient Longman, VI Edition,	1987
2.	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R.Kulandaivelu	Sultan Chand & sons, New Delhi, 2 nd Edn.	1997
3.	Inorganic Semimicro Qualitative analysis.	V.V. Ramanujam	National Publishing Co	1971

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Vogel's Text book of quantitative inorganic analysis	J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham	ELBS/Longman, England, 4 th Edn,	1986
2.	Experimental Inorganic Chemistry	W.G. Palmer	Van Nostrand Reinhold Co., London	1972
3.	An advanced course in practical Inorganic Chemistry	D.N. Grindley	Butterworths	1964

SEMESTER - V

ELECTICE-I	B.Sc. Chemistry	2019-2020
M19UCHE01	ANALYTICAL CHEMISTRY	
Credits: 4		

Objectives

This course summarizes the basic principles, applications and techniques to understand chromatography, TGA, EGA, colorimetry, water and fuel analysis.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate the theories, principles and industrial importance of chromatography	K2
CO2	Explains the principles and applications of Thermal analysis method.	K2
CO3	Outline the principles and applications of colorimetry	K3
CO4	Deliberate water quality assessment for portable and industrial uses.	K4
CO5	Infer basic concepts and ultimate analysis for fuels	K1

UNIT I

Chromatography: classification – principles of adsorption – Types of chromatography, absorbents - Preparation of column, elution, recovery of substance.

Thin layer chromatography – choice of adsorbent and solvent preparation, R_f value - Ion exchange chromatography – principle, Resins – action of resins, experimental techniques, application.

UNIT II

Thermogravimetric analysis (TGA): Principle, derivative thermogravimetric analysis, factors affecting TGA, application - Thermometric titrations, Differential thermal analysis – Simultaneous DTA,

TGA curves. Electogravimetric analysis: Theory, instrumentation, applications.

Coulometric analysis, coulometric titrations, applications - Polarographic curves, application to qualitative and quantitative analysis - Amperometric titrations – principle and applications.

UNIT III

Colorimetric analysis: Laws of colorimetry - principle, instrumentation - applications of colorimetry - Estimation of nickel using DMG and aluminium using oxine. Complexometric titrations – principle and applications sequestering agents - masking agents- Structure of EDTA and its complexes.

Photo chemical Reactions: Principles and techniques used to follow the kinetics of ordinary, fast and photo chemical Reactions (volumetry, polarimetry, actinometry - one example for each method) and flash photolysis.

UNIT IV

Water Analysis: Sampling and preservation of water samples – physical examination of water: colour, odour, turbidity, taste and electrical conductivity – chemical characterization: pH, acidity, alkalinity, TDS, total, temporary, permanent, degree of hardness, BOD, COD, DO, detergents and pesticides – residual chlorine and chlorine demand.

UNIT V

Fuel Analysis: Solid fuels: coal – classification – proximate analysis: moisture content, ash content, volatile matter and fixed carbon – ultimate analysis: carbon, hydrogen, nitrogen, sulphur and oxygen – heating values – grading of coal – comparison of coal and coke.

Liquid fuels: flash point, aniline point, octane number and carbon residues – gaseous fuels: producer gas and water gas – calorific values.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Principle of Instrumental Analysis	Douglas A. Skoog, F. James Holler, Timothy A. Nieman,	Cengage learning	2018
2.	Instrumental Methods of Analysis	H. H Willard L. L Merrit, J. A settle	CBS Publishers	1986
3.	Chemical Analysis	A. K. Srivastava and P. C. Jain	S. Chand and Company Ltd.,	1963
4.	Instrumental Methods of Chemical Analysis	B. K. Sharma	Goel Publishing	2012
5.	Instrumental Methods of Analysis	B. Sivasankar	Oxford University Press	2012

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Fundamental of Analytical Chemistry	D. A. Skoog, D. M. West, F. J. Holler	Harcourt Asia	2001
2.	Analytical Chemistry	G. D. Christian	WSE, Wiley	2003
3.	Wastewater Engineering	L. Winther	Polyteknisk Forlag	1978
4.	Environmental Chemistry	A.K. De	Wiley Eastern Ltd, New Delhi.	1989
5.	Principles of Water Analysis	Kerry J House	Wiley	2012

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - V

ELECTIVE-I	B.Sc. Chemistry	2019-2020
M19UCHE02	POLYMER CHEMISTRY	
Credits: 4		

Objectives

This course imparts knowledge in polymers preparation, structure, stereochemistry, properties, molecular weight determination and their processing techniques.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand basic concepts and classification of polymers.	K2
CO2	Classify the polymer based on stereochemistry of polymers.	K2
CO3	Calculate the molecular weight of polymers by various methods	K3
CO4	Understand variety of Natural and synthetic rubbers.	K2
CO5	Illustrate the different polymer processing techniques	K3

UNIT I

Polymers: Natural and synthetic polymers. Classification of Polymers - addition and condensation polymers. General methods of preparation of polymers. Polymerization through functional groups, multiple bonds and ring opening. Coordination polymerization.

UNIT II

Structure of polymers - linear, branched and cross linked Stereochemistry of polymers - Isotactic, Syndiotactic and Atactic - properties of polymers: state, melting point, transition temperature.

UNIT III

Copolymerisation – Definitions – types. Block copolymers and Graft copolymers. Molecular weight of polymers. Number average molecular weight and weight average molecular weight. Determination of molecular weight by Viscosity and Osmometry methods.

UNIT IV

Synthesis of Polymers: Poly olefins - polythene, PTFE, Freons, PVC, polypropylene and polystyrene. Natural and synthetic rubbers - Constitution of natural rubber. Butyl, Buna, Buna-S, Buna-N, Neoprene, SBR, Thiocol, Polyurethane and silicone rubbers.

UNIT V

Plastics and Resins: Definitions - Types and uses. Constituents of plastic - fillers, dyes, pigments, plasticizers, Lubricants and catalysts.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Polymer Science	V. R. Gowrikar, N. V. Viswanathan	Wiley Eastern Limited, New Delhi.	1986
2.	Introduction to Polymer Chemistry A Text Book in	R. B. Seymour	MC Craw Hill, New York S. Chand &	1971
3.	Engineering Chemistry	S. S. Dara	Company Ltd, New Delhi	1992
4	Text Book of Polymer Chemistry	M. Bhatnagar & S. Chand	Chand Publication	2004

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Principles of Polymer Science	Bahadur & N.V. Sastry	Narosa Publishers	2007
2.	Polymer Chemistry An Introduction	M.P. Stevens	Oxford Publications	2009
3.	Polymer Science & Technology	J.R. Fred	Prentice Hall of India	2014
4.	Polymer Synthesis	E. Kowsari	Nova Science publishers Inc.	2012

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - V

ELECTIVE-I	B.Sc. Chemistry	2019-2020
M19UCHE03	CHROMATOGRAPHIC TECHNIQUES	
Credits: 4		

Objectives

This course gives idea about the Principles, Isolation, Identification and analysis of various components in mixtures by chromatographic techniques.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand and analyze different types of chromatographic techniques	K2
CO2	Examine the significance and applications of Thin layer chromatography	K4
CO3	Understand the basic theories and separation techniques of paper chromatography	K2
CO4	Illustrate the techniques and application of ion exchange chromatography	K4
CO5	Discuss about working technique and application of gas chromatography	K2

UNIT I

Chromatography: Types - Classification - Basic terms - partition, adsorption, adsorbent, adsorbate, stationary phase, mobile phase, effluent, sample, solute, solvent, retention time, retention volume.

Column chromatography: Principle - Instrumentation - Applications.

UNIT II

Thin layer chromatography: Theory - advantages of TLG over column and paper chromatography - Applications.

Experimental technique: preparation of the chromatoplates, activation of chromatoplates. Choice of adsorbents, selection of solvent, sample

application. Development of chromatogram location of compounds on chromatogram, detection methods.

UNIT III

Paper chromatography: Types – Theory, R_f value, factors influencing R_f value. Experimental method ; choice of filter paper, choice of solvents, preparation of solution, Application of sample to the paper, development of chromatogram, drying the chromatogram, quantitative estimations.

Types of paper chromatography: ascending chromatography, descending chromatography, ascending – descending chromatography, radial chromatography, Applications of paper chromatography

UNIT IV

Ion – exchange chromatography: Introduction, ion- exchangers, properties of ion – exchangers. Cation exchange resins, action of cation exchanger- Anion exchange resins, action of anion exchanger. Theory of ion – exchange chromatography, experimental technique of ion – exchange chromatography. Applications of ion - exchange chromatography

UNIT V

Gas chromatography: Introduction, types, Theory, Instrumentation. Working technique, interpretation of gas chromatogram, factors affecting separation in gas chromatography. Applications of gas chromatography.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Instrumental Approach to Chemical Analysis	A. K. Srivasta and P. C Jain	S. Chand & Company Ltd, New Delhi, India.	2009
2.	Chromatographic Method	R. Stock and C.B.F. Rice	Elsevier, Netherlands	1964
3.	Instrumental methods of chemical analysis	H. Kaur	Pragati Publication	2008
4.	Gas Chromatography	A. B. Little Wood	Elsevier	1970

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Elements of Analytical chemistry	R.Gopalan, P.S. Subramanian, K.Rengarajan	Sultan Chand & Sons	1986
2.	Instrumental Methods of analysis	B. K. Sharma	Goel publication	1996
3.	Chromatography: Concepts and Contrasts	James M. Miller	John Wiley& Sons, USA	2005

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - V

ELECTIVE-I	B.Sc. Chemistry	2019-2020
M19UCHE04	MATERIAL SCIENCE	
Credits: 4		

Objectives

This course gives an insight into the fascinating area of advanced material tools and characterization techniques for magnetic and modern engineering materials.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand basic concepts of inorganic solid electrolytes with ionic conductivity thus enabling solid state batteries and fuel cells.	K2
CO2	Explain the fundamentals of Polarizable solids, Ferro electricity, and magnetism.	K2
CO3	Impart basic knowledge about modern engineering materials and biomaterials.	K1
CO4	Understand basics of Nanochemistry.	K2
CO5	Recite synthesis and applications of nanomaterials	K3

UNIT I

Type of ionic crystals – Alkali halide –silver chloride – alkali earth fluovider – simple stoichiometric oxides. Types of ionic conductors – halide ion conductors – oxide ion conductors. Solid electrolytes – application of solid electrolytes. Crystal defects in solids – line and plane defect – point defects – Schottky and Frenkel defects.

Electronic properties and band theory: metals, semiconductor – inorganic solids – colour, magnetic and optical properties, luminescence, lasers. Electrochemical cell – principle – batteries, sensors and fuel cells.

UNIT II

Magnetic Materials: Introduction – types of magnetic materials – diamagnetism – paramagnetism, ferromagnetism. Ferrites: preparation and their application in microwave- floppy disc – magnetic bubble memory and applications.

Insulating materials: Classification – on the basis of temperature – Polymer insulating materials and ceramic insulating materials Ferro electric materials; examples, application of ferroelectrics.

UNIT III

Metallic glasses – introduction – composition, properties and applications. Shape memory alloys: introduction – examples - application of SMA- advantages and disadvantages. Biomaterials: Introduction – metals and alloy in biomaterials- Ceramic biomaterial, composite biomaterials – polymer biomaterials.

UNIT IV

Nanochemistry: Nanoscale, nanomaterials – definition. Types of nanomaterials – quantum wells, quantum wires, quantum dot. Different types of nano structures – nanoclusters, nanocrystals, nanowires and nanotubes, definition of nanotechnology, nanoscience and nanochemistry. Significance of the nanoscale. Factors responsible for the special properties of nanomaterials.

Nanotechnology and health issues - risks from nanoparticles and nanosafety. Nanotechnology and environmental issues.

UNIT V

Methods of synthesis of nanomaterials – Laser Ablation, Sonication, phase – transfer methods and sol – gel method. Application of nanotechnology – medicine diagnostics, drug delivery, food and drinks, cosmetics, textiles, sports / outdoor, filtration chemical industry, catalysis, electronic, displays.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Solid state chemistry and its application	Anthony R. West	John Wiley & Sons, USA	1989
2.	Materials Science and Engineering	Raghavan V.R	Printice Hall (India) Ltd	2001
3.	Nanoscale materials chemistry	Kenneth J. Klabunde	A. John wiley and Sons Inc. Publications	2009
4.	New trends in Green Chemistry	V. K. Ahuwalia, M. Kidwar	Anamaya Publisher, New Delhi	2004
5.	Solid State Chemistry	Lesley E. Smart & Elaine A. Moore	CRC Press	2012

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Introductory Solid State Physics	H. P. Meyers	Viva Books Private Limited	1998
2.	Introduction to Nanotechnology	C. P. Poole, and Jr. F. J. Owens	Wiley Interscience, New Jersey	2003
3.	Solid State Chemistry and its applications	A. R. West	John-Wiley and sons	1987
4.	Advance in Solid state Chemistry	C. N. R. Rao	World Scientific Publishing Co. Pvt. Ltd.	1995
5.	New Directions in Solid State Chemistry	C. N. R. Rao	Cambridge University Press	2010
6.	Nanomaterials	Dieter Vollah	Wiley VCH	2013

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - VI

ELECTIVE-II	B.Sc. Chemistry	2019-2020
M19UCHE05	DAIRY CHEMISTRY	
Credits: 4		

Objectives

This course provides knowledge about the composition of Milk, Creams and Butter and factors affecting the gross composition of milk also acquire knowledge about the washing procedure using dairy detergents.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the Physico-Chemical aspects of milk.	K2
CO2	Discuss about milk carbohydrate, milk proteins, minerals, water soluble vitamins.	K4
CO3	Apply basic methods using separation of Cream and Butter.	K3
CO4	Explain the manufacturing process of Milk powder and Ice cream.	K4
CO5	Discuss sterilization process and dairy detergents.	K2

UNIT I

Milk: General composition of milk, factors affecting the gross composition of milk, physic - Chemical change taking place in milk due to processing parameters - boiling pasteurization - sterilization and homogenization.

UNIT II

Milk lipids - terminology and definitions - Milk proteins: Physical properties - Electrical properties, hydration and solubility. Reaction of milk proteins with formaldehyde and ninhydrin. Milk carbohydrate - Lactose -

Estimation of lactose in milk. Milk vitamins-water and soluble vitamins, effect of heat and light on vitamins. Ash and mineral matters in milk.

UNIT III

Creams: Definition-composition - chemistry of creaming process - gravitational and centrifugal methods of separation of cream - Factors influencing cream separation (Mention the factors only) - Cream neutralization. Estimation of fat in cream.

Butter: Definition - % composition-manufacture - Estimation of fat, acidity, salt and moisture content - Desi butter.

UNIT IV

Milk powder: Definition-need for making powder - drying process - spraying, drum drying, jet drying and foam drying-principles involved in each. Manufacture of whole milk powder by spray drying process - keeping quality of milk powder.

Ice cream: Definition-percentage composition - types - ingredients needed - manufacture of ice-cream stabilizers - emulsifiers and their role.

UNIT V

Dairy Detergents: Definition - characteristics - classification - washing procedure (modern method) sterilization - chloramin-T and hypochlorite solution.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Outlines of Dairy Technology	Sukumar De	Oxford University Press	2002
2.	Principles of Dairy Chemistry	Robert Jenness and S. Patorn	John Wiley& Sons, USA	1959
3.	Advanced Dairy Chemistry	P. F. Fox, M. C. Sweeney & L. H. Paul	Springer	2006

TEXT BOOKS

S.No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Indian Dairy products	K.S. Rangappa and K.T. Achaya	Asia Publishing House	1974
2.	Modern Dairy technology	R. Robinson	APV Baker Ltd	1994
3.	Fundamental Concepts of Applied Chemistry	Jayashree Gosh	S. Chand Ltd	2006
4.	Fundamentals of Dairy Chemistry	Werb Jhonson & Alford	CSB Publishing & distributors	2005
5.	Fundamentals of Dairy Chemistry	P. Wong	Aspen Publishers	1999

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - VI

ELECTIVE-II	B.Sc. Chemistry	2019-2020
M19UCHE06	SPECTROSCOPY	
Credits: 4		

Objectives

In this course student can learn the basic principle, instrumentation and identification of various structural compounds by UV, IR, NMR and Mass spectroscopy.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand about interpretation of UV-Visible spectroscopy.	K2
CO2	Analyze basic principles of IR spectroscopy, and different vibration modes of molecule.	K4
CO3	Understand thorough knowledge of the fundamentals of Raman spectroscopy.	K1
CO4	Analyze Interpretation of NMR spectra of simple organic compounds.	K4
CO5	Apply the principle of mass spectrometer and Interpretation of Mass spectra of simple organic compounds.	K3

UNIT I

Definition of spectrum. Electromagnetic radiation, quantization of different forms of energies in molecules (translational, rotational and electronic). UV-VISIBLE Spectroscopy - Types of electronic transitions - Applications.

Beer's - Lambert's law - O.D., chromophore, auxochrome, bathochromic and hypsochromic shifts - Instrumentation.

UNIT II

I.R.Spectroscopy - principles - modes of vibration of diatomic, triatomic linear (CO₂) and non-linear triatomic molecules (H₂O) - stretching

and bending vibrations - selection rules. Expression for vibrational frequency (derivation not needed) – instrumentation - sampling techniques. Applications.

UNIT III

Raman spectroscopy - condition - Rayleigh and Raman scattering, Stokes and anti-Stokes lines. Differences between Raman and IR Spectroscopy. Mutual exclusion principle (CO₂ and N₂O).

Microwave spectroscopy - theory, selection rule. Calculation of moment of inertia and bond length of diatomic molecules.

UNIT IV

NMR Spectroscopy: Principle - basic instrumentation - number of signals - chemical shift - shielding and deshielding – spin-spin coupling and coupling constants - TMS as NMR standard. Interpretation of NMR spectra of simple organic compounds such as Acetone, Anisole, Benzaldehyde, Ethyl acetate, Ethylamine, Ethyl Bromide, Toluene and Isopropyl phenyl ketone.

UNIT V

Mass spectroscopy - Basic principles – instrumentation - molecular ion peak, base peak, metastable peak, isotopic peak- their uses. Nitrogen rule - ring rule - fragmentation. Interpretation of mass spectra of simple organic compounds such as Acetone, Anisole, Benzaldehyde, Ethyl acetate, Ethylamine, Ethyl Bromide, Toluene and Isopropyl phenyl ketone.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Organic Spectroscopy	Kalsi. L	New Age International Company New Delhi	1998
2.	Organic Chemistry	Seyhan N. Ege	Houghton Mifflin Co., New York	2004
3.	Elements of Organic Spectroscopy	YR Sharma	S Chand Publications	2010

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Spectrometric identification of organic compounds	R. M. Silverstein and F. X. Webster	John Wiley & Sons, USA	1997
2.	Organic Spectroscopy	W. Kemp	MacMillon	1994
3.	Introduction to Spectroscopy	Pavia, Lampman and Kriz	Brooks/Cole Pubs. Co	1979
4.	Spectroscopic methods in organic chemistry	D. H Williams and Ian Fleming	Tata McGraw Hill	1998

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - VI

ELECTIVE-II	B.Sc. Chemistry	2019-2020
M19UCHE07	BIO-INORGANIC CHEMISTRY	
Credits: 4		

Objectives

This course deals the principles of bioinorganic chemistry, role of bioinorganic molecules in biology and the biological functions of co-ordination complexes

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand typical roles and chemistry of the bioinorganic elements in living system.	K2
CO2	Analyze the role of Alkali and Alkaline Earth Metal Ions for Catalysis and regulation of bioenergetic processes.	K4
CO3	Illustrate primary processes in Photosynthesis at the Center of metals.	K1
CO4	Understand essential role of Cobalamins for living system.	K2
CO5	Relate body systems involved in the copper homeostasis process.	K3

UNIT I

Occurrence, availability and functions of Inorganic elements in biological systems. Biomineralisation - Control and assembly of advanced materials in Biology - Nucleation and crystal growth – various biominerals – calcium phosphate – calcium carbonate – Amorphous silica, Iron-biominerals – strontium and barium sulphate.

UNIT II

Characterization of K^+ , Na^+ , Ca^{2+} and Mg^{2+} - complexes of alkali and alkaline earth metal ions with macrocycles - Ion channels – ion pumps.

Catalysis and regulation of bioenergetic processes by the Alkaline Earth Metal ions Mg^{2+} and Ca^{2+} .

UNIT III

Primary Processes in Photosynthesis – Photosystems I and II - Light Absorption (Energy Acquisition) – Exciton transport (Direct Energy Transfer) – Charge separation and electron transport – Manganese catalyzed oxidation of water to O_2 .

UNIT IV

Reactions of the alkyl cobalamins – One electron Reduction and Oxidation – Co-C Bond Cleavage – coenzyme B12 – Alkylation reactions of methylcobalamin. Heme and Non-heme Proteins - Hemoglobin and Myoglobin – Oxygen transport and storage – Electron transfer and Oxygen activation. Cytochromes, Ferredoxins and Rubredoxins – Model systems, mononuclear non-hemiron enzymes.

UNIT V

Copper Containing Proteins: Classification and examples - Electron transfer – Oxygen transport - Oxygenation – oxidases and reductases – Cytochrome oxidase – Superoxide dismutase (Cu, Zn).

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Inorganic Chemistry	J. E. Huheey	Row Publishers, Singapore W. B. Saunders	1972
2.	Inorganic Chemistry	Purcell and Kotz	Company, Philadelphia.	1977
3.	Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life	W. Kaim, B. Schewederski	John Wiley & Sons, New York, USA	1994
4.	Advanced Inorganic Chemistry	Cotton and Wilkinson	Wiley Inter science Publication, John Wiley & Sons, New York, USA.	1980

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Principles of Bioinorganic Chemistry	S. J. Lippard and J. M. Berg	Panima Publishing Company, New Delhi	1997
2.	Inorganic Biochemistry	G. L. Eichorn	Elsevier Scientific Publishing Company, New York.	1973
3.	The Organometallic Chemistry of the Transition Metals	R. H. Crabtree	John Wiley & Sons, NewYork	1988
4.	Problems and Solutions in Organometallic Chemistry	S. E. Kegley and A. R. Pinhas	University Science Books, Oxford University Press	1987

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - VI

ELECTIVE-II	B.Sc. Chemistry	2019-2020
M19UCHE08	CORROSION SCIENCE	
Credits: 4		

Objectives

This course presents an idea about corrosion types and its reaction mechanism and corrosion prevention techniques.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand basic principles of corrosion science.	K1
CO2	Analyze various types corrosion including Crevice Corrosion, Pitting, Intergranular Corrosion.	K4
CO3	Apply the knowledge of a materials composition and its microstructure on its corrosion performance.	K3
CO4	Describe methodologies for predicting, measuring and analyzing corrosion performance of materials.	K2
CO5	Identify materials that will exhibit adequate corrosion resistance of metals.	K4

UNIT I

Corrosion: Introduction - Definition – Mechanism – Electrochemical Reactions – Polarization – Passivity – Effect of Oxygen and Oxidizers, Velocity, Temperature, Corrosion Concentration and Galvanic Coupling

UNIT II

Types of Corrosion: Metal Corrosion – Types (Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion, Stress Corrosion) - Hydrogen Damage.

UNIT III

Corrosion Testing: Introduction – Classification – Purpose – Materials and Specimens – Surface Preparation – Measuring and Weighing – Exposure Techniques – Duration – Interval Tests – Aeration – Cleaning Specimens after Exposure – Temperature – Standard Expression for Corrosion Rate – Test for Stainless Steels (Huey, Streicher) – Warren Test – NACE.

UNIT IV

Corrosion Test Methods: Slow – Stain – Rate Tests – Linear Polarization – AC Impedance – Small – Amplitude Cyclic Voltammetry – Paint Tests – Sea Water Test – Miscellaneous Tests of Metals.

UNIT V

Corrosion Prevention: Metals and Alloys – Metal Purification – Alteration of Environment – Changing Mediums – Inhibitors – Design – Wall Thickness – Design Rules – Cathodic Protection – Anodic Protection – Comparison of Anodic and Cathodic Protection – Coatings – Metallic and Inorganic Coatings – Organic Coatings – Corrosion Control Standards.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Corrosion Engineering	Mars G. Fontana	McGraw- Hill International Editions	1987
2.	Corrosion Hand Book	Herbert H. Uhlig	John Wiley and Sons, New York	1948
3.	Corrosion Inhibitors, Principle and Applications	V.S. Sastri	John Wiley and Sons, Newyork	1998

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Corrosion Inhibitors	C.C. Nathan	National Association of Corrosion Engineers Houston	1974
2.	Introduction to corrosion science	Mccafferety	Springer	2010
3.	Corrosion Chemistry	Volkan Cicek, Bayan Al-Numan	Scrivener Publishing	2011

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	M	M	S	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

SEMESTER - III

SEC-I	B.Sc. Chemistry	2019-2020
M19UCHS01	SEC-I - FOOD AND NUTRITION	
Credits: 2		

Objectives

Expand and build human and institutional capacity to solve problems of food and nutrition.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate the concept of Food adulteration and the uses of food.	K4
CO2	Gain awareness about food poisoning.	K3
CO3	Learn knowledge about Food Preservation and Processing.	K2
CO4	Study the Sources and deficiency diseases of Vitamins.	K2
CO5	Infer Knowledge about Mineral elements in food.	K1

UNIT I

Food: Definition - Sources, types, advantages and disadvantages of foods, constituents of foods, carbohydrate, protein, fats, oils, colours, flavours, natural toxicants.

UNIT II

Food Poisoning: Sources, causes and remedy- Causes and remedies for acidity, gastritis, indigestion and constipation.

UNIT III

Food Preservation and Processing: Food spoilage, causes of food spoilage, types of Food spoilage, food preservation, preservation and processing by heating- sterilisation, pasteurisation.

UNIT IV

Food adulteration: Definition - adulterant, adulteration - types of adulterants - common adulterants and their determination in milk, oils,

ghee, honey, chilly powder, coriander powder, turmeric powder, coffee powder, tea dust, asafetida.

UNIT V

Vitamins: Sources, requirement deficiency diseases of A, C, K, E1 and B1, B2, B6.

Minerals: Mineral elements in food - Principal mineral elements-source. Function - Deficiency and daily requirements-Na, K, Mg, Fe, S and P.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Food Chemistry	Werner Grosch	Springer	2009
2.	The Extraordinary Chemistry for ordinary things	Car H. Synder	John Wiley & Sons Inc., New York.	1992
3.	Food Safety	Jinap Selamat	Heidelberg Springer Int. Publishing	2016
4.	Introduction to Food Chemistry	Richard Owusu – apenten	CRC Press	2004

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Food Chemistry	Seema Yadav	Anmol publishing (P) Ltd, New Delhi.	1998
2.	Text book of Nutrition & Dietetics	Sharda Gupta, Santosh Jain	Elite Publishing House Pvt Ltd.	2016
3.	Food Processing and Preservation	B. Siva Sankar	PHI Learning (P) Ltd, New Delhi.	2002

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	S
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	M	S	S	M	M
CO5	M	S	S	S	M

S- Strong; **M**-Medium.

SEMESTER - IV

SEC-II	B.Sc. Chemistry	2019-2020
M19UCHS02	SEC-II - INDUSTRIAL CHEMISTRY	
Credits: 2		

Objectives

This course make the students well-grounded in the principles and thorough knowledge of scientific techniques on industrial chemistry.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Acquire knowledge about chemical explosives.	K1
CO2	Transfer the process involved in Leather Industry.	K3
CO3	Extract knowledge about fertilizer and agrochemical industries.	K2
CO4	Relate the role and need of Paints, Varnishes & Cleansing Agents	K2
CO5	Recite the knowledge on construction material.	K1

UNIT I

Chemical Explosives: Preparation and chemistry of lead azide, nitroglycerine, nitrocellulose, TNT, RDX, Dynamite, cordite, picric acid, gunpowder, rocket propellant: Classification, Properties and examples.

UNIT II

Leather Industry: Curing, preservation and tanning of hides and skins, process of dehairing and dyeing. Treatment of tannery effluents.

UNIT III

Agrochemical Industries: Important categories of insecticides, fungicides, herbicides, rodenticide, Mode of action and synthesis of pesticides: gammexane, DDT, Parathion, Malathion,.

UNIT IV

Paints, Varnishes: Primary constituents of paints, Dispersion medium (solvent), binder Pigments, formulation of paints and varnishes. Requirements of a good paint.

Cleansing Agents: Preparation of toilet and washing soaps, synthetic detergents - alkyl aryl sulphonates, ethanolamines, non-ionic detergents, builders, additives, corrosion inhibitors.

UNIT V

Cement: Manufacture – Wet Process and Dry process, types, analysis of major constituents, setting of cement, reinforced concrete.

Glass: Composition and manufacture of glass. Types of glasses - optical glass, coloured glasses and lead glass

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Industrial Chemistry	B.N.Chakrabarty	Oxford & IBH Publishing Co, New Delhi	1981
2.	Industrial Chemistry	B.K. Sharma	Goel Publishing House, Meerut	2000
3.	College Industrial Chemistry	P.P.Singh, T.M.Joesph, R.G.Dhavale	College Industrial Chemistry, Bombay, 4 th Ed.,	1983

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Hand book of Industrial Chemistry: Organic Chemicals	Mohammad Farhat Ali, Bassam M. El Ali	MC Graw Hill Education	2005
2.	The Chemistry of Explosives	Jacqueline Athavan	Royal Society of Chemistry	2011
3.	Chemistry in Everyday Life	Kirpal Singh	PHI Learning Pvt Ltd.	2012

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	S
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	M	S	S	M	M
CO5	M	S	S	S	M

S- Strong; **M**-Medium.

SEMESTER - V

SEC-III	B.Sc. Chemistry	2019-2020
M19UCHS03	SEC-III - PHARMACEUTICAL CHEMISTRY	
Credits: 2		

Objectives

This course provides knowledge of human health through safe, efficacious and affordable pharmaceutical interventions.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the significance of pharmaceutical terms in the profession.	K1
CO2	Discuss some important method of preparation of drugs and their mechanism.	K2
CO3	Interpret chemical behaviour of the Analgesics.	K4
CO4	Illustrate the importance of Anaesthetics.	K1
CO5	Bring out idea of Diabetics, AIDS and some natural medicinal plants.	K3

UNIT I

Drug: Definition – terms - drug, pharmacophore, pharmacodynamics, pharmacopoea, pharmacology, bacteria, virus, fungus, actinomycetes, metabolites, antimetabolites, LD50, ED50. Therapeutic index.

UNIT II

Sulphonamides - mechanism and action of sulpha drugs - preparation and uses of sulphadiazine, sulphapyridine. Antibiotics – Definition - classification as broad and narrow spectrum, Antibiotics - penicillin, ampicillin, structure and mode of action only (no structural elucidation, preparation, assay)

UNIT III

Analgesics – Definition, Types of actions - narcotic and non narcotic - morphine, Heroin. Antipyretic analgesics - salicylic acid derivatives - methyl salicylate, aspirin.

UNIT IV

Anaesthetics: Definition – classification - local and general - volatile, nitrous oxide, ether, chloroform, uses and disadvantages – nonvolatile – intravenous - thiopental sodium, -local anaesthetics –cocaine and benzocaine. Antianaemic drugs-iron, vitamin B12 and folic acid-mode of action.

UNIT V

Diabetics - Hypoglycemic agents - sulphonyl urea, biguanides. AIDS - causes, prevention and control. Indian medicinal plants and uses - tulasi, kilanelli, mango, semparuthi, adadodai and thoothuvalai.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Pharmaceutical Chemistry	Bentley and Drivers	Oxford University Press	2004
2.	Pharmaceutical Chemistry	Alen Chidambaram	Birla Publications Pvt Ltd	2008
3.	Pharmaceutical Chemistry Theory & Application	L.G. Chatten	CBS Publisher	2008

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Organic Pharmaceutical Chemistry.	Singh. H and Kapoor V.K	VallabhPrakashan	2014
2.	Pharmaceutical Chemistry-Inorganic	G.R. Chatwal	Himalaya Publishing House	2018
3.	Pharmaceutical Chemistry	Jayashree Ghosh .S	S. Chand Publishing	2012
4.	Pharmaceutical Chemistry-Organic	G.R. Chatwal	Himalaya Publishing House	2015

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	S
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	M	S	S	M	M
CO5	M	S	S	S	M

S- Strong; **M**-Medium.

SEMESTER - VI

SEC-IV	B.Sc. Chemistry	2019-2020
M19UCHS04	SEC-IV - GREEN CHEMISTRY	
Credits: 2		

Objectives

This course helps to think of chemistry as a sustainable activity.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Classify the principles of green chemistry and sustainable chemistry.	K2
CO2	Sketch the processes of green chemistry.	K3
CO3	Learn alternative solvent media and energy sources for chemical processes.	K2
CO4	Understand the basics of nanochemistry.	K2
CO5	Apply analytical techniques for the synthesis.	K3

UNIT I

Green chemistry: Need for green chemistry – principles of green chemistry – atom economy – definition with example (ibuprofen synthesis) – green oxidant – hydrogen peroxide. Microwave assisted organic synthesis – apparatus required – examples of MAOS – advantages and disadvantages of MAOS. Organic reactions by Sonication method – apparatus required only.

UNIT II

Green Reactions: Acetylation of primary amine, base catalyzed aldol condensation (synthesis of dibenzalpropanone), halogen addition to C=C bond (bromination of trans-stilbene), [4+2] cyclo addition reaction (Diels-Alder reaction between furan and maleic acid). Electrophilic aromatic substitution reactions (nitration of phenol, bromination of acetanilide)zeolite catalyzed Friedel-Crafts acylation.

UNIT III

Green Solvents: Ionic liquids: simple preparation – types – properties and application – ionic liquids in organic reactions (Heck reaction, Suzuki

reactions, epoxidation)-advantages and disadvantages. Diels-Alder reaction in water.

UNIT IV

Nanochemistry: Basics of Nanochemistry: Definition, length scales and importance of nanoscale and its technology – self assembly of materials – self assembly of molecules – porous solids, nanowires, nanomachines and quantum dots. Nano particles: Introduction – types of nanoparticles – preparation, properties and uses of gold, silicon, iron oxide, alumina and nanoparticles.

UNIT V

Synthesis and their characterization: Techniques to synthesize nanoparticles – top down and bottom up approaches – common growth methods. Electron microscopes – scanning electron microscopes (SEM) – transmission electron microscopes (TEM) – scanning probe microscopy – scanning tunneling electron microscope (STEM) only.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Green Chemistry: Environmental Friendly Alternatives	R. S. Sanghi and M.M. Srinivatava	Narosa Publishing House, New Delhi.	2003
2.	Green Chemistry	V.K. Ahluwalia	Narosa, New Delhi	2011
3.	Nanotechnology	S. Shanmugam	MJP Publishers, Chennai.	2010
4.	A Handbook on Nanochemistry	Patrick Salomon	Dominant Publishers and Distributers, New Delhi.	2008

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Industrial Application of Green Solvents	Inamuddin, Mohd Imran Ahmed, M. aniri	Materials Research Forum LLC.	2019
2.	An Introduction to Nanoparticle & Technology	Maria Benelmekki	Claypool Publishers	2015
3.	Nanobiotechnology	S. Balaji	MJP Publishers, Chennai.	2010

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	S
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	M	S	S	M	M
CO5	M	S	S	S	M

S- Strong; **M**-Medium.

SEMESTER - III

NMEC-I	B.Sc. Chemistry	2019-2020
M19NCH01	NMEC - I - APPLIED CHEMISTRY	
Credits: 2		

Objectives

This course gives a deep insight about the terms, facts and uses involved in material science and general chemistry.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Extract the composition and uses of natural gas, coal gas, semiwater gas.	K2
CO2	Sketch the fertilizers, Pesticides, Insecticides and Herbicides; their role in plant life.	K3
CO3	Understand production of sulphite pulp and conversion into paper in paper industry	K1
CO4	Classify the types of polymers and recognize the basic concepts	K3
CO5	Summarize manufacture and uses of Glass, Cement and Dyes in daily life	K4

UNIT I

Industrial Fuels: Gaseous fuels – Non petroleum fuels: Introduction - Natural gas and CNG - composition and uses; Coal gas - manufacture, composition and uses Water gas - manufacture, composition and uses; Producer gas - manufacture, composition and uses; Power alcohol - manufacture, composition and uses; Liquefied petroleum gases (LPG), Gobar gas, Benzol and Semiwater gas – Composition and uses.

UNIT II

Fertilizers: Manufacture of N, P, K and mixed fertilizers, Micronutrients and their role in plant life.

Pesticides: Classification of pesticides with examples.

Insecticides: DDT and BHC

Herbicides: 2, 4-D and 2,4,5- T

Fungicides: Bordeaux mixture, Sulphur compounds

UNIT III

Sugar industry: Double sulphitation process, refining, and grading of sugar. Saccharin: synthesis and uses as a sugar substitute. Ethanol: manufacture from molasses by fermentation.

Paper industry: Manufacture of paper: production of sulphite pulp and conversion to paper (bleaching, filling, sizing and calendaring).

UNIT IV

Polymers: Classification, types of polymerization. Natural polymers: polysaccharides (starch and cellulose), polyhydrocarbons (natural rubber) and proteins. Synthetic polymers: Preparation, properties and uses of Polyolefins-polythene, PVC, Polypropylene and Polystyrene.

Synthetic rubber: Neoprene and Buna-S, vulcanization of rubber, additives used in rubber manufacture. Plastics and Resins: Thermoplastic and thermo setting resins, Examples and its uses.

Fibres: Rayon, Terylene and Nylon.

UNIT V

Glass: Composition, manufacture and uses. Cement: Manufacture: wet and dry processes, composition and setting of cement

Dyes: Classification based on structure and application. Synthesis of Congo red and malachite green. Pharmaceuticals: Manufacture of aspirin and penicillin (fermentation process) mention of antibiotics.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Polymer Science	V. R. Gowrikar, N.V.Viswanathan	Wiley Eastern Limited, New Delhi	1986
2.	Applied Chemistry	Biswas, A.K., Frontiers	Narosa Publishing house	1989
3.	Text Book of Applied Chemistry	S.Chauhan	Vayu Education of India	2013

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Introduction to Polymer Chemistry	R.B. Seymour	MC Craw Hill, New York	1971
2.	Pharmaceutical chemistry	Thiagarajan V.T.	K.S.C. Desikan & Co, Chennai	1995
3.	A Text Book in Engineering Chemistry	S.S. Dara	S.Chand & Company Ltd, New Delhi	1992
4.	Polymer Chemistry	Malcolm Stevens	Oxford University Press	2010

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M-**Medium.

SEMESTER - III

NMEC-I	B.Sc. Chemistry	2019-2020
M19NCH02	NMEC - I - AGRO INDUSTRIAL CHEMISTRY	
Credits: 2		

Objectives

This course gives idea exposure to agricultural chemistry, different methods of cultivation using fertilizers, pesticides, Insecticides, manures.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Interpret the basic concepts of Soil chemistry	K2
CO2	Know the uses of inorganic fertilizers	K1
CO3	Explain General methods of manure preparation and its storage	K2
CO4	Distinguish between the application and toxicity of Insecticides, fungicides and herbicides	K3
CO5	Sketch about the manufacture of sucrose from cane sugar and Beetroot.	K1

UNIT I

Soil: Origin of soil – definition of soil — soil formation - main components of soil – organic, inorganic constituents – soil texture – pore space – Acid, alkaline and saline soil – diagnosis – Methods of reclamation and after care.

UNIT II

Fertilizers: Classification, Macronutrients – role of nitrogen, potassium and phosphorous on plant growth – Manufacture of urea, muriate potash and triple superphosphate. Complex fertilizers, mixed fertilizers and bio-fertilizers – their composition. Micronutrients – their role in plants.

UNIT III

Manures: Bulky organic manures – Farm yard manure – oil cakes – blood meal – fish manures – Composting process – handling and storage.

UNIT IV

Pesticides: Definition - Classification based on the use and chemical composition – examples – Benefits of pesticides – safety measures – first aid.

Insecticides: Plant products – Nicotine, pyrethrin – Inorganic pesticides – borates. Organic pesticides – DDT and BHC.

Fungicides: Sulphur compounds, Copper compounds, Bordeaux mixture.

Herbicides: Acaricides – Rodenticides. Attractants – Repellants.

UNIT V

Chemistry of Sugar: Manufacture of sugar from molasses and beetroot. Fermentation: Manufacture of spirits and wines. Distillation: Manufacture of vinegar and ethyl alcohol.

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Industrial Chemistry	M.C. Arora & M. Singh	Anmol publications	1994
2.	Engineering Chemistry	P.C.Jain, M.Jain	Dhanpat Raj Publishing Company Pvt Ltd	2007
3.	Insecticides, Pesticides and Agro based Industries	R.C.Palful, K.Goel, R.K.Gupta	Small business publications	1998

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Industrial Chemistry	B.K. Sharma	Goel Publishing House	2008
2.	Agricultural Chemistry	B.A. Yagodin	Mir Publishers (Moscow)	1976
3.	Manures, Fertilizer and Pesticides. Theory and Application	Amitava Rakshit, Priyankar Raha	CBS Publishers	2015
4.	Cane Sugar Hand Book	James C. P. Chin	Wiley	1993

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - IV

NMEC-II	B.Sc. Chemistry	2019-2020
M19NCH03	NMEC - II - FOOD CHEMISTRY	
Credits: 2		

Objectives

This course explains about food processing and different methods of preparing food using additives.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain food science and know about cooking objectives	K1
CO2	Classify the advantage and disadvantages of Microwave cooking & Solar cooking	K2
CO3	Identify food adulterants and Changes in food constituents due to spoilage.	K3
CO4	Examine methods of food preservation	K1
CO5	Analyze the functions and uses of food additives.	K4

UNIT I

Introduction to food science- Source, functions of food – food groups – food guide – basic five food groups, usage of the food guide – food in relation to health.

Cooking - Objectives, limitations, preliminary preparations - Cleaning, Peeling and Stringing, Cutting and Grating, Sieving, Soaking, Processing, Coating, Blanching, Marinating, Sprouting, Fermentation, Grinding, Filtering, Roasting.

UNIT II

Cooking Methods: Classification of cooking methods - Moist heat methods - Boiling, Simmering, Poaching, Stewing, Steaming, Pressure cooking. Dry heat methods - Air as medium of cooking - Grilling, Pan broiling, baking. Fat as medium of cooking - sautéing, shallow fat frying, deep fat frying. Microwave cooking - Advantages and disadvantages. Solar cooking - Advantages and disadvantages.

UNIT III

Food Adulterants: Common adulterants in different foods – milk and milk products, vegetable oils, and fats, spices and condiments, cereals, pulses, sweetening agents and beverages. Contamination with toxic chemicals – pesticides and insecticides. Principles involved in the analysis of detection and prevention of food adulteration.

Food spoilage: Microbiological spoilage - Moulds, yeasts, pseudo yeasts, viruses, bacteria. Biochemical spoilage - spoilage by insects, Parasites and Rodents. Mechanical spoilage, Chemical spoilage. Changes in food constituents due to spoilage.

UNIT IV

Food Preservation: Principles of food preservation-Preservation by low temperature - Freezing, slow freezing, quick freezing process, dehydro freezing, freezing foods, effect of freezing and nutritive value. Preservation by high temperature - Pasteurization, Canning. Preservation by preservatives, Preservation by high Osmotic pressure, Preservation by dehydration and by irradiation.

UNIT V

Food Additives: Definition, need for additives, functions and uses of food additives. Classification of food additives - preservatives, antioxidants, sequestrants, surface active agents, bleaching and maturing agents, starch modifiers, flavoring agents and flavour enhancers, non - nutritive dietary sweeteners, nutrient supplements, food colours, stabilizers and thickeners.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Food Science	B. Srilakshmi	New Age International Pvt Ltd	2003
2.	Food Chemistry	Seema Yadav	Anmol publishing (P) Ltd, New Delhi	2002
3.	Foods: Facts and Principles	N. Shakuntala Manay, M. Shadaksharaswamy	New Age International Publishers	2008

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Text Book on Food storage and Preservation	Vijaya Khader	Kalyani Publishers	1999
2.	Food Chemistry	Alex V Ramani	MJP Publishers	2009
3.	Food Processing and Preservation	Sivasankar	PHI.(Eastern Economy Editions)	2004
4.	Advanced Text Book on Food and Nutrition Vol. I & II	M. Swaminathan	Bapcco Ltd	2015
5.	Food Science	Owen R. Fennema	Marcel Dekker Publishers	2007

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	M	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

SEMESTER - IV

NMEC-II	B.Sc. Chemistry	2019-2020
M19NCH04	NMEC - II - BIOLOGICAL CHEMISTRY	
Credits: 2		

Objectives

This course describes the major role and function of nucleic acid, Vitamins and Minerals in biological functions of hormones and enzymes.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Acquire knowledge about essential and nonessential of amino acids for living system	K1
CO2	Explain the classification and biological functions of carbohydrate and lipids	K2
CO3	Illustrate the Deficiency diseases of Vitamins A, C, K, E1 and B6.	K4
CO4	List out deficiency disease for micro and macro minerals for Human health	K2
CO5	Predict biochemical functions of enzymes and hormones for living system	K3

UNIT I

Amino acids - classification, essential and nonessential amino acids and functions. Nucleic acids - DNA, RNA - constituents, structure and functions.

UNIT II

Carbohydrates; Classification and functions. Lipids - classification, biological functions and difference between fats and oils.

UNIT III

Vitamins: Classification, sources, biological function and deficiency diseases of Vitamins A, C, K, E1 and B6.

UNIT IV

Minerals: Sources, biological functions and deficiency disease of macro minerals - Sodium, Potassium, Calcium, Phosphorous and Magnesium. Micro minerals: Selenium, copper, Iron, Zinc and Manganese.

UNIT V

Enzymes: Classification and functions. Hormones: Classification and biochemical functions of Adrenalin, Thyroxine, Oxytocin, Insulin and Sex hormones

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Fundamental concepts of applied chemistry	S.Jayashree Ghosh	S.Chand & company	2006 1 st Edn
2.	Biochemistry	U.Satyanarayana and U.Chakrapani	Elsevier India Pvt.Ltd	1998 4th Edn
3.	Fundamentals of Biochemistry	J. L. Jain	S. Chand Publication	2016

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year of Publication
1.	Laboratory manual for analytical biochemistry and separation techniques	P. Palanivelu	School of Biotechnology, Madurai Kamaraj University Press, Madurai.	2000
2.	Natural products	Gurdeep Chatwaal	Goel Publishing House, New Delhi	1986
3.	Applied Chemistry	H. D. Gesser	Springer	2001

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	S
CO4	S	M	S	M	M
CO5	S	M	M	S	S

S- Strong; **M**-Medium.

ENHANCEMENT COMPULSORY COURSES

SEMESTER - I

ECC-I	B.Sc. Chemistry	2019-2020
M19UVE01	VALUE EDUCATION - YOGA	
Credits: 2		

Objectives

This course provides the basic knowledge on physical body, health concepts, Simplified Physical Exercises, Asanas and Meditation. It also helps to Introspect and improve the students behaviors.

Course outcomes

On the successful completion of the course, students will be able to

CO	Statement	Knowledge Level
CO1	Remember the basic idea about yoga	K1
CO2	Understand the Physical Exercises	K2
CO3	Analyze the body and mind	K4
CO4	Analyze the health concepts	K4
CO5	Apply the mind with yoga concepts	K3

அலகு 1

யோகமும் உடல் நலமும் உடலமைப்பு - எளிய முறை உடற்பயிற்சி - மகராசனம் - யோகாசனங்கள்

அலகு 2

இளமை காத்தல் - பாலுணர்வும் ஆன்மீகமும் - மனதின் 10 படிநிலைகள் - மனஅலைச்சுழல்.

அலகு 3

குணநலப்பேறு வாழ்வின் நோக்கம் - எண்மை ஆராய்தல் - ஆசை சீரமைத்தல் - சினம் தவிர்த்தல்.

அலகு 4

கவலை ஒழித்தல் - வாழ்த்தும் பயனும் - நட்பு நலம் - தனி மனித அமைதி.

அலகு 5

செயல் விளைவுத் தத்துவம் - மனத்தூய்மை, வினைத்தூய்மை - அன்பும் கருணையும் - பண்பாட்டுக் கல்வி.

REFERENCE BOOKS

S.No.	Author	Title of Book	Publisher	Year of Publication
1.	மனவளக்கலை யோகா	மனவளக்கலை யோகா	உலக சமுதாய சேவா சங்கம் வேதாத்திரி பதிப்பகம்	2008
2.	மனவளக்கலை யோகா	மனவளக்கலை யோகா –I	உலக சமுதாய சேவா சங்கம் வேதாத்திரி பதிப்பகம்	2009
3.	மனவளக்கலை யோகா	மனவளக்கலை யோகா –II	உலக சமுதாய சேவா சங்கம் வேதாத்திரி பதிப்பகம்	2012
4.	மனவளக்கலை யோகா	மனவளக்கலை யோகா –III	உலக சமுதாய சேவா சங்கம் வேதாத்திரி பதிப்பகம்	2015
5.	மனவளக்கலை யோகா	எளிமுறை உடற்பயிற்சி	உலக சமுதாய சேவா சங்கம் வேதாத்திரி பதிப்பகம்	2009

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	M
CO2	S	M	S	M	S
CO3	M	S	M	S	M
CO4	M	S	S	M	S
CO5	S	M	S	S	M

S- Strong; **M-**Medium

SEMESTER - II

ECC-II	B.Sc. Chemistry	2019-2020
M19UES01	ENVIRONMENTAL STUDIES	
Credits: 2		

Objectives

This course provides the basic idea about our environment, ecosystem, natural resources, pollution and environment policies and practices.

Course outcomes

On the successful completion of the course, students will be able to

CO	Statement	Knowledge Level
CO1	Remember the basic fundamentals of our environment	K1
CO2	Understand our natural resources	K2
CO3	Sketch the concept of food chain and Bio diversity	K3
CO4	Understand the environmental pollution	K2
CO5	Analyze how the environment affects the human health	K4

UNIT I

Environment: Definition, Scope, Structure and Function of Ecosystems– Producers, Consumer and Decomposers – Energy Flow in the Ecosystem –Ecological Succession – Food Chain, Food Webs and Ecological Pyramids –Concept of Sustainable Development.

UNIT II

Natural Resources: Renewable Resources – Air, Water, Soil, Land and Wildlife resources, Non-Renewable Resources, Coal, Oil and Natural Gas, Environment problems related to the extraction and use of Natural Resources.

UNIT III

Biodiversity: Definition – Values – Consumption use, Production Social, Ethical, Aesthetic and Option Values Threats to Biodiversity – Hotspots of Biodiversity – Conservation of Biodiversity: In-situ, Ex-situ, Bio-Wealth National and Global Level.

UNIT IV

Environmental Pollution: Definition – Causes, Effects and Mitigation Measures – Air, Water, and Soil Pollution, Noise Pollution, Thermal pollution, Nuclear Hazards, Solid Wastes, Acid Rain, Climate change and Global Warming, Environmental Laws and Regulations in India – Earth summit.

UNIT V

Pollution and Environment: Population Explosion – Environment and Human Health – HIV/AIDS – Women and Child Welfare – Resettlement and rehabilitation of people, Role of Information Technology in Environmental Health – Environment Awareness, Environmental Awareness, Environment Disaster Management – Fire Safety and Prevention.

REFERENCE BOOKS

S No	Title of Book	Author	Publisher	Year of Publication
1.	This Fissured Land: An Ecological History of India	Gadgil M., Guha	Univ. of California Press	1993
2.	Global Ethics and Environment	Gleeson B. and Low N	London, Routledge	1999
3.	Essentials of Ecology & Environmental Science	S. V. S Rana	Prentice Hall India Learning Pvt. Ltd.	2013

TEXT BOOKS

S No	Title of Book	Author	Publisher	Year of Publication
1.	Environmental Science	Benny Joseph	Mc Graw Hill Education	2018
2.	Environmental Studies	Erach Bharuche	Orient Black Swan	2013
3.	Text Book of Environmental Studies	Asthana & Meera Asthana	Chand Publications	2010

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	M
CO2	S	M	S	M	S
CO3	M	S	M	S	M
CO4	M	S	S	M	S
CO5	S	M	S	S	M

S- Strong; **M**-Medium