Bangalore University
Department of Chemistry

Jnanabharathi Campus

Bengaluru – 560 056

Syllabus for

I & II Semester Chemistry Courses

Under-Graduate (UG) Programme

Framed according to the National Education Policy (NEP 2020)

September 2021

FOREWORD

National Education policy 2020 has been one among the intensely debated policies in the recent times. Given the long reach of Education as a social and economic transformation tool - more so for a developing nation like ours- the traction it has garnered in public domain is no surprise.

Karnataka is the first state in the country to implement NEP in higher education. But playing the role of a pioneer is not child's play. Transforming the policy into a working framework and befitting a competent curriculum and syllabus is always a challenging task. The state has come up with the NEP framework for all the UG programmes starting from the academic year 2021.

Undergraduate programmes were traditionally conceived as preparation for post graduation. Since decades its structure remained unchanged and was long due for an overhaul. The rigidity in choosing subjects through fixed combinations had to be reconsidered. The aspects of all-round development of the students, skill acquisition outside chosen subjects and research were undermined but NEP has changed all of these in one stroke.

The prominent features of the NEP framework are:

I. Flexibility in choosing subjects and even disciplines for the graduate programmes
II. Vertical and horizontal mobility across subjects throughout the programme
III. Multiple entry and exit points
IV. Main-streaming of skill based courses
V. Credit based evaluation system
VI. Integration of research into 4th year of the programme leading to Honors degree

Such radical modifications have put the learner at the center of the education system. The framework has nudged the academic faculty to work out syllabi aligned with national standards, if not global. The road map is in place. It is the implementation of NEP in its letter and spirit that would catalyze raising the bar for the quality in Higher Education.

I place on record my appreciation and regard to all those who were involved in the endeavor of the syllabus preparation for the undergraduate Chemistry programme of Bangalore University. The fact that all efforts have been made to align the syllabus with the NEP structure is further satisfying. I sincerely hope that periodical revisions will take place in coming years.

V. V. Sureshbabu, Ph.D.
CHAIRMAN
Department of Chemistry
Bangalore University
Bengaluru

Preamble

The syllabus for the B.Sc. Chemistry subject was long due for revision. It was incidental that timing of the revision overlapped with that of framing new syllabus in accordance to NEP framework to be implemented in higher educational institutions throughout the state.

Honorable Vice Chancellor of Bangalore University Dr. K. C. Venugopal provided the directions and vital inputs to undertake this uphill task of framing new syllabus for Chemistry subject of the B. Sc. programme. The model syllabus was to be provided by the state level expert committee, but this was to be modified and adopted according to our ingenious needs. The syllabus had to be compatible with the B.Sc. (Honors) programme which was to be newly introduced from the academic year 2021-22.

To accomplish the task, Department of Studies in Chemistry, Jnana Bharathi Campus, Bangalore University aligned with the Core Group of expert Teachers of the Affiliated colleges and University Department . The Core Group participated in virtual meetings on **13.09.2021, 17.09.2021, 19.09.2021 and 20.09.2021** and shaped a draft in accordance with the objectives of the NEP model curriculum. Several new elements like development of interdisciplinary skills, bridging the skill gap and knowledge-application to local problems were introduced.

Studying Chemistry subject in the B.Sc. and B,Sc.(Honors) is molded to Choice Based Credit System (CBCS) and the courses are spread over all semesters. The syllabus is intended to familiarize students with the sound basic understanding of the subject as well as expose them to advanced learning which would link to postgraduate and/or research programmes. Due importance is also given to the study of application oriented topics so as to build a foundation to acquiring skills.

The exercise of framing syllabus was a collective endeavor. Faculty of various branches of Chemistry namely Inorganic, Organic, Physical, Bio Chemistry, Analytical and Industrial had separate as well as joint brainstorm sessions and arrived at a draft syllabus for two semesters.

The Draft was brought to the attention of a wider group of teachers for further refinement and the final version incorporating the suggestions was placed before the Department Council on **22.09.2021** and then the Board of Studies in Chemistry (UG) on **23.09.2021** for approval.

V. V. Sureshbabu

Proceedings of the Syllabus Core Committee meeting held on 21-09-2021 at 10.30 am through cloud meeting platform

The Chairman welcomed the members of the Board to the meeting and placed the agendas for discussion.

The Chairman informed the members to frame syllabus for Chemistry subject of B.Sc. programme as per the directive from the Bangalore University and in accordance with the NEP- model programme structure. B.Sc. (Honors) Chemistryprogramme has been prepared with the help of the Faculty

members of the Core committee from Department of Chemistry, Bangalore University and from the affiliated Colleges of Bangalore University, Bengaluru. Proposed new syllabus is to be Introduced from 2021-22 after the approval from different bodies.

In this connection, Chairman directed the formation of four committees of expert teachers according to their specialization from various affiliated colleges of the University. Committees were instructed to hold virtual meetings too.

Chairman informed that,

- With the changing trends and voluminous development in the subject updating of the curriculum is a necessary exercise.
- The learners have to be equipped with sound subject know-how as well as skills required for their careers in teaching, industry and research.
- The rules governing the NEP - model (semester scheme) for UG programme are as per the university guidelines have to be adhered during syllabus framing.

Members of the core committee for the preparation of the Chemistry syllabus

Physical Chemistry Section

1**.** K. Ramakrishna Reddy, 2. Nagegowda P, 3. Nebula Murukesh

Analytical and Inorganic Chemistry Section

1. M. Shubha, 2. R. Nalini, 3. B. M. Savitha

Organic Chemistry Section

1. Renuka Manjunath , 2. Jisha S P, 3. Sumaiya Tabassum, 4. Meenaakshi Srinivasan

Bio Chemistry Section

1.Prasannakumar S G, 2. Kantharaju S

Proceedings of the meeting of the Board of studies in Chemistry-UG held on 23-09-2021 at 10.30 am in C_1 Lecture Hall, Department of Chemistry, Bangalore University

The Chairman welcomed the members of the Board and placed the agendas for discussion.

Agenda 1: The BOS unanimously resolved to co-opt Prasanna Kumar S G, M S Ramaiah College of Arts, Science and Commerce, Nebula Murukesh, St. Francis de Sales College and Sumaiya Tabassum, Surana College.

Agenda 2: Framing of syllabus (theory and practical) under NEP- model programme structure for the undergraduate programmes in universities and colleges scheme of examination.

Chairman informed that the tabled syllabus has been prepared as per the guidelines from the NEP.

- A core committee was formed to accomplish this task, which included the senior teachers from affiliated colleges and also the professors from the University department.
- Three meetings were held to finalize the theory and practical syllabus for I to II semester on 13.09.2021, 17.09.2021, 19.09.2021 and 20.09.2021.
- The teachers of the core committee have played a pivotal role in preparing the syllabus and their effort was duly appreciated.
- The draft syllabus was then finalized in a virtual meeting conducted on **20-09- 2021** in the presence of a wider group of teachers represented by affiliated colleges.

The draft syllabus was then placed before the Department Council for further recommendations and finally before the Board of Studies (UG) which approved the Syllabus after some modifications. The Chairman acknowledges with gratitude all the teachers involved in the preparation of this syllabus.

1. B. M. SREENIVASA
2. M. SHUBHA
3. NAGEGOWDA P. NOT PRESENT
4. JISHA S P
5. RENUKA MANJUNATH
6. MALLESH - RETIRED
7. B. VIJAYA BABU- RETIRED
8. K RAMAKRISHNA REDDY
9. K R MUDDUKRISHNA- NOT PRESENT
10. V V SURESHBABU

Co-opt members

1. Prasanna Kumar S G, M S Ramaiah College of Arts, Science and Commerce
2. Nebula Murukesh, St. Francis de Sales College
3. Sumaiya Tabassum, Surana College

Chemistry Syllabus for B.Sc. / B.Sc. (Honors) Programme

Discipline Core: Chemistry **Total Credits for the Programme: 186**

Year of implementation: 2021-22

Programme Outcomes:

By the end of the programme the students will:

1. Understand the basic principles of various branches of Chemistry
2. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups
3. Apply the key concepts and standard methodologies to solve problems related to Chemistry
4. Apply methodologies to the solution of unfamiliar types of problems
5. Exhibit skills leading to employability in Chemistry and allied industries
6. Comprehend the fundamental aspects of research in Chemistry
7. Possess the level of proficiency in subject required for post graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects
8. Design solutions stemming from the application of Chemistry to the local issues

Assessment: Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment/ESE
Theory	40	60
Practical	25	25
Projects	-	-
Experiential Learning (Internships etc.)	-	-

PROGRAMME STRUCTURE

Sem.	Discipline Core (DSC) (L+T+P)	Discipline Elective(DSE)/ Open Elective (OE)	Ability Enhancement Compulsory Courses (AECC), Languages (L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (L+T+P)	Value based (L+T+P)	
I	DISCIPLINE A1 (4 + 2) DSC-1:Analytical and Organic Chemistry-I DSC lab-1:Analytical and	OE – 1 (3 CREDITS) Chemistry in	L1-1 (3), L2-1(3)		SEC-1: Digital Fluency (2) (1+0+2)	Physical education and Yoga(1) (0+0+2),	25

	Organic Practicals-I DISCIPLINE-B1(4+2)	Daily Life				Health and Hygiene(1)(0+0+2)	
II	DISCIPLINE A2(4 + 2) DSC-2:Inorganic and Physical Chemistry-I DSC Lab-2:Inorganic and Physical Practicals-I DISCIPLINE-B2(4+2)	OE – 2 (3 CREDITS) Molecules of Life	L1-2(3), L2-2 (3) (3+1+0 each)	Environmental Studies (2)		Health and Wellness/ Social & Emotional Learning (2)	25
Exit option with Certificate (50 credits)							
III	DISCIPLINE A3(4 + 2) DSC-3:Analytical and Organic Chemistry-II DSC Lab-3: Analytical and Organic Practicals-II DISCIPLINE-B3(4+2)	OE – 3 (3 CREDITS)	L1-3 (3), L2-3(3) (3+1+0 each)		SEC-2: Artificial Intelligence(2)(1+0+2)	Sports/NCC/ NSS etc(0+0+2)	25
IV	DISCIPLINE A4(4 + 2) DSC-4: Inorganic and Physical Chemistry-II DSC Lab-4: Inorganic and Physical Practicals-II DISCIPLINE-B4(4+2)	OE – 4 (3 CREDITS)	L1-4 (3), L2-4(3) (3+1+0 each)	Constitution of India (2)		Sports/NCC/ NSS etc (0+0+2)	25
Exit option with Diploma (100 credits)							
Choose any one Discipline as Major, the other as the Minor							
V	DISCIPLINE A5 (3 + 2) DSC-5: DSC Lab-5 DISCIPLINE A6 (3 + 2) DSC-6: DSC Lab-6: DISCIPLINE B5 (3 + 2)	Vocational 1 (3 CREDITS)			SEC-3: (2) SEC such as Cyber security(2) (1+0+2)	Physical Education(1) (0+0+2) NCC/NSS/R&R(S&G)/Cultural)(1) (0+0+2)	22
VI	DISCIPLINE A7 (3 + 2) DSC-7 DSC Lab-7 DISCIPLINE A8 (3 + 2) DSC-8 DSC Lab-8 DISCIPLINE B6 (3 + 2)	Vocational 2 (3 CREDITS) Internship (2 CREDITS)			SEC-4: Professional Communication(2)	Physical Education(1) (0+0+2) NCC/NSS/R&R(S&G)/Cultural)(1)(0+0+2)	24
Exit option with B. Sc. Basic Degree (146 credits)							
VII	DISCIPLINE A9 (3 + 2) DSC-9						

	DSC Lab-9 DISCIPLINE A10 (3) DSC-10 DISCIPLINE A11 (3) DSC-11	DSE A3 (3 CREDITS) DSE A4 (3 CREDITS RESEARCH METHODOLOGY (3 CREDITS)					20
VIII	DISCIPLINE A12 (3+2) DSC-12 DISCIPLINE A13 (3) DSC-13 DISCIPLINE A14 (3) DSC-14	DSE A4 (3 CREDITS) RESEARCH PROJECT (6 CREDITS)					20
Award of B.Sc. (Hons) degree (186 credits)							

***In lieu of the research Project, two additional elective papers/ Internship may be offered.**

COURSE PATTERN AND SCHEME OF EXAMINATION

Sl. No.	Semester	Title of the Paper	Teaching Hours	Hours / week		Examination Pattern Max. & Min. Marks /Paper						Duration of Exam (hours)		Total Marks / paper	Credits	
				Theory	Practical	ESE(Theory)		IA	ESE(Practical)			Theory	Practical		Theory	Practical
						Max.	Min.		Max.	Min.	IA					
1	I	**DSC-1: Analytical and Organic Chemistry-I**	**56**	**4**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**4**	**-**
		DSC LAB-1: Analytical and Organic Chemistry-I	**56**	**-**	**4**	**-**	**-**	**-**	**25**	**10**	**25**	**-**	**4**	**50**	**-**	**2**
		Chemistry-OE-1: Chemistryin Daily life	**42**	**3**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**3**	**-**

2	**II**	**DSC-2: Inorganic and Physical Chemistry-I**	**56**	**4**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**4**	**100**	**4**	**-**
		DSC LAB-2: Inorganic and Physical Chemistry-I	**56**	**-**	**4**	**-**	**-**	**-**	**25**	**10**	**25**	**-**	**4**	**50**	**-**	**2**
		Chemistry-OE-2:- Molecules of Life	**42**	**3**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**3**	**-**

Scheme of Internal Assessment Marks: Theory

Sl. No.	**Particulars**	IA Marks
1	Attendance	**05**
2	Internal Tests (Minimum of Two)	**25**
3	Assignments /Seminar	**10**
TOTAL Theory IA Marks		**40**

Scheme of Internal Assessment Marks: Practicals

Sl. No.	**Particulars**	IA Marks
1	Practical Test	**20**
2	Active participation in practical classes	**05**
TOTAL Practical IA Marks		**25**

Programme Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately

Semester	Title /Name Of the course	Programme outcomes that the course addresses	Pre-requisite course(s)	Pedagogy	Assessment
1	**DSC-1: Analytical and Organic Chemistry-I**	● The concepts of chemical analysis, accuracy, precision and statistical data treatment ● Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc. ● Understand the mechanism of nucleophilic, electrophilic reactions	P.U.C with Chemistry	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC lab-1: Analytical and Organic Practicals-I	● The students will be able to learn how to handle the glassware, prepare and dilute solutions and perform the experiments with prepared reagents ● The students will be able to determine the analyte through volumetric and gravimetric analysis and understand the Chemistry involved in each method of analysis. ● The students will be able to deduce the conversion factor based on stoichiometry and in turn use this value for calculation	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
2	**DSC-2: Inorganic and Physical Chemistry-I**	● The Bohr's theory of atomic structure and how it was developed ● Quantum numbers and their necessity in explaining the atomic structure ● The concept of unit cell, symmetry elements, Nernst distribution law.	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -2: Inorganic and Physical Practicals-I	● Techniques like precipitation, filtration, drying and ignition ● Various titrimetric techniques and gravimetric methods		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		To determine the physical constants of organic liquids and molecular weight of non-volatile solute.			
3	**DSC-3: Analytical and Organic Chemistry-II** **DSC Lab-3: Analytical and Organic Practicals-II**		DSC-1 and DSC-2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
4	**DSC-4: Inorganic and Physical Chemistry-II** **DSC Lab-4: Inorganic and Physical Practicals-II**			Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
5.	**DSC-5:** **DSC Lab-5:** **DSC-6:** **DSC Lab-6:**		DSC-3 and DSC-4	MOOC, Problem solving	Internal tests, Assignments, Quiz
6.	**DSC-7:** **DSC Lab-7:** **DSC-8:** **DSC Lab-8:**			MOOC, Problem solving	Internal tests, Assignments, Quiz
7.	**DSC-9 :** **DSC Lab-9:** **DSC-10:** **DSC Lab-10 :** **DSC-11:**		DSC-5, DSC-6, DSC-7 and DSC-8	MOOC, Problem solving	Internal tests, Assignments, Seminar, Debate, Quiz
8.	**DSC-12:** **DSC Lab-12** **DSC-13:** **DSC Lab-13** **DSC-14:**			Project work, Industrial Visit	Internal tests, Assignments, Seminar, Debate, Quiz

Semester 1

Course Title: DSC-1: Analytical and Organic Chemistry-I	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment (IA) Marks: 40	Duration of Summative Assessment/ ESE: 3 hrs
Syllabus Authors: Chairman	Summative Assessment Marks: 60

Course Pre-requisite(s): *PUC with Chemistry*/ Any equivalent

Course Outcomes (COs):

At the end of the course the student should be able to:

1. Learn the concepts of chemical analysis, accuracy, precision and statistical data treatment
2. Prepare the solutions after calculating the required quantity of salts in preparing the reagents/solutions and dilution of stock solution.
3. Know the concept of volumetric and gravimetric analysis and deducing the conversion factor for determination
4. Handle toxic chemicals, concentrated acids and organic solvents and practice safety procedures.
5. Understand the concepts of Organic reactions and techniques of writing the movement of electrons, bond breaking, bond forming
6. Learn the Concept of aromaticity, resonance, hyper conjugation, etc.
7. Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc.
8. Understand the mechanism of nucleophilic, electrophilic reactions

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Programme Outcomes (POs 1-8)

Course Outcomes (COs) / Programme Outcomes (POs)	1	2	3	4	5	6	7	8
1. Learn the concepts of chemical analysis, accuracy, precision and statistical data treatment	X							
2 Prepare the solutions after calculating the required quantity of salts in preparing the reagents/solutions and dilution of stock solution		X						
3.Know the concept of volumetric and gravimetric analysis and deducing the conversion factor for determination		X	X					
4. Handle toxic chemicals, concentrated acids and organic solvents and practice safety procedures						X		
5 Understand the concepts of Organic reactions and techniques of writing the movement of electrons, bond breaking and bond forming			X	X				
6. Learn the Concepts of aromaticity, resonance and hyper conjugation	X					X	X	
7 Understand the preparation of alkanes, alkenes, alkynes and their reactions			X			X		
8 Understand the mechanism of nucleophilic and electrophilic reactions						X	X	X

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular programme outcome.

Title of the Course: DSC-1: Analytical and Organic Chemistry – I

Number of Theory Credits	Number of lecture hours/ semester
4	**56**

Content of Theory Course 1	56Hrs
Unit – 1	14 Hrs
Analytical Chemistry: Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method - accuracy, precision, sensitivity, selectivity, method validation. Figures of merit of analytical methods and limit of detection (LOD), Limit of quantification (LOQ), linear dynamic range (working range). Errors and treatment of analytical data:Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples -mean, median, range, standard deviation and variance. External standard calibration - regression equation (least squares method), correlation coefficient (R^2). Acid-base titrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity. Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water. Redox titrimetry: Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, Theory of redox indicators, calculation of standard potentials using Nernst equation. Applications. Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences. Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation, Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG). Numerical problems on all the above aspects.	
Unit - 2	14 Hrs
Classification and nomenclature of organic compounds, hybridization-types, shapes of organic molecules, influence of hybridization on bond properties. **Nature of bonding in Organic molecules** Types of chemical bonding, formation of covalent bond, notations used to represent electron movements and directions of reaction- curly arrows, formal charges. Types of bond breaking- homolytic and heterolytic. Types of reagents-Electrophiles, nucleophiles, nucleophilicity and basicity. Homolytic and heterolytic fission of bonds. Carbocations, carbanions, free radicals, carbenes, nitrenes and benzyne.**Electronic displacement effects**: Inductive effects, Electromeric effect, Resonance effect, Hyperconjugation and steric effects, explanation with examples. **Types of Organic Reactions:** Substitution, addition, elimination, rearrangement and pericyclic reactions, explanation with examples. **Aliphatic Hydrocarbons:Alkanes**: Nomenclature of branched chain alkanes; *Preparation:* Corey-House synthesis, Wurtz reaction and Wurtz-Fittig reaction. Physical and chemical properties (Free radical substitution, halogenation- relative reactivity and selectivity) and commercial importance. Difference between conformation and configuration. Conformations of ethane, propane and n-butane, explanation of stability based on energy profile diagrams. Nomenclature of n-butane conformations using Klyne-Prelog terminology. Conformation and stability of 1,2-	

dichloroethane, ethylene glycol and acetaldehyde. **Cycloalkanes:** Nomenclature, method of formation. Explanation for stability based on heat of hydrogenation data. Baeyer's strain theory and stability of cyclopropane. Conformations of cyclohexane (chair, twist boat, boat, half-chair and envelop forms and their stability). Geometrical isomerism with examples, *cis* and *trans* isomerism in 1,2-dimethylcyclopropane and 1,2-dimethylcyclohexane.	
Unit - 3	14 Hrs
Carbon-carbon pi bonds **Alkenes**: Preparation by Wittig reaction-stereoselectivity, from but-2-yne to cis-alkenes – (partial catalytic hydrogenation) and trans-alkenes – (Birch reduction). Formation of alkenes by elimination reaction. Mechanism of E_1, E_2, E_1cB reaction. Saytzeff and Hofmann eliminations. Reactions: Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereospecificity of halogen addition. Addition of hydrogen halides to alkenes (Free radical addition of HBr to propene), mechanism, regioselectivity and relative rates of addition. Ozonolysis mechanism - ozonolysis of propene. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with examples. Diels-Alder reaction, allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene. Conformation and stability of propene. Steric effect- Relative stability of trans and cis-2-butene. **Dienes:** Classification- isolated, conjugated and cumulated- one example. Structure of allene and butadiene. **Reactions:** 1, 2 addition and 1, 4 addition reactions. Diels Alder reaction: 1, 3-butadiene with maleic anhydride. **Alkynes**: Preparation*:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: alkylation of terminal alkynes and conversion to higher alkynes, ozonolysis and oxidation with hot alk. $KMnO_4$.	
Unit - 4	14 Hrs
Nucleophilic substitution:. Mechanism of S_N^1 and S_N^2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting S_N^1 and S_N^2 reactions **Arenes:** Nomenclature: mono, di and tri substituted benzenes, aromaticity: Huckel's rule - application to benzenoid (benzene, naphthalene, anthracene and phenanthrene) and non-benzenoid (cyclopropenyl cation, cyclopentadienyl anion, tropylium cation) compounds, anti-aromaticity, homoaromaticity. Benzene: molecular orbital picture and resonance energy. Preparation-from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Aromatic Electrophilic substitution reactions, mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: S_N^{Ar} and Benzyne mechanism with suitable examples, Birch reduction, side chain oxidation of toluene to benzaldehyde and benzoic acid. Polynuclear hydrocarbons: naphthalene, anthracene and phenanthrene- Preparations, resonance structures, oxidation of naphthalene, anthracene and phenanthrene. Electrophilic and nucleophilic substitution reactions of naphthalene and anthracene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, *cis*- and *trans*-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.	

Text Books

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007).
2. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
3. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

4. Organic Reaction mechanism by V. K. AhIuwalia and K. Parashar (Narosa Publishers).
5. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)

References

1.Finar, I. L. *Organic Chemistry (Volume I),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

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

Pedagogy :

Chalk and Talk, ICT Tools and Models

Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Formative Assessment/ IA	40
Summative Assessment/ESE	60
Total	100

DCE-Lab-1 Analytical and Organic Practicals-1

Course Outcome:

After studying the course the student will be able to

1. Understand the safety practices in the Chemistry Laboratory
2. Develop awareness regarding toxicity of chemicals
3. Know the importance of calibration of glassware, pipette, burette and volumetric flask
4. Prepare standard/working solutions, standardization of solutions and determination of the respective analytes
5. Select suitablesolvent for purification of organic compounds
6. Gain an insight to the mechanism behind the reaction and the significance of catalysts
7. Learn the importance of green methods over conventional methods and proficiently handle the byproducts and disposal of waste
8. Enthuse students to conduct experiments by arousing the curiosity which would help them in learning basics and advanced concepts through simulation-based labs

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Programme Outcomes (POs 1-8)

Course Outcomes (COs) / Programme Outcomes (POs)	1	2	3	4	5	6	7	8
1.Understand the safety practices in the Chemistry Laboratory	X	X						
2.Develop awareness regarding toxicity of chemicals	X					X		
3.Know the importance of calibration of glassware, pipette, burette and volumetric flask	X	X						
4.Prepare standard/working solutions, standardization of solutions and determination of the respective analytes	X	X	X					
5.Select suitable solvent for purification of organic compounds		X	X				X	
6.Gain an insight to the mechanism behind the reaction and the significance of catalysts						X		X
7.Learn the importance of green methods over conventional methods and proficiently handle the byproducts and disposal of waste				X			X	X
8.Enthuse students to conduct experiments by arousing the curiosity which would help them in learning basics and advanced concepts through simulation-based labs				X		X		X

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular programme outcome.

Number of practical Credits	Number of practical hours/ semesters
2	**56**

Tutorials
Calibration of instruments, glasswares etc. to be performed in the beginning of the experiments
Specific arrangements to be made for proper disposal of chemicals, broken glasswares and solutions after the experiments
Green Principles to be adopted in the laboratories
Preparation of Standard solution along with calculations to be taught
Handling and dilution of mineral acids to be emphasized
Use of suitable indicators to be explained

List of Experiments to be conducted

PART-A Analytical Chemistry

1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glass wares.
2. Calibration of glassware, pipette, burette and volumetric flask.
3. Determination of sodium carbonate and sodium bicarbonate in a mixture.
4. Determination of alkali present in soaps/detergents
5. Determination of iron(II) using potassium dichromate
6. Determination of oxalic acid using potassium permanganate solution
7. Determination of Fe^{2+} as Fe_2O_3

   Virtual Experiments
8. Standardization of EDTA solution and determination of hardness of water
9. Gravimetric estimation of Barium
10. Gravimetric estimation of Nickel

PART-B Organic Chemistry

1. Selection of suitable solvents for Purification/Crystallization of organic compounds.
2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method).
3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture.
4. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method)
5. Synthesis of diazoaminobenzene from aniline (conventional method).
6. Preparation of dibenzalacetone (Green method).

7. Diels Alder reaction between furan and maleic acid (Green method).

Virtual Experiments

8. Simple Distillation
9. Separation of Compounds by Column Chromatography
10. Detection of Functional Groups

Note:

1. Questions from both sections should be given in each batch.
2. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations
3. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals
4. The last 20 minutes the teacher is expected to solve related problems based on the experiments.

Title of the Course: OE-1: CHEMISTRY IN DAILY LIFE

Course Outcome:

After studying the course the student will be able to

1. Analyse the fat content and minerals in milk, butter and other dairy products
2. Know about various food preservatives, adulterants, additives and their analysis
3. Know about the Sources, role and deficiency symptoms of Vitamins
4. Learn the importance of renewable energy sources
5. Be aware of the applications of polymers as plastics in various fields and strategies for development of environment friendly polymers

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Programme Outcomes (POs 1-8)

Course Outcomes (COs) / Programme Outcomes (POs)	1	2	3	4	5	6	7	8
1.Analyse the fat content and minerals in milk, butter and other dairy products	X		X		X			
2.Know about various food preservatives, adulterants, additives and their analysis				X	X			X
3.Know about the Sources, role and deficiency symptoms of Vitamins	X					X	X	
4.Learn the importance of renewable energy sources	X	X						
5.Be aware of the applications of polymers as plastics in various fields and strategies for development of environment friendly polymers.			X			X		X

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular programme outcome.

Number of Theory Credits	Number of lecture hours/ semester
3	**42**

Content of Theory Course 1	42 Hrs
Unit – 1	14 Hrs
Dairy Products: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages. **Food additives, adulterants, and contaminants**- Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate. **Artificial food colorants:** Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.	
Unit - 2	14 Hrs
Vitamins: Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.	

Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test. **Soaps & Detergents**: Definition, classification, manufacturing of soaps and detergents, composition and uses	
Unit - 3	14 Hrs
Chemical and Renewable Energy Sources:	
Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer.	
Polymers: Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronics, automobile components, medical fields and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.	

Text Books

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry- Ashtoush Kar.
3. Analysis of Foods – H.E. Cox: 13
4. Fred Billmeyer: Textbook of polymer science; Willey 3rd addition.

References

1.Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)

2.Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.

Pedagogy :

Demonstration activities using live examples

Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Formative Assessment/ IA	40
Summative Assessment/ESE	60
Total	100

Semester 2

Course Outcome:

After studying the course the student will be able to

1. Learn scientific theory of atoms, concept of wave functions, the fundamentals of quantum mechanics and concept of operators
2. Understand the physical and chemical characteristics of elements
3. Identify the given element, relative size, charges of proton, neutron and electron and their assembly to form different atoms
4. Learn the theory of dilute solutions, distribution law and its applications
5. Properties of liquid as solvent for various household and commercial use
6. Explain the laws governing the behaviour of ideal gases and real gases including their comparison
7. Understand the laws of crystallography, X-ray diffraction techniques, Bragg's law and its applications
8. Solve the problems related to quantum mechanics, different molecular velocities, critical constants and molar mass of non-volatile solutes

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Programme Outcomes (POs 1-8)

Course Outcomes (COs) / Programme Outcomes (POs)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1.Learn scientific theory of atoms, concept of wave functions, the fundamentals of quantum mechanics and concept of operators	X					X		X
2.Understand the physical and chemical characteristics of elements			X	X				
3.Identify the given element, relative size, charges of proton, neutron and electron and their assembly to form different atoms	X		X	X				
4.Learn the theory of dilute solutions, distribution law and its applications							X	X
5.Properties of liquid as solvent for various household and commercial use					X			X
6.Explain the laws governing the behaviour of ideal gases and real gases including their comparison	X	X	X					
7.Understand the laws of crystallography, X-ray diffraction techniques, Bragg's law and its applications			X		X			
8.Solve the problems related to quantum mechanics, different molecular velocities, critical constants and molar mass of non-volatile solutes				X	X	X	X	

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular programme outcome.

Title of the Course: DSC – 2: INORGANIC AND PHYSICAL CHEMISTRY– I

Number of Theory Credits	Number of lecture hours per semester
4	**56**

Content of Theory Course 2	56Hrs
Unit – 1	14 Hrs
Atomic structure Review of Bohr's theory and its limitations and atomic spectrum of hydrogen atom. Need of a new approach to atomic structure. Wave mechanics: de Broglie equation, Problems on calculation of wavelength of an electron Heisenberg's Uncertainty Principle and its significance What is Quantum Mechanics? Sinusoidal wave equation (Explain sinusoidal wave, Classical wave mechanics). Schrodinger's wave equation – derivation. Applications of Schrodinger's equation to the hydrogen atom. significance of ψ and $\psi 2$ Postulates of quantum mechanics. Hamiltonian operator. Eigen values and function. Concept of orbitals, Radial and angular parts of the hydrogenic wave function (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (graphical representation only). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers: Significance of quantum numbers. The four types of quantum numbers, shapes, s, p and d atomic orbitals, discovery of spin, spin quantum numbers (s) and magnetic spin quantum number (ms). Electronic configuration of elements. Principles (Aufbau, Pauli's exclusion principle and Hund's rule). Stability of half-filled and completely filled orbitals. Relative energies of atomic orbitals, Anomalous electronic configurations.	
Unit - 2	14 Hrs

Periodic Table & Periodic Properties The long form of periodic table. Classification of elements in to s, p, d and f-block elements. Periodic properties & trends in the periodic properties with reference to s and p-block elements: (a) Atomic radii (van der Waals) (b) Ionic and crystal radii. (c) Covalent radii (d) Ionization enthalpy, successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (e) Electron gain enthalpy, trends of electron gain enthalpy. (f) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Trends in the periodic properties. Applications in predicting and explaining chemical behaviour. Trends in the Chemistry of the compounds of groups 13 to 17 (hydrides, carbides, oxides and halides).	
Unit - 3	14 Hrs
Gaseous State Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of σ and η, variation of viscosity with temperature and pressure. Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required), law of equipartition of energy. Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, vander Waals equation of state (no derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO_2, critical constants and their calculation from van der Waals equation, Continuity of states, Law of corresponding states. Numerical problems. **Liquid State** **Surface Tension**: Definition and its determination using stalagmometer, effect of temperature and solute on surface tension **Viscosity**: Definition, Coefficient of viscosity. Determination of viscosity of a liquid using Oswald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces. **Refraction**: Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer. Additive and constitutive properties. **Parachor:** Definition, Atomic and structure parachor, Elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical constitution. Numerical Problems.	

Unit - 4	14 Hrs
Dilute solutions- Review of colligative properties and concentration terms Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method ; (ii) Beckmann's method (ΔT^f) and (iii) Landsberger's method. Numerical problems **Distribution Law** Nernst Distribution Law – Statement. Distribution constant, factors affecting distribution constant, validity of Distribution Law, Modification of distribution law when molecules undergo a) Association b) Dissociation. Application of Distribution Law in Solvent extraction, numerical Problems **Solids** **Forms of solids:** Unit cell and space lattice, anisotropy of crystals, size and shape of crystals. Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry (Symmetry elements), Crystal systems, Bravais lattice types and identification of lattice planes. Miller indices and its calculation, X–Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Single crystal and powder diffraction methods. Defects in crystals, glasses and liquid crystals. Numerical problems.	

Text Books

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
2. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.
3. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
4. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018)

References

1. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India
2. Physical Chemistry by Samuel Glasstone, ELBS (1982).
3. A Text Book of Physical Chemistry P.L.Soni , O.P. Dharmarhaand and U.N.Dash, Sultan Chand and Sons.

Pedagogy :

Chalk and Talk, ICT Tools and Models

Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Formative Assessment/ IA	40
Summative Assessment/ESE	60
Total	100

DSC LAB-2 Inorganic and Physical Practicals

Course Outcome:

After studying the course the student will be able to

1. Inculcate the significance of physical constants organic liquids
2. Weigh accurately compounds up to fourth decimal
3. Know the importance of calibration of instruments, pipette, burette and volumetric flask
4. Understand the concept of distribution coefficient, Nernst Distribution law, and how it takes different form when solute undergo association or dissociation in one of the layer
5. Prepare standard/working solutions, standardization of solutions and determination of the respective analytes
6. Handle proficiently byproducts and disposal of waste
7. Learn the importance of green methods over conventional methods.
8. Enthuse students to conduct experiments by arousing the curiosity which would help them in learning basics and advanced concepts through simulation-based labs

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Programme Outcomes (POs 1-8)

Course Outcomes (COs) / Programme Outcomes (POs)	1	2	3	4	5	6	7	8
1.Inculcate the significance of physical constants organic liquids	X	X						
2,Weigh accurately compounds up to fourth decimal		X						X
3,Know the importance of calibration of instruments, pipette, burette and volumetric flask		X		X				
4.Understand the concept of distribution coefficient, Nernst Distribution law, and how it takes different form when solute undergo association or dissociation in one of the layer		X			X			X
5.Prepare standard/working solutions, standardization of solutions and determination of the respective analytes		X			X			
6.Handle proficiently byproducts and disposal of waste						X	X	
7.Learn the importance of green methods over conventional methods.						X	X	X
8.Enthuse students to conduct experiments by arousing the curiosity which would help them in learning basics and advanced concepts through simulation-based labs		X			X		X	

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular programme outcome.

Number of practical Credits	Number of practical hours per semester
2	**56**

Tutorials
Green Principles to be adopted in the laboratories
Specific arrangements to be made for disposal of chemicals and solutions after the experiments
Calibration of instruments, glasswares etc to be performed in the beginning of the experiments
Preparation of Standard solution along with calculations to be taught
Handling and dilution of mineral acids to be emphasized
Selection and usage of Indicators to be explained

List of Experiments to be conducted

PART-A Inorganic Chemistry

TITRIMETRY

1. Determination of carbonate and hydroxide present in a mixture.
2. Determination of oxalic acid and sodium oxalate in a given mixture using standard $KMnO_4$/NaOH solution
3. Standardization of potassium permanganate solution and determination of nitrite in a water sample
4. Determination of alkali content in antacids
5. Determination of chlorine in bleaching powder using iodometric method.

Virtual Experiments

6. Determination of concentration of Potassium Permanganate solution using Ferrous Ammonium sulphate
7. Standardization of silver nitrate and determination of chloride in a water sample
8. Soil Analysis-Determination of pH of soil.

PART-B Physical Chemistry

1. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids)
2. Study of the variation of viscosity of sucrose solution with the concentration of a solute
3. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids)
4. Study of variation of surface tension of detergent solution with concentration.
5. Determination of molar mass of non-electrolyte by Walker-Lumsden method
6. Determination of partition/distribution coefficient of Benzoic acid in water and toluene
7. Determination of compositionof liquid mixtures by refractometry. (toluene and alcohol, water and sucrose)
8. Determination of specific and molar refraction by Abbes refractometer (ethyl acetate, methyl acetate, ethylene dichloride)

Virtual Experiments

9. Determination of molar mass of a non-volatile solute by cryoscopic method
10. Determination of viscosity by average molecular weight of a polymer
11. Determination of partition co-efficient of Iodine between water and carbon tetrachloride

Note:

1. Questions from both sections should be given in each batch.
2. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations
3. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals
4. The last 20 minutes the teacher is expected to solve related problems based on the experiments.

Title of the Course: OE – 2: Molecules of Life

Course Outcome:

After studying the course the student will be able to

1. Know about the biological importance of biomolecules
2. Learn about the structure of amino acids and proteins.
3. Understand the correlation of enzyme function with drug action
4. Learn the classification and clinical significance of lipids
5. Know about the concepts of bioenergetics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Programme Outcomes (POs 1-8)

Course Outcomes (COs) / Programme Outcomes (POs)	1	2	3	4	5	6	7	8
1.Know about the biological importance of biomolecules	X					X		
2.Learn about the structure of amino acids and proteins	X							
3.Understand the correlation of enzyme function with drug action			X				X	
4.Learn the classification and clinical significance of lipids	X			X				X
5.Know about the concepts of bioenergetics			X			X		

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular programme outcome.

Number of Theory Credits	Number of lecture hours per semester
3	**42**

Content of Theory Course 2	42 Hrs
Unit – 1	14 Hrs
Carbohydrates Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation. Carbohydrates as a source of energy **Amino Acids, Peptides and Proteins** Classification ofamino acids, Zwitterions structure and Isoelectric point. Peptides: structure and conformation, example and function of biologically important Peptides. Proteins: Classification based on composition, shape and function with examples. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Importance of primary structure by taking sickle cell anemia as example. Determination of primary structure of peptides. Denaturation of proteins:, Renaturation of proteins.	
Unit - 2	14 Hrs

Enzymes and correlation with drug action Brief introduction, Nomenclature (E.C. No. upto 2nd digit) and classification of enzymes, Effect of pH and temperature. Enzyme specificity and theories-Lock and key model, induced fit theory. Active site and its characteristics, Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereo specificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition). **Drug action**-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring. **Lipids** Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats,Hydrogenation, Rancidity of oils. Triglycerides:: Biological importance of triglycerides. Saponification, saponification value and its significance, Unsaturation in acyl glycerols- iodine number and iodine number of different oils.Prostaglandins: definition and example, biological role of prostaglandins in general, Waxes: definition, types, biological importance. Lipoproteins: Types and functions, clinical significance.	
Unit - 3	14Hrs
Nucleic Acids Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature)**, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, -(general features and about Central dogma of Molecular biology) Biological roles of DNA and RNA: Replication, Transcription and Translation. Physico- chemical properties of nucleic acids - effect of alkali, acid and heat (denaturation and renaturation), Mutation Mutagens- chemical and physical, Molecular basis of mutation: spontaneous and induced mutations. Types of mutation, **Concept of Energy in Bio systems** Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, and Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates. Introduction to bioenergetics, stages of energy transformation- Photosynthesis respiration and utilization of energy. Exergonic and endergonic reactions. standard free energy change.	

Text Books

1.Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2.A Text Book ofBioChemistry, V. S. S. Rama Rao, UBSPD,1998.

References

1.Concise Text Book ofBioChemistry,T. N. Pattabhiraman, All India Publishers, 2000.
2.W. H. Freeman. Berg, J.M., Tymoczko, J.L. & Stryer, L. *BioChemistry*, , 2002.

Pedagogy :

Chalk and Talk, ICT Tools and Models

Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Formative Assessment/ IA	40
Summative Assessment/ESE	60
Total	100

BANGALORE UNIVERSITY

III & IV Semester Chemistry Syllabus

for

B.Sc. / B.Sc. Honors Courses

Framed According to the National Educational Policy (NEP 2020)

(To be implemented from the academic year 2022-23)

DEPARTMENT OF CHEMISTRY
Bangalore University
Jnanabharathi
Bangalore-560056

AUGUST-2022

Preamble

The Board of studies in UG Chemistry headed by Prof G Krishnamurthy, the Chairman, Department of Studies in Chemistry, Jnanabharathi Campus, Bangalore University had the thorough discussions on the syllabus of III and IV semester Chemistry for BSc/ BSc Honors courses using the syllabus provided by the NEP Chemistry syllabus drafting Committee. This syllabus has to be accepted for the academic year 2022-23.

The Core committee consisting of the faculty members of different branches of Chemistry namely Analytical, Physical, Inorganic and Organic Chemistry which comprising the BOS and also additional faculty members from different UG Colleges of Bangalore University have made effective joint brain storming discussions and arrived at a Syllabus in Chemistry for **III and IV** semesters on **23.08.2022** and **24.08.2022**.

The final syllabus incorporating all the suggestions was finally approved by the members of the Board of Studies in Chemistry (UG) on **24.08.2022**. The following Faculty Members of the Core Committee were involved in the preparation of the Chemistry Syllabus.

Physical Chemistry Section

1. G. Krishnamurthy
2. K. Ramakrishna Reddy
3. P Nagegowda

Analytical and Inorganic Chemistry Section

1. M. Shubha
2. R. Nalini
3. B. M. Savitha
4. B M Sreenivas

Organic Chemistry Section

1. Renuka Manjunath
2. Vasudeva Reddy
3. Sumaiya Tabassum
4. Meenaakshi Srinivasan

Sd/-

PROF. G. KRISHNAMURTHY
CHAIRMAN
BOS in Chemistry (UG)
Bangalore University
Bangalore -560056

Proceedings of the meeting of the Board of Studies in Chemistry- UG held on 23rd & 24th August 2022 from 10.30 am to 6.30 pm in the Department of Chemistry, Bangalore University, Jnana Bharathi, Bengaluru-560 056

A meeting of the Board of Studies (UG) in Chemistry was held on 23rd & 24th August 2022 from 10.30 am to 6.30 pm in the Department of Chemistry, Bangalore University, Jnana Bharathi, Bangalore-56. The Chairman welcomed the members and placed before them the following agenda for deliberations.

Approval of B.Sc Chemistry Syllabus-NEP 2021-2022 batch: The syllabus of B.Sc Chemistry III and IV semesters for 2022-2023 was considered, discussed in detail, all suggestions incorporated and unanimously approved by the members.

Revision of B.Sc Chemistry syllabus (NEP-2020) I and II Semesters of 2022-2023 batch: The I and II semester syllabus was done without taking care of equal distribution of different branches of Chemistry such as Analytical, Organic, Inorganic and Physical Chemistry. It was very unfair for Chemistry learning students at 1 year (I/II semesters) level. So, all the board members unanimously decided to revise the syllabus. The syllabus was thus revised by thoroughly discussing in detail and the same has been unanimously approved by all the members.

The meeting ended with vote of thanks by the Chairman, Department of Chemistry, Bangalore University, Jnana Bharathi, Bangalore- 560 056.

MEMBERS OF THE BOS (UG)		Signature
1. Prof. G. Krishnamurthy	Chairman	
2. Prof. B. M. Sreenivasa	Member	
3. Prof. M. Shubha	Member	
4. Dr. Nagegowda P	Member	
5. Dr. Renuka Manjunath	Member	
6. Dr. K. Ramakrishna Reddy	Member	
7. Dr. K. R. Muddukrishna	Member	Absent
8. Dr. Prasannakumar S G	Member (Coopted)	Absent
9. Dr. Sumaiya Tabassum	Member (Coopted)	

Retired/Transferred to other University

1. Dr. Jisha S. P.
2. Dr. B. Vijaya Babu
3. Dr. Mallesh

24/8/2022

Prof. G. KRISHNAMURTHY
Chairman
Department of Chemistry
Bangalore University
Jnanabharathi Campus
Bangalore - 560 056.

PROGRAMME STRUCTURE

Sem.	Discipline Core (DSC) (L+T+P)	Discipline Elective(DSE)/ Open Elective (OE)	Ability Enhancement Compulsory Courses (AECC), Languages (L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (L+T+P)	Value based (L+T+P)	
I	DISCIPLINE A1 (4 + 2) DSC-1:Analytical and Organic Chemistry-I DSC lab-1:Analytical and Organic Practicals-I DISCIPLINE-B1(4+2)	OE – 1 (3 CREDITS) Chemistry in Daily Life	L1-1 (3), L2-1(3)		SEC-1: Digital Fluency (2)		23
II	DISCIPLINE A2(4 + 2) DSC-2:Inorganic and Physical Chemistry-I DSC Lab -2:Inorganic and Physical Practicals-I DISCIPLINE-B2(4+2)	OE – 2 (3 CREDITS) Molecules of Life	L1-2(3), L2-2 (3) (3+1+0 each)	Environmental Studies (2)		Health and Wellness/ Social & Emotional Learning (2)	25
Exit option with Certificate (48 credits)							
III	DISCIPLINE A3(4 + 2) DSC-3:Analytical and Organic Chemistry-II DSC Lab-3: Analytical and Organic Practicals-II DISCIPLINE-B3(4+2)	OE – 3 (3 CREDITS)	L1-3 (3), L2-3(3) (3+1+0 each)		SEC-2: (2)		23
IV	DISCIPLINE A4(4 + 2) DSC-4: Inorganic and Physical Chemistry-II DSC Lab-4:Inorganic and Physical Practicals=II DISCIPLINE-B4(4+2)	OE – 4 (3 CREDITS)	L1-4 (3), L2-4(3) (3+1+0 each)	Constitution of India (2)		Sports/NCC/NSS etc	25
Exit option with Diploma (96 credits)							
Choose any one Discipline as Major, the other as the Minor							
V	DISCIPLINE A5 (3 + 2) DSC-5: DSC Lab-5 DISCIPLINE A6 (3 + 2) DSC-6: DSC Lab-6: DISCIPLINE B5 (3 + 2)	DSE A1 (3 CREDITS)			SEC-3: (2)	Ethics & Self Awareness (2) (1+0+2)	20
VI	DISCIPLINE A7 (3 + 2) DSC-7 DSC Lab-7 DISCIPLINE A8 (3 + 2) DSC-8 DSC Lab-8 DISCIPLINE B6 (3 + 2)	DSE A2 (3 CREDITS)			SEC-4: (2)		20
Exit option with B. Sc. Basic Degree (136 credits)							
VII	DISCIPLINE A9 (3 + 2) DSC-9 DSC Lab-9 DISCIPLINE A10 (3 + 2) DSC-10 DSC Lab-10: DISCIPLINE A11 (4) DSC-11	DSE A3 (3 CREDITS) RESEARCH METHODOLOGY (3 CREDITS)					20

VIII	**DISCIPLINE A12 (4)** **DSC-12** **DISCIPLINE A13 (4)** **DSC-13** **DISCIPLINE A14 (3)** **DSC-14**	**DSE A4** **(3 CREDITS)** **RESEARCH PROJECT** **(6 CREDITS)**					**20**
Award of B.Sc. CHEMISTRY (Hons) degree (176 credits)							

***In lieu of the research Project, two additional elective papers/ Internship may be offered.**

Sl. No.	**Semester**	**Title of the Paper**	**Teaching Hours**	**Hours / week**		**Examination Pattern Max. & Min. Marks /Paper**						**Duration of Exam (hours)**		**Total Marks / paper**	**Credits**	
				Theory	**Practical**	**ESE**		**IA**	**Practical**			**Theory**	**Practical**		**Theory**	**Practical**
						Max.	**Min.**		**Max.**	**Min.**	**IA**					
1	**I**	**DSC-3: Analytical and Organic Chemistry-II**	**56**	**4**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**150**	**4**	**-**
		DSC LAB-3: Analytical and Organic Chemistry-II	**56**	**-**	**4**	**-**	**-**	**-**	**25**	**9**	**25**	**-**	**4**	**50**	**-**	**2**
		Chemistry-OE-3: Chemistry in Daily life	**42**	**3**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**3**	**-**
2	**II**	**DSC-4: Inorganic and Physical Chemistry-II**	**56**	**4**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**4**	**150**	**4**	**-**
		DSC LAB-2: Inorganic and Physical Chemistry-II	**56**	**-**	**4**	**-**	**-**	**-**	**25**	**9**	**25**	**-**	**4**	**50**	**-**	**2**
		Chemistry-OE-4:- Industrial Applications in Chemistry	**42**	**3**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**3**	**-**

ASSESSMENT: WEIGHTAGE FOR ASSESSMENT
Common for both III and IV semesters

TYPE OF ASSESSMENT	SUMMATIVE (MARKS)	FORMATIVE (MARKS)
THEORY	**60**	**40**
PRACTICAL	**25**	**25**

SCHEME OF INTERNAL ASSESSMENT MARKS:
THEORY PAPERS
Common for both III and IV semesters

Sl N	PARTICULARS	MARKS
1	**Attendance**	**10**
2	**Assignments/ Seminars**	**10**
3	**Internal Tests (Average of two tests)**	**20**
TOTAL		**40**

PRACTICALS
Common for both III and IV semesters

SL NO	PARTICULARS	MARKS
1	**Attendance**	**05**
2	**Record writing**	**05**
3	**Internal Tests (Average of two tests)**	**15**
TOTAL		**25**

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately

Semester	Title /Name Of the course	Program outcomes that the course addresses	Pre-requisite course(s)	Pedagogy	Assessment
1	**DSC-1: Analytical and Organic Chemistry-I**	● The concepts of chemical analysis, accuracy, precision and statistical data treatment ● Understand the preparation of alkanes, alkenes and alkynes, their	P.U.C with Chemistry	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		reactions, etc. ● Understand the mechanism of nucleophilic, electrophilic reactions			
	DSC lab-1: Analytical and Organic Practicals-I	● The students will be able to learn how to handle the glassware, prepare and dilute solutions and perform the experiments with prepared reagents ● The students will be able to determine the analyte through volumetric and gravimetric analysis and understand the chemistry involved in each method of analysis. ● The students will be able to deduce the conversion factor based on stoichiometry and in turn use this value for calculation	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
2	**DSC-2: Inorganic and Physical Chemistry-I**	● The Bohr's theory of atomic structure and how it was developed ● Quantum numbers and their necessity in explaining the atomic structure ● The concept of unit cell, symmetry elements, Nernst distribution law.	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -2: Inorganic and Physical Practicals-I	● Techniques like precipitation, filtration, drying and ignition ● Various titrimetric		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		techniques and gravimetric methods ● To determine the physical constants of organic liquids and molecular weight of non-volatile solute.			
3	**DSC-3: Analytical and Organic Chemistry-II**	● The concepts of chemical analysis, accuracy, precision and statistical data treatment ● Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc. ● Understand the mechanism of nucleophilic, electrophilic reactions	DSC-1 and DSC-2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-3: Analytical and Organic Practicals-II	● The students will be able to learn how to handle the glassware, prepare and dilute solutions and perform the experiments with prepared reagents ● The students will be able to determine the analyte through volumetric and gravimetric analysis and understand the chemistry involved in each method of analysis. ● The students will be able to deduce the conversion factor based on stoichiometry and in turn use this value for			

		calculation			
4	**DSC-4: Inorganic and Physical Chemistry-II**	● The Bohr's theory of atomic structure and how it was developed ● Quantum numbers and their necessity in explaining the atomic structure ● The concept of unit cell, symmetry elements, Nernst distribution law.		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-4: Inorganic and Physical Practicals-II	● Techniques like precipitation, filtration, drying and ignition ● Various titrimetric techniques and gravimetric methods ● To determine the physical constants of organic liquids and molecular weight of non-volatile solute.			
5.	**DSC-5:** **DSC Lab-5:** **DSC-6:** **DSC Lab-6:**		DSC-3 and DSC-4	MOOC, Problem solving	Internal tests, Assignments, Quiz
6.	**DSC-7:** **DSC Lab-7:** **DSC-8:** **DSC Lab-8:**			MOOC, Problem solving	Internal tests, Assignments, Quiz
7.	**DSC-9 :** **DSC Lab-9:** **DSC-10:** **DSC Lab-10 :** **DSC-11:**		DSC-5, DSC-6, DSC-7 and DSC-8	MOOC, Problem solving	Internal tests, Assignments, Seminar, Debate, Quiz
8.	**DSC-12:** **DSC Lab-12** **DSC-13:** **DSC Lab-13** **DSC-14:**			Project work, Industrial Visit	Internal tests, Assignments, Seminar, Debate, Quiz

CHEMISTRY

DSC-3: Analytical and Organic Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Credit Points :4

Evaluation: Continuous Internal Assesment-40 Marks

Semester End Examination -60 Marks

Course Objectives:

1) Interrelationship among frequency, wavelength and wave number and importance of validation parameters of an instrumental method will be taught
2) Principle, instrumentation and applications of spectrophotometry, nephelometry and turbidometry will be taught
3) Fundamentals of separation methods and principles of paper, thin layer and column chromatography will be taught
4) Principle, types and applications of solvent extraction will be taught
5) Principle and mechanism of ion-exchange, types of resins and domestic andindustrial applications of ion-exchange chromatography will be taught
6) The concept of mechanism and its importance will be taught to the student
7) Concept and importance of intermediates in organic chemistry will be taught taking proper examples
8) The various techniques for identification of reaction mechanism will be taught to the student taking proper examples
9) Concept of stereochemistry and its importance will be taught.
10) The various projection formulae and the techniques of designating the moleculesinto R, S, D, L will be taught taking proper examples
11) The theory and concept of Cis-, Trans- isomerism and its importance and thetechniques to differentiate between them will be taught taking examples

Course Specific Outcomes

After the completion of this course, the student would be able to

1) Understand the importance of fundamental law and validation parameters in chemical analysis
2) Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric, nephelometric and turbidometric methods.
3) Understand the requirement for chemical analysis by paper, thin layer and column chromatography.
4) Apply solvent extraction method for quantitative determination of metal ions in different samples
5) Utilize the ion-exchange chromatography for domestic and industrial applications
6) Explain mechanism for a given reaction.
7) Predict the probable mechanism for a reaction. Explain the importance of reaction intermediates, its role and techniques of generating such intermediates

8) Explain the importance of Stereochemistry in predicting the structure and property of organic molecules.
9) Predict the configuration of an organic molecule and able to designate it.
10) Identify the chiral molecules and predict its actual configuration.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	X							
2	X							
3	X							
4	X							
5	X							
6	X							
7	X							
8	X							

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

DSC-3: Analytical and Organic Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Unit-I

Quantitative Analysis-Instrumental methods

Electromagnetic spectrum, absorption of electromagnetic radiation, Definition and unitsof frequency, wavelength, wave number, Beer's law, Beer-Lambert law derivation,deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation, single beam and double beam spectrophotometers, quantitativeapplications of colorimetry (determination of Fe, Mo, Cu, Ti and $PO4^{3-}$) and numericalproblems on application of Beer's law. **10 hrs**

Nephelometry and Turbidimetry: Introduction, principle, instrumentations of nephelometry and turbidimetry; effects of concentration, particle size and wavelength on scattering; choice between nephelometry, applications of nephelometry and turbidimetry (determination of $S04^{2-}$ and $PO4^{3-}$). **4 hrs**

Unit-II

Separation methods

Solvent Extraction: Definition of solvent extraction, Types- batch, continuous, efficiency, selectivity, Nernst distribution law, derivation, distribution coefficient, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper. **4hrs**

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version. **3hrs**

Paper chromatography: Theory and applications.

Thin layer chromatography (TLC): Mechanism, Rf value, efficiency of TLC plates, methodology–selection of stationary and mobile phases, development, spray reagents, identification and detection, qualitative applications. **4 hrs**

Ion exchange chromatography: resins, types with examples- cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides, industrial applications). **3hrs**

Unit-III

Reaction Intermediates: Generation, Stability and Reactions of,

i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Rearrangement.
ii) Carbanions : Perkin Reaction, Aldol condensation, Claisen-Schmith condensation.
iii) Free Radicals: Sandmeyer Reaction

iv) Carbenes and Nitrenes: Singlet and Triplet states, their relative stability andreactions

v) Arynes: Formation and detection **8 hrs**

Methods for identifying reaction mechanism:

Product analysis, Isolation and Identification of Intermediates, Stereochemical Evidences, Effect of Catalyst, crossover Experiments, Isotopic studies, Kinetic Studies.

6 hrs

Unit-IV

Stereochemistry of Organic Compounds:

Fischer projection, Newmann and Sawhorse projection formulae and their interconversions. Geometrical isomerism: Cis-trans and syn-anti isomerism, E/Z notations with C.I.P rules. Optical Isomerism: Optical activity, Specific rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral centres, Diasteroisomers, meso structures, Racemic mixtures and Resolution, Relative and absolute configuration, D/L and R/S designations

14 hrs

References:

1) Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
2) Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
3) Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, PHI Learning PvtLtd. New Delhi (2009).
4) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M. J. K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt Ltd. (2007).
5) Organic Reaction Mechanism, V. K. Ahluwalia and R. K. Parashar, Narosa Publishers, (2007).
6) Organic Chemistry, S. M Mukherji, S. P Singh and R. K Kapoor (Volume II), International Pvt Ltd. Narosa Publishers, (2003).
7) Organic Chemistry, R.N Morrison and R.N Boyd, Darling Kindersley (India) Pvt. Ltd. Pearson Education, (2016).
8) Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, I. L Finar (Volume I), I. L Finar, (Volume II), Dorling Kindersley India Pvt Ltd. Pearson Education, (2002).
9) Stereochemistry, Conformation and Mechanism, P.S Kalsi, New age International, (2005).
10) Stereochemistry of Organic Compounds, Wiley, E.L Eliel and S.H Wilen, (London), (2020).

PRACTICALS

Credit Points: 2 **Teaching Hours:4 hrs**

Evaluation: Continuous Internal Assessment-20 marks

Semester End Examination :30 marks

Course Objectives

1) To impart skills related to preparation of stock and working solutions and handling of instrumental methods
2) To know the principle of colorimetric analysis and construction of calibration plot
3) To understand the chemistry involved in colorimetric determination of metal ions andanions
4) To determine Rf values of different metal ions present in a mixture
5) To impart knowledge on the importance of functional groups in organic compounds.
6) Techniques to identify the functional groups in a compound by performing physical and chemical tests
7) To record its melting point/boiling point.
8) To prepare suitable derivative for that compound and to characterize it.

Course Specific outcomes

After the completion of this course, the student would be able to

1) Understand the importance of instrumental methods for quantitative applications
2) Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples
3) Understand how functional groups in a compound is responsible for its characteristic property
4) Learn the importance of qualitative tests in identifying functional groups.
5) Learn how to prepare a derivative for particular functional groups and how to purify it.

PART-A (Analytical Chemistry)

1) Colorimetric determination of copper using ammonia solution
2) Colorimetric determination of iron using thiocyanate solution
3) Colorimetric determination of nickel using DMG solution
4) Colorimetric determination of titanium using hydrogen peroxide
5) Colorimetric determination of nitrite in a water sample (diazo coupling Reaction/Griess reagent
6) Colorimetric determination of phosphate as ammonium phosphomolybdate
7) Determination of Rf values of two or three component systems by TLC
8) Separation of different metal ions by paper chromatography/ Solvent extraction of ironusing oxine solution **(demonstration)**

PART-B(Organic Chemistry)

Qualitative analysis of bifunctional Organic compounds such as:

1)Salycilic acid , p-Nitro benzoic acid, Antranilicacid, p-Chloro benzoic acid

2) o-Cresol, p-Cresol, Resorcinol,o- Nitrophenol, p-nitophenol

3)o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p- Bromoaniline,

4)Ethyl Salicylate, Salicylaldehyde, Actophenone, p-Dichlorobenzene, p-Nitro toluene,,Benzamide etc.(Atleast 6-8 compounds to be analysed in a semester)

References

1)Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt Ltd (2007).

2) Vogels Text Book of Qualitative Chemical Analysis, ELBS (1989).

OE1: For Science students

Title of the Course: Open Elective-3: ATOMIC STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY

Contact Hours: 42 **Workload: 3 hours per week**

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks

Semester End Examination - 60 marks

Course Objectives:

1) To develop an understanding of principles of Atomic structure
2) To know the importance of quantum numbers, writing of electronic configurations and represention of orbitals
3) To develop an understanding of the periodic trends
4) To understand the nature of bonding and to predict the shapes of molecules
5) To construct MO energy level diagrams and predict the properties of molecules
6) To understand the formation of sigma and pi bonds and the bond strength.
7) To study the classification of organic reactions
8) To learn nomenclature preparation and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds

COURSE CONTENT

Unit I: Atomic Structure and Periodic Properties

History of an atom. Idea of de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, Bohr's model of hydrogen atom and its limitations. Quantum numbers and their importance, atomic orbitals and shapes of s, p, d orbitals, Multi-electron atoms, Aufbau and Pauli exclusion principle and Hund's multiplicity rule- Electronic configurations of the elements (atomic no. up to 30), effective nuclear charge and shielding. **8 hrs**

Periodic Properties

Atomic radius, Covalent, ionic and van der Waal radii-explanation with examples. Definition and periodicity of the following properties - ionic radii, ionisation potential, electron affinity and electronegativity, methods of determination of electronegativity. Factors affecting the values of ionisation energy. **6 hrs**

Unit II: Chemical Bonding

Ionic Solids– Ionic structures (NaCl, CsCl, TiO_2, ZnS), radius ratio rule and coordination number, limitation of radius ratio rule, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule and their consequences. **4 hrs**

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent

bond, various types of hybridization with examples and shapes of simple inorganic molecules and ions. Shapes of NH_3, I_3^+, I_3^-, SF_4, CIF_3, IF_5, ICl_2^- and H_2O using valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, physical picture of bonding and antibonding wave functions. Applications of MO theory to explain the stability of homo dinuclear (He_2, N_2, O_2, F_2, C_2) and hetero dinuclear (NO and CO) molecules. Comparison of M.O. and V.B. Models.

7 hrs

Metallic bond-free electron, Band theory-electrical properties of metals, semiconductors and insulators.

Weak interactions – Hydrogen bonding and its consequences, van der Waals forces. **3 hrs**

Unit III: Bonding and molecular structure and hydrocarbons

Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital [MO] method, sp, $sp^2$and sp^3 hybridization, bond length, bond dissociation energies and bond angles (open chain and cyclic compounds). Electronegativity and polarity of the bonds. Classification and reactions of organic compounds (with examples). **7 hrs**

Alkanes, Alkenes and Alkynes

Definition, Nomenclature, preparations (any two methods)

Reactions: Electrophilic, nucleophilic and free radical addition reactions

Alicyclic compounds:

Nomenclature, preparation and stability of cyclopropane, cyclobutane, cyclopentane and cyclohexane. **7 hrs**

Reference Books:

1. Concise Inorganic Chemistry, J. D. Lee, ELBS. (1996)
2. Fundamental Concepts of Inorganic Chemistry, A. K. Das, 3rd edition, Vol 1. (2020)
3. Inorganic Chemistry: Principles of Structure and Reactivity, J. E Huheey, E. A Keiter, R. L Keiter & O. K Medhi, Pearson Education India, (2006)
4. Inorganic Chemistry, D.F Shriver & P. W Atkins, Oxford University Press. (2009)
5. Schaum's Outline Series Theory and Problems of Organic Chemistry. SI (metric) edition Herbert Meislich, Howard Nechamkin and Jacob Sharefkin. (2013)
6. Organic chemistry. Robert T. Morrison and Robert N. Boyd, 6th Edition. (1992)
7. Organic Chemistry, I. L.Finar (Volume I). (2002)

COURSE OUTCOME:

On completion of the course the student will learn and be able to understand/explain

1) the concept of atomic structure, significance of quantum numbers, filling of electrons of atoms/ions in various orbitals as per rules
2) the trends in periodic properties
3) the structures of ionic solids, applications of B-H cycle, solubility of compounds and consequences of polarization of ions
4) the shapes of molecules/ions based on VSEPR theory

5) the construction of MO energy level diagrams and prediction of properties of molecules/ions like bond order, bond energies, bond lengths and magnetic properties.
6) the formation of sigma and pi bonds and the bond strength
7) the classification of organic reactions
8) nomenclature preparation, and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds.

OE 2 : For Other than Science Students

CHEMISTRY

DSC-4: Inorganic and Physical Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Credit Points :4

Evaluation: Continuous Internal Assesment-40 MarksSemester End Examination -60 Marks

Course Objectives:

Students learn about

1) Different types of bonding in molecules/compounds/ions
2) The structures of molecules/compounds/ions based on different models/theories
3) Properties of compounds based on bonding and structure
4) The fundamentals of thermodynamics including the laws, the concept of entropy and free energy functions and their applications.
5) The concepts of surface chemistry, catalysis and their applications.
6) The theoretical and experimental aspects of chemical kinetics including basic theories of reaction rates and methods of determining order.
7) Electrochemistry dealing with electrolytes in solution. Conductance measurements and applications. Concept of ionic mobility and their determination.

Course outcomes:

After the completion of this course, the student would be able to

1) Predict the nature of the bond formed between different elements
2) Identify the possible type of arrangements of ions in ionic compounds
3) Write Born - Haber cycle for different ionic compounds
4) Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids
5) Explain covalent nature in ionic compounds
6) Write the M.O. energy diagrams for simple molecules
7) Differentiate bonding in metals from their compounds
8) Learn important laws of thermodynamics and their applications to various thermodynamic systems
9) Understand adsorption processes and their mechanisms and the function and purpose of a catalyst
10) Apply adsorption as a versatile method for waste water purification.
11) Understand the concept of rate of a chemical reaction, integrated rate equations, energy of activation and determination of order of a reaction based on experimental data
12) Know different types of electrolytes, usefulness of conductance and ionic mobility measurements
13) Determine the transport numbers

DSC-4: Inorganic and Physical Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Unit - I

Structure and Bonding -I

The ionic bond: Structures of ionic solids

Radius ratio rules, Calculation of some limiting radius ratio values, Coordinationnumber 3

(planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral), Close packing. **3hrs**

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCI)

Ionic compounds of the type AX_2 (Calcium fluoride (fluorite) and Rutile structureLayer structures CdI_2 , Cadmium iodide structure

Limitations of radius ratio concept **2 hrs**

Lattice energy and Born-Haber cycle, Derivation of Born-Lande equation and itsdrawbacks, Kapustinskii equation, solvation energy and solubility of ionic solids,polarizing power and polarizability, Fajan's rules with applications.

Numerical problems **5 hrs**

Covalent bond: Valence bond theory, The Lewis theory, The octet rule, Exceptions to the octet rule, Sidgwick- Powell theory. Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF_3 and BF_4^-, NH_3 and NH_4^+, H_2O, PCl_5, CIF_3, SF_4, $I_3^-$and I_3^+, SF_6, and IF_7.

Limitations of VSEPR. **4 hrs**

Unit - II

Structure and Bonding -II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp^2, sp^3 dsp^2 dsp^3, d^2sp^3, sp^3d^2 with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory. **3 hrs**

Molecular Orbital theory:

LCAO concept: s-s, s-p, p-p, p-d and d-d combinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals

Examples of molecular orbital treatment for homonuclear diatomic molecules, H_2 molecule, H^+ He_2 molecule, He^{+2} molecule ion, Li_2 molecule, Be_2 molecule, B_2 molecule, C_2 molecule, N_2 molecule, N_2^+, O_2 molecule, O^- and O_2^{2-} M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO^+, CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT. **7 hrs**

Metallic Bonding:

General properties of metals: Conductivity, Lustre, Malleability and cohesive force Crystal structures of metals and Bond lengths

Theories of bonding in metals:

Free electron theory, Valence bond theory, Molecular orbital or band theory of solids Prediction of conducting properties of conductors. insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory. **4 hrs**

UNIT III

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work,Internal Energy, First Law of Thermodynamics, Enthalpy of a System,Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters.

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation.

Third Law of Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. **9 Hrs**

Surface Chemistry

Adsorption: Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis: Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten mechanism. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements. **5 Hrs**

UNIT IV

Chemical Kinetics

Differential and integrated form of rate expressions up to second order reactions, Derivation of expression of rate constant of second order reaction (a=b and a ≠ b), Problems on rate constant (a=b), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide. **7 Hrs**

Electrochemistry – I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems. **7 Hrs**

Reference Books

1. Physical Chemistry, Peter Atkins & Julio De Paula, 9th Edition, Oxford University Press, (2010)
2. Physical Chemistry, G. W Castellan, 4th Edition, Narosa publishers, (2004)
3. Physical Chemistry, R. G Mortimer, 3rd Edition, Elsevier: Noida, UP (2009)
4. Principal of Physical Chemistry, B. R Puri, L. R Sharma and M. S Pathania, Vishal Publishing Co. (2008)
5. Essentials of Physical chemistry, B. S Bahl, G. D Tuli and Arun Bahl, S Chand & Company Ltd. (1994)
6. A textbook of Physical Chemistry, A. S Negi and S. C Anand, New Age International Publishers, (2022)
7. Advanced Physical chemistry, B. N Bajpai, S Chand and Company Ltd, (2012)
8. Chemistry for Degree Students, R. L Madan, Semester I, II, III and IV, S. Chand and Company Ltd.
9. Textbook of Physical Chemistry, P. L Soni, O. P Dharmarha and U N Dash, Sultan Chand and Sons (2021)

PRACTICALS

Credit Points: 2 **Teaching Hours:4Hrs**

Evaluation: Continuous Internal Assessment-20 marks

Semester End Examination: 30 marks

Course objective:

To attain practical knowledge about:

1) Analytical skills in detecting the constituents present in unknown samples bysystematically carrying out thequalitative analysis.
2) The methods of determining rates of chemical reactions.
3) Designing electrochemical cells and making measurements related to it.
4) Determination of physical characteristics of electrolytes using conductivitymeasurements in solution.
5) Adsorption phenomenon, mechanism and basic models to explain adsorption.
6) Simple techniques like conductometry to obtain physicochemical parameters ofelectrolytes.

Course outcomes: At the end of the course student would be able to

1) Understand the chemical reactions involved in the detection of cations and anions.
2) Explain basic principles involved in classification of ions into groups in semi-micro qualitative analysis of salt mixture
3) Carryout the separation of cations into groups and understand the concept of commonion effect.
4) Understand the choice of group reagents used in the analysis.
5) Analyse a simple inorganic salt mixture containing two anions and cations
6) Use instruments like a conductivity meter to obtain various physicochemical parameters.
7) Apply the theory about chemical kinetics and determine the velocity constants ofvarious reactions.
8) Learn about the reaction mechanisms.
9) Interpret the behavior of interfaces, the phenomena of physisorption andchemisorption and their applications in chemical and industrial processes.
10) Learn to fit experimental data with theoretical models and interpret the data

Part A- Inorganic Chemistry Practicals

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations.Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

Cations: $NH4^{+}$, Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^{+}, K^{+} and Li^{+}.

Anions: CO_3^{2-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, BO_3^{3-}, SO_4^{2-}, $C_2O_4^{2-}$ and PO_4^{3-}

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. The study of kinetics of potassium persulphate and potassium iodide volumetrically.

3. Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.
4. Determination of equivalent conductivity of strong electrolyte and verification ofDHO equation.
5. Determination of dissociation constant of weak acid by conductivity method.
6. Conductometric titration of strong acid and strong base.
7. Conductometric titration of weak acid and strong base.
8. Determination of solubility product of sparingly soluble salt conductometrically.

References

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, (2002)
2. Advanced Physical Chemistry, J. B Yadav, Krishna Prakashan Media (P) Ltd,Meerut (2014)
3. Senior Practical Physical Chemistry, B. D Khosla, V. C Garg, & A. R Gulati, Chand & Co. New Delhi (2011)
4. Experiments in Physical Chemistry,C. W Garland, J. W Nibler & D. P Shoemaker, 8th Edition McGraw-Hill: New York (2003)
5. Experimental Physical Chemistry, A. M Halpern & G. C McBane, W.H Freeman & Co, New York (2003)

Semester 4
B Sc / B Sc (Honors)

Title of the Course: Open Elective: Applications of Chemistry in Industries

Number of Theory Credits	Number of lecture hours/semester
3	42

Evaluation Scheme for Theory:
Continuous Internal Assessment (CIA): 40 MarksSemester End Examination (SEE): 60 marks

This course provides a broad introduction to the fundamental principles of Electrochemistry, Corrosion and Metallurgy. The student will gain an understanding of basic and practical applications in various fields of Electrochemistry, Corrosion and Metals and Alloy behaviour andmanufacturing processes. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

Course Objectives

This course will deal with

1) Types of conductance, concept of electrolytes, electrolysis, redox reactions and EMF
2) Concept of different types of electrochemical cells, Types of electrodes and electrode potential. Application of electrochemical series.
3) Basic principles and applications of conductometric, potentiometric and pH titrations.
4) Different types of Batteries their principle construction and working - lead-acid storage

and lithium ion battery. Study of Fuels cells.

5) Concept of corrosion, types of corrosion and its prevention by different methods.Introduction to electroplating.
6) Introduction to ores and minerals, extraction of metals from their ores, and purification. Eg., Manganese, Titanium and Uranium.
7) Study of alloys, classification, production and uses of alloys.

Expected Course Outcomes

Upon completion of the course students will be able to

1) Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.

2) Learn the different types of electrochemical cells, their symbolical representation and application of electrochemical series.
3) Apply conductometric, potentiometric and pH titrations
4) Know the principle, construction and working of batteries
5) Understand different types of corrosion and its prevention by different methods
6) Learn the methods of extraction of metals from their ores and purification

UNIT I

Electrochemical Energy Sources

Batteries:Definition of a Cell and a Battery, Examples to each, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell,

Oxidation -reduction reactions, electrode potential, EMF of an electrochemical cell, Electrochemical series and its importance.

Primary and Secondary batteries, Battery components and their role. Working of thefollowing Batteries- Lead acid, Lithium Storage, Batteries, Fuel cells. **12 hrs**

Types of Electrodes- Hydrogen, Calomel and Glass electrodes. Determination of pH using glass electrode. **2 hrs**

UNIT II

Corrosion: Introduction, definition, damages of corrosion, reasons for corrosion to occur, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage,nature of corrosion product. Environmental Factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium.

5hrs

Prevention of Corrosion: Material selection - Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating. **5 hrs**

Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electro less

plating: Introduction, distinction between electroplating and electroless plating processes. Electroless plating of copper. **4 hrs**

UNIT III

Metallurgy

Introduction: Ore, minerals, important ores of some common elements in India, General Principles of pyrometallurgy, roasting, Calcination, Gangue, Smelting, Flux, Gravity separation, Froth flotation process, leaching. Techniques employed for Purification of metal (Distillation process, Bessemerization, Electro-refining, Van Arkel and De Boer's Filament. **6 hrs**

Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium. **4 hrs**

Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferro alloys; Ferrochrome, Ferro Manganese, Uses of alloys. **4 hrs**

Reference Books

1) Physical Chemistry, Barrow. G.M, Tata McGraw-Hill, (2007)
2) An introduction to Electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)
3) Text book of Physical chemistry, Samuel Glasstone, 2nd Edition, Mac Millan India Ltd, (1991)
4) Principles and applications of Electrochemistry, D. R. Crow, 3rd edition, Chapmanhall London, (1988)
5) Fundamentals of Electrochemical deposition, Milan Paunovic and Mordechay Schlesinger, Wiley Interscience Publications, New York, (1998)
6) Engineering Chemistry, V R Kulkarni and K Ramakrishna Reddy, New Age International, (2015)
7) Electrochemistry and Corrosion Science, Nestor Perez, Springer (India) Pvt. Ltd, (2004)
8) Principles and Prevention of Corrosion, D. A. Jones, Macmillan Publ. Co, (1996)
9) Essential of Materials Science and Engineering, Donald R. Askeland, Thomson Learning, 5th Edition, (2006)
10) Introduction to Engineering Materials, B. K. Agarwal, Tata McGraw Hill, 1st Edition (1988)
11) Material Science and Engineering, V. Raghavan, PHI Learning, 5th Edition (2009)
12) Engineering Materials and Metallurgy, R. K. Rajput, S. Chand - 1st Edition, (2011)

BANGALORE UNIVERSITY

V& VI Semester Chemistry Syllabus
for
B.Sc. / B.Sc. Honours Program

(To be implemented from the academic year 2023-24)

DEPARTMENT OF CHEMISTRY

Bangalore University
Jnanabharathi
Bangalore-560056

AUGUST-2023

Preamble

The Board of studies in UG Chemistry headed by **Prof G Krishnamurthy**, the Chairman, Department of Studies in Chemistry, Jnanabharathi Campus, Bangalore University had the thorough discussions on the syllabus of V and VI semester Chemistry for BSc/ BSc Honors courses using the syllabus provided by the NEP Chemistry syllabus drafting Committee. This syllabus has to be accepted for the academic year 2023-24.

The Core committee consisting of the faculty members of different branches of Chemistry namely Analytical, Physical, Inorganic and Organic Chemistry which comprising the BOS and also additional faculty members from different UG Colleges of Bangalore University have made effective joint brainstorming discussions and arrived at a Syllabus in Chemistry for **V and VI** semesters on **28.08.2023** and **29.08.2023**.

The final syllabus incorporating all the suggestions was finally approved by the members of the Board of Studies in Chemistry (UG) on **29.08.2023**. The following Faculty Members of the Core Committee were involved in the preparation of the Chemistry Syllabus.

Physical Chemistry Section

1. G. Krishnamurthy
2. K. Ramakrishna Reddy
3. P. Nagegowda

Inorganic and Biological Chemistry

4. Dr. Lakshmi Devi
5. Dr. Muddukrishna K R
6. M. Shubha
7. Nebula Murukesh
8. B. M. Sreenivas
9. Dr. Shalini K. S.
10. Dr. Shashikumar N. D.

Organic Chemistry Section

11. Dr. Vasudeva Reddy K
12. Dr. Sumaiya Tabassum

Sd/-

PROF. G. KRISHNAMURTHY

CHAIRMAN

BOS in Chemistry (UG)

Bangalore University

Bangalore -560056

PROGRAMME STRUCTURE

Semester	Title of the Paper	Teaching Hours	Hours / week		Examination Pattern Max. & Min. Marks /Paper						Duration of Exam (hours)		Total Marks / paper	Credits	
					ESE			Practical							
			Theory	Practical	Max.	Min.	IA	Max.	Min.	IA	Theory	Practical		Theory	Practical
V	DSC-5: Organic and Physical Chemistry -III	60	4	-	60	22	40	-	-	-	3	-	100	4	-
	DSC LAB 5: Organic and Physical Chemistry -III	60	-	4	-	-	-	25	9	25	-	3	50	-	2
	DSC-6: Inorganic and Biological Chemistry-III	60	4	-	60	22	40	-	-	-	3	-	100	4	-
	DSC LAB 6 Inorganic and Biological Chemistry- III	60	-	4							-	3	50	-	2
VI	DSC-7: Organic and Physical Chemistry -IV	60	4	-	60	22	40	-	-	-	3	-	100	4	-
	DSC LAB 7: Organic and Physical Chemistry - IV	60	-	4	-	-	-	25	9	25	-	3	50	-	2
	DSC-8: Inorganic and Biological Chemistry- IV	60	4	-	60	22	40	-	-	-	3	-	100	4	-
	DSC LAB 8: Inorganic and Biological Chemistry- IV	60	-	4								3	50		2

Proceedings of the BOS meeting held on 28th and 29th August 2023.

The BOS meeting was held on 28th and 29th August 2023 for scrutinizing and approving the syllabus of V and VI Semester of BSc Chemistry for the academic year 2023-24 from 10.30 am in the board room at the department of Chemistry, Bangalore university, Jnana Bharathi, Bangalore-56.

Agenda of the Meeting:

1. Srutinizing the V and VI semester Syllabus of UG chemistry (NEP) for the Academic year 23-24 onwards.
2. Approval of Panel of Examiners in UG Chemistry for the Academic year 2023-24.
3. Approval of BOE Panel in UG Chemistry for the Academic year 2023-24.

The BOS Chairman, Prof G Krishnamurthy, the Charman, Dept of Chemistry Bangalore University, Bangalore Welcomed all the members for the BOS meeting. He briefed the members to scrutinizing the syllabus thoroughly and finalize it.

All the members involved in the active discussions and scrutinized and prepared the final syllabus and unanimously approved the syllabus of V and VI semester UG chemistry (NEP) for the Academic year 23-24 onwards.

All the members unanimously Approved the Approval of Panel of Examiners in UG Chemistry for the Academic year 2023-24.

All the members unanimously Approved the BOE Panel in UG Chemistry for the Academic year 2023-24.

29/08/2023

BOS CHAIRMAN

Prof. G. KRISHNAMURTHY
Chairman
Department of Chemistry
Bangalore University
Jnanabharathi Campus
Bangalore - 560 056.

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The members who attended the BOS meeting and their signatures

MEMBERS OF THE BOS (UG) CHEMISTRY

1.	Prof G Krishnamurthy	Chairman	Signature
2.	Prof M Shubha	Member	
3.	Dr Nagegowda P.	Member	
4.	Dr Jisha S P	Member	ABSENT
5.	Dr K Ramakrishna Reddy	Member	
6.	Dr K R Muddukrishna	Member	
7.	Prof B M Sreenivas	Member	

MEMBERS RETIRED

4.	Dr Renuka Manjunath	Member(Retired)
5.	Dr B Vijaya Babu	Member(Retired)
6.	Dr Mallesh	Member(Retired)

FACULTY MEMBERS(INVITED)

1. Dr Lakshmi Devi, GFGC, Ramanagara, Karnataka.
2. Dr Vasudevareddy, GFGC, Vijayanagar, Bangalore.
3. Dr Prasanna Kumar, M S Ramaiah College, Bangalore. PRESENT
4. Nebula Murukesh, St Francis de Sales college, Bangalore.
5. Dr. Shalini K S, Maharani' s science College for Women, Bangalore-01.
6. Dr. Sridhar, Maharani' s science College for Women, Bangaluru-56001. PRESENT
7. Dr Sumaiya, Surana College, Bangalore.
8. Dr. Shashi Kumar N D, Christ Academy of Institute for Advanced Studies, B, lore- 83.

G Krishnamurthy 24/08/2023
Chairman, BOS
UG Chemistry, BUB

Prof. G. KRISHNAMURTHY
Chairman
Department of Chemistry
Bangalore University
Jnanabharathi Campus
Bangalore - 560 056.

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PROGRAMME OUTCOMES (POs)

By the end of the programme the students will:

PO 1. Understand the basic principles of various branches of Chemistry

PO 2. Learning all adequate theoretical concepts

PO 3. Analysing the leant concepts

PO 4. Conceptualizing the learnt concepts

PO 5. Developing the skill to apply the concepts for broader learning

PO 6. Apply the key concepts and standard methodologies to solve problems related to Chemistry

PO 7. Apply methodologies to the solution of unfamiliar types of problems

PO 8. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups

PO 9. Exhibit skills leading to employability in Chemistry and allied industries

PO 10. Comprehend the fundamental aspects of research in Chemistry

PO 11. Possess the level of proficiency in subject required for post-graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects

PO 12. Design solutions stemming from the application of Chemistry to the local issues

DISCIPLINE CORE COURSE SEMESTER – V (NEP)

DSC-5- Chemistry –V: Organic and Physical Chemistry

Contact hours- 60 **Credit point-4**

Workload-4 h/week **Each unit: 15h**

COURSE OBJECTIVES

1. Recognize and classify alcohols, thiols, and phenols based on their structural characteristics.
2. Explore the reactivity of alcohols, thiols, and phenols, including their reactions with various reagents and under different conditions**.**
3. Explore the reactivity of aldehydes and ketones, including their reactions with various reagents, such as nucleophiles and oxidizing agents.
4. Explore the reactivity of aldehydes and ketones, including their reactions with various reagents, such as nucleophiles and oxidizing agents.
5. Learn methods for the synthesis of carboxylic acids, including laboratory techniques and industrial processes.
6. To impart the concepts of photochemistry and study beer lamberts law and to understand the photochemical and photophysical processes and their quantum yield expressions. And also to acquire knowledge on nuclear reactions and radioactive decay
7. To develop expertise on the fundamental concepts of quantum mechanics and its application in chemistry
8. To know different types of electrochemical cells, types of electrodes and electrode potential

COURSE SPECIFIC OUTCOMES (COs)

After the completion of this course, the students would be able to

1. Demonstrate a solid understanding of the properties, structures, and nomenclature of alcohols, thiols, and phenols and to perform laboratory experiments safely and effectively, including the synthesis and analysis of alcohols, thiols, and phenols.
2. Evaluate the suitability of different synthetic methods and reagents for specific applications involving aldehydes and ketones and understanding the practical applications of aldehydes and ketones & carboxylic acids in various industries, research, and daily life.
3. Explain the Lambert-Beer's law, the laws of photochemistry, photochemical and photophysical processes as well as to calculate the quantum yield of photochemical combinations. Also to develop an understanding on nuclear stability, nuclear reactions, radioactive decay and applications of nuclear and radiochemistry
4. Explains the fundamental concepts of quantum mechanics and its application in chemistry
5. Learning about the fundamental of electrochemistry and to determine the electrode potential of a half cell, identify different types of electrodes, construct cells and demonstrate its application.

ORGANIC CHEMISTRY III:

UNIT-I

Alcohols,Thiols and Phenols **10h**

Alcohols: Introduction and classification. Methods of preparation-(i) From carbonyl compounds-reduction of aldehydes and ketones (by Meerwein-Pondorff- Verley reaction);(ii) from acids and esters (by reduction with LiAlH4); (iii) From alkenes (by hydroboration oxidation with alkaline peroxide); (iv)hydration of alkenes.

Reactions of alcohols: Acidic nature, esterification, oxidation of alcohols with KMnO4. Comparison of the reactivity of 1°,2°and 3°alcohols- Lucas test, oxidation with $K_2Cr_2O_7$.

Glycols: Preparation from alkenes using OsO_4, $KMnO_4$ and from epoxides.Oxidation of glycols by periodic acid and lead tetraacetate with mechanism. Pinacol- pinacolone rearrangement.

Glycerol:Preparation from propene and from oils/fats. Uses. Reactions of glycerol: (i) nitration, (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid.

Thiols: Nomenclature. Methods of formation and chemical reactions (with sodium,NaOH,metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes. Introduction of umpolung character (reversal of polarity) in carbonyl compounds.

Phenols

Classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids.Effect of electron withdrawing $–NO_2$ group and electron donating $–CH_3$ group on acidity of phenols at o-, m-, p- positions. Pechmann reaction, Mechanism of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii)methyl salicylate, (iii) salol, (iv)salicylsalicylic acid.

Aldehydes and Ketones **5h**

Nomenclature. Preparation of aldehydes: (i)from acid chlorides (Rosenmund reaction), (ii) Gattermann- Koch aldehyde synthesis. Preparation of Ketones: (i) From nitriles,from carboxylic acids with alkyl lithium, (ii) from acid chlorides with metal alkyls.

Mechanisms of Cannizzaro reaction, Benzoin condensation, Reformatsky Reaction and Knoevenagel condensation.General mechanism of condensation with ammonia and its derivatives ($NH2-R;R=-NH_2,-OH,-NH-CO-NH_2$).

Reduction:Reduction by $LiAlH_4$ and $NaBH_4$.Mannich reaction.Mechanisms of Clemmensen and Wolff-Kishner reductions.

UNIT -II

Carboxylic acids and their derivatives **10h**

Carboxylic acids:Nomenclature,Classification-mono,di,tricarboxylic acids,hydroxy acids- lactic acid, tartaric acid and citric acid. Mono carboxylic acids: preparation- acid hydrolysis of nitriles with mechanism. Acidic strength- pKa values.

Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. Comparison of acid strength of formic and acetic acid, acetic acid and mono-chloro, dichloro, trichloroacetic acids, benzoic and p-nitrobenzoic acid, p-aminobenzoic acid, explanation.

Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Volhard- Zelinsky reaction, decarboxylation and reduction using LiAlH4.

Di and tri carboxylic acids: Action of heat on dicarboxylic acids -oxalic acid, malonic acid, succinic acid, glutaric acid and adipic acid. Reactions of tartaric acid and citric acid- action of heat and reduction with HI.

Acid derivatives: Acid chlorides- hydrolysis, reaction with alcohol, ammonia and lithium dialkyl cuprates. Acid anhydrides –acetic anhydride- hydrolysis, reaction with alcohol and ammonia.

Amides-hydrolysis,reduction,Hoffmann degradation.

Esters-acid hydrolysis and alkaline hydrolysis, ammonolysis and alcoholysis.

Amines **5h**

Classification. Preparation of alkyl and aryl amines- reductive amination of carbonyl compounds, Gabriel phthalimide synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles– Methylation, quaternary salts, Hofmann elimination with mechanism. Distinguishing reactions of primary, secondary and tertiary amines.

Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (Conversion to chlorobenzene, bromo benzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (p-hydroxy azo benzene and 1- phenyl azo-2-naphthol).

PHYSICAL CHEMISTRY III:

UNIT-III

Photochemistry **6h**

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients.

Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law – Statements, differences between photophysical and photochemical processes-any four differences with examples.

Comparison of photochemical and thermal reactions with an example each. Quantum yield definition, Magnitude of Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene: reason for low, high and medium quantum yields.

Photosensitization-definition with example, photostationary equilibrium – definition and example. Singlet and triplet states – definitions. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors definitions of all these with suitable examples.

Nuclear and Radiochemistry. **9h**

Nucleus: Structure and stability, binding energy calculations. Instability of the nuclei, radioactive decay law, half-life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ-radiation, α, n, p,and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes- use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems.

UNIT-IV

Quantum Mechanics **8h**

Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Angular Momentum operators and their properties. Commutation of operators. Solutions of Schrödinger wave equation for a free particle, particle in a three-dimensional box. Quantum mechanical degeneracy, tunneling (no derivation). Application of Schrödinger equation to harmonic oscillator, rigid rotator.

Application of Schrödinger wave equation to hydrogen atom. Schrödinger equation to hydrogen atom in spherical polar coordinates. Separation of variables.

List of wave functions for few initial states of hydrogen like atoms. The Stern-Gerlach experiment and the concept of electron spin, spin orbitals (elementary idea only) and Pauli's exclusion principle.

Approximate methods: Need for approximate methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Electrochemistry II **7h**

Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nernst equation for single electrode potential (free energy concept).

Weston-cadmium cell: Determination of Emf of a cell by compensation method. Determination of E of Zn/Zn^{2+} and Cu/Cu^{2+}electrodes.

Liquid junction potentials, elimination of liquid junction potential.

Types of electrodes: Metal and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems.

Concentration cells: (i) Emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, Emf of redox electrodes. Potentiometric titration involving only redox systems

DSC LAB 5: Chemistry Practical -V: Organic and Physical Chemistry Practicals

ORGANIC CHEMISTRY PRACTICALS

Preparations(onestage)

1. Cannizzaro Reaction:Benzaldehyde.
2. Fries Rearrangement:Phenylacetate.
3. Sandmeyer Reaction: 4-Chlorotoluene From 4-toluidine.
4. Pechmann Reaction:Resorcinolandethylacetoacetate.
5. Oxidation of Cyclohexanol.
6. Preparation of S-Benzylthiuronium chloride.
7. Synthesis of P-iodonitrobenzene
8. Synthesis of Phenyl-2,4-dinitroaniline.
9. Synthesis of 2,4,6-tribromoaniline.

PHYSICAL CHEMISTRY PRACTICALS

1. Verification of Beer's Law for Cu^{2+} ions
2. Verification of Beer's Law for Fe^{2+} ions
3. Estimation of Fe^{2+} ions concentration in the given solution by titration of FAS versus $KMnO_4$ through colorimetric method.
4. Estimation of Fe^{2+} ions concentration using EDTA through colorimetric method.
5. Study the hydrolysis of methyl acetate in presence of two different concentrations of HCl and report the relative strength.
6. Study the hydrolysis of methyl acetate in the presence of HCl at different temperatures and report the energy of activation
7. Evaluation of Arrehenius parameter for the reaction between $K_2S_2O_8$ versus KI (first order).

Pedagogy:

Practically learning; Assignments; Seminars/ Presentations; Viva-voce; Quiz; ICT (online) learning.

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

COs \ POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	2	3	2	**1**	3	1	**2**	**2**	**3**	**1**	**1**
CO 2	3	**2**		2	1	**3**	3		1	3	2	1
CO 2	3		2		3		1	2	1			1
CO 3	2	**1**	**2**	3	**1**		3	**2**		**2**	**3**	**1**
CO 3	3	1	**2**		3	**1**		3		2	1	1

Note: High = 3; Medium = 2; and Low = 1.

REFERENCES

1. Advanced Organic Chemistry. Arun Bahl and B.S Bahl, 22nd Edn, New Delhi, 2016.
2. Organic Chemistry, Volumes I and II, I L Finar, Longman, (1999).
3. Organic Natural products. Gurudeep and Chatwal, Vol I , 2019.
4. Chemistry of Natural products 1 & 2. OP Agarwal, 2019.
5. Organic Chemistry, R T Morrison and R N Boyd, Prence-Hall, (1998).
6. Organic reactions and their mechanisms. Kalsi. P.S, 2nd Edn, New Delhi, 2000.
7. A textbook of Organic Chemistry. OP Agarwal, 2012.
9. Spectroscopy of Organic compounds. Kalsi. P.S, 6th Edn 2004.
10. Spectrometric identification of organic compounds, R.M. Silverstien & F.X.Webster.1998.
11. Physical Chemistry, P. W. Atkins, Julio de Paula, ELBS, 7th ediBon, (2002).
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14. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S.Pathania, S. L. N. Chand & Co., 1987
15. Introduction to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill, (1988).
16. Quantum Chemistry, Ira. N. Levine, PrenBce Hall, New Jersey, (1991).
17. Quantum Chemistry, R. K. Prasad, New Age InternaBonal, 2nd ediBon, (2000).
18. Quantum Chemistry through problems and solutions, R. K. Prasad, New Age InternaBonal (1997).
19. Chemical Kinetics- K. J. Laidler, McGraw Hill. Inc. New York (1988).
20. Principles of Chemical KineBcs - House J. E. Wm C Brown Publisher, Boston, (1997).
21. Kinetics and Mechanism - A. A. Frost and R. G. Pearson, John-Wiley, New York, (1961).
22. Chemical Kinetic Methods - C. Kalidas, New Age InternaBonal Publisher, New Delhi (1995)

(Practicals)

1. Findlays practical physical chemistry revised by P. B. Levi. Z, Longman's London (1966).

2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill InternatIonal. (1966)
3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
5. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
6. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
7. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983)
8. Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow, S. R. Cohen an Green Macmillan publishing Co.,.New York (1994).
9. Textbook of Practical Organic Chemistry- A. I. Vogel, (1996).
10. Textbook of Quantitative Organic Analysis- A. I. Vogel, (1996).

DISCIPLINE CORE COURSE SEMESTER – V (NEP)

DSC-6 Chemistry -VI: Inorganic and Biological Chemistry

Contact hours- 60 **Credit point-4**

Workload-4 h/week **Each unit: 15h**

COURSE OBJECTIVES

1. To teach students the concept of nomenclature of coordination compounds, geometries (e.g., octahedral, tetrahedral, square planar), and the factors that influence the geometry of coordination complexes by taking various examples.
2. To understand how coordination chemistry interfaces with other branches of chemistry and related fields, such as bioinorganic chemistry and organometallic chemistry.
3. To develop a solid understanding of the different materials used in industry, including their properties, applications, and manufacturing processes.
4. The requisite background knowledge in the field of Biochemistry.
5. A thorough knowledge about the structure, chemistry and functions of biomolecules like carbohydrates, lipids and proteins.
6. A knowledge about the salient features of nucleic acids.
7. The principle and the applications of Blotting and Electrophoretic techniques.
8. The basic characteristics of enzyme and its classification, mechanism enzyme action, enzyme kinetics, enzyme inhibition and co-enzymes.

COURSE SPECIFIC OUTCOMES

After the completion of this course, the students would be able to

1. Define and explain what coordination compounds are, including their structure, bonding, and properties.
2. Understand the practical applications of coordination compounds in various fields, such as catalysis, medicinal chemistry, and materials science.
3. Gain knowledge of the manufacturing and processing methods for various industrial materials, including the techniques used to shape, heat treat, and finish them.
4. Exposed to a strong theoretical and practical background in fundamental concepts. Also to get insights of multiple important technical areas of Biochemistry.
5. Able to correlate structure and function of biomolecules like carbohydrates, lipids and proteins.

INORGANIC CHEMISTRY III:

UNIT-I

Coordination and Organometallic compounds **15h**

Coordination compounds, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds in detail. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory in detail and its limitations). EAN rule, Valence bond theory- postulates, low spin and high spin complexes with examples, limitations of VBT. Crystal field theory (octahedral, tetrahedral and square planar complexes). Crystal field splitting and crystal field stabilization energies, limitations of CFT. Magnetic properties of $[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$. Spectral properties of $[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$,

$[CoCl_4]^{2-}$. Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism with examples. Organometallic compounds – ligands, classification (hapticity). Synthesis and structure of $K[PtCl_3(\eta 2\text{-}C_2H_4)]$ and $[Fe(\eta 5 - C_5H_5)_2]$.

Metal carbonyls – $Cr(CO)_6$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations with examples.

Applications of coordination/organometallic compounds:cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation, Monsanto acetic acid process.

UNIT-II

Industrial Materials **15h**

Refractories: Properties, classification, determination of PCE values.

Abrasives – definition and classification with examples, applications, hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glasses, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials grades, manufacture of Portland cement (by wet process), setting of cement.

Paints and Varnishes: Constituents of oil and emulsion paints and their role, constituents of varnishes.

Fuels: Characteristics, Calorific value and its determination using bomb calorimeter, Coal- Varieties, Gaseous fuels-advantages, constituents and their significance, production of Coal gas and composition of LPG. Octane number.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification, and their applications.

BIOLOGICAL CHEMISTRY I:

UNIT-III

Essential biological concepts **4h**

Contributions of Lavosier, Wohler, Emil Fischer, Louis Pasteur, Embden, Meyerhof, Parnas. Hans Kreb, Michaelis and Menton, Watson and Crick, Chargaff, H.G. Khorana, Knoop, Pauling, Hopkins and Miescher. Elemental and biochemical composition of living organisms. Role of water in biochemical systems (mention the properties of water which makes water a solvent of life). Importance of water in biological system with special reference to the maintenance of the native structure of biological molecules. Types of bonding in biological molecules.Biological relevance of pH and pKa of functional groups in biopolymers, proteins and nucleic acids. Buffers, pH value of various bio-entities, buffer action, buffer capacity and their importance in biological systems.

Carbohydrates **4h**

Structure and biological importance of derivatives of monosaccharides. Amino sugars: β-D-glucosamine, galactosamine and their N-acetylated forms: Nacetylmuramic acid (NAMA); N-acetylneuraminic acid (NANA) Sugar acids–structure and biological importance of D- gluconic acid, D-glucuronic acid and D-glucaric acid. Sugar phosphates–structure and biological importance of Glucose-6-P, Fructose-6-P, Fructose1, 6-di-P, β-D-ribose-5-P and β- D-deoxyribose-5-P. Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose. Polysaccharides - source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and insulin.

Lipids **4h**

Introduction, Classification. Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides- acid and alkali hydrolysis, saponification number and its significance, iodine number andits significance.I odine number of different oilsrancidity (oxidative and hydrolytic).

Nucleic acids **3h**

Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial

structure of polynucleotide. Structure of DNA (Watson - Crick Model) and RNA. Biological roles of DNA and RNAs. Protein-nucleic acid interaction- chromatin and viral nuclear capsid

UNIT-IV

Proteins **5h**

α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non-essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin. Peptide bond, nomenclature and classification of peptides, Levels of organizations of Protein: Primary structure, Secondary structure (α-helix, triple helix eg., Collagen and β-pleated sheet) forces stabilizing secondary structure, tertiary structure and forces stabilizing it, quaternary structure. Importance of primary structure by taking sickle cell anaemia as example.

Hormones **2h**

Definition. Classification - a) amino acid derivatives (epinephrine and thyroxine); b) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid hormones (progesterone, testosterone) with functions. Role of insulin and glucagon in glucose homeostasis. Mediators of hormone action – Ca^{2+}, cyclic AMP.

Enzymes **6h**

Introduction, Holo enzyme (apo enzyme and coenzyme). Active site, specificity. Classification of enzymes (EC code number not required). Enzyme substrate interaction- Fischer and Koshland models. Enzyme kinetics–factors affecting rate of enzymatic reactions – enzyme concentration, substrate concentration, pH and temperature (mention M. M. equation). Allosteric enzymes–definition and example Enzyme Inhibitions- Competitive, non-competitive and uncompetitive inhibition with one example for each. Co- enzymes and cofactors and their role in biological reactions.

Biochemical techniques **2h**

Principle and applications Electrophoresis–cellulose acetate membrane electrophoresis and PAGE. Blotting techniques- Basic principle, types and application.

DSC LAB 6 ; Chemistry Practicals -VI:

Inorganic and Biological Chemistry Practicals

INORGANIC CHEMISTRY PRACTICALS

VOLUMETRIC ANALYSIS

1. Estimation of Zinc using EDTA.
2. Estimation of Nickel using EDTA and standard zinc sulphate.
3. Determination of Total Hardness of Water using EDTA
4. Estimation of Copper in Brass.
5. Estimation of Percentage of Iron in Haematite ore using barium diphenylamine sulphonate as an internal indicator.

BIOLOGICAL CHEMISTRY PRACTICALS

1. Preparation of buffers and determination of their pH values using pH meter.
2. Estimation of reducing sugars by Hegdorn-Jensen method.
3. Estimation of lactose in milk by Nelson-Somogi's method.
4. Estimation of creatinine by Jaffe's method.
5. Estimation of inorganic phosphate by Fiske-Subbarow method.
6. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
7. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.

Pedagogy:

Practically learning; Assignments; Seminars/ Presentations; Viva-voce; Quiz; ICT (online) learning.

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

COs \ POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	2	3	2	**1**		3	**2**		**2**	**1**	**1**
CO 2	3	**2**		2	2	**3**			1	3	2	1
CO 2	3		2		3		1	2	1			1
CO 3	2	**3**	**2**	3	**1**		3	**2**		**2**	**3**	**1**
CO 3	3	2	**3**		2	**1**		3		2	1	1

Note: H = 3 ; M = 2; and L = 1.

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(Practicals)

1. Vogel's Textbook of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's textbook of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

DISCIPLINE CORE COURSE SEMESTER – VI (NEP)

DSC-7; Chemistry - VII: Organic and Physical Chemistry

Contact hours- 60 **Credit point-4**

Workload-4 h/week **Each unit: 15h**

COURSE OBJECTIVES

1. Recognize and classify heterocyclic compounds based on their ring structures and heteroatoms.
2. Understand the principles and strategies involved in the total synthesis of complex natural products.
3. To keep students informed about current market trends, emerging technologies, and the role of innovation in the organic chemical industry.
4. To introduce students to various spectroscopic techniques, including UV-Vis, IR, NMR, and their applications in organic compound analysis.

5. To acquire and consolidate the fundamental concepts of chemical dynamics
6. To learn the basics of Voltammetry as an electroanalytical technique
7. To develop a good understanding of the electromagnetic spectrum and describe the principles of Vibrational, Raman, Electronic and Electronic spectroscopy
8. Introduce the NMR and ESR spectroscopy and discuss the applications of spectroscopy

COURSE SPECIFIC OUTCOMES

After the completion of this course, the students would be able to

1. Apply knowledge to solve problems related to the synthesis and reactions of heterocyclic compounds and to recognize the importance of natural products in drug discovery, agriculture, and other applied fields.
2. Demonstrate a strong awareness of chemical safety protocols and hazard mitigation in industrial settings and to use spectroscopic data to deduce the structure and connectivity of organic compounds.
3. Explain the theories of chemical kinetics, thermodynamical formulation of reaction rates and conceptualize steady state kinetics, kinetics of Chain reactions, homogeneous, enzyme catalysis.
4. Gain expertise to explain the different methods to study the of kinetics of fast reactions. Also to demonstrate skills to explain the principles of DME and experimental set up for cyclic voltammetry.
5. Predict the spectroscopic technique and understand its role in the structure elucidation based on its interaction with electromagnetic radiation.

ORGANIC CHEMISTRY IV:

UNIT: I

Heterocyclic Compounds **5h**

Introduction, classification, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine.

Mechanism of electrophilic substitution reactions. Comparison of basicity of pyrrole, pyridine and piperidine. Preparation and reactions of indole, quinoline and isoquinoline.

Chemistry of Natural Products **10h**

Carbohydrates: Introduction and classification.

Mono saccharides: Aldoses, structures of all the D-aldohexoses. Elucidation of open chain structure of D-glucose. Mechanism of mutarotation and anomeric effect. Elucidation of ring structure of D-glucose in detail. Ketoses:Fructose,inter-conversion of glucose and fructose.

Disaccharides: Glycosidic bond. Structures of maltose, lactose and sucrose- Haworth and conformational structures.

Terpenes and terpenoids: Occurrence,classification and isoprene rule. Elucidation of structure and synthesis of citral and zingiberene. Structures of limonene, menthol, α- terpineol, camphor, β-carotene, Vitamins-A and their uses.

Alkaloids: Introduction, classification and general characteristics. Structural elucidation and synthesis of nicotine. Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

UNIT-II

Industrial Organic Chemistry **5h**

Synthetic dyes: Introduction and classification. Colour and constitution. Synthesis of Congo red, malachite green, alizarin and indigo.

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac, ranitidine, sulphanilamide and chloramphenicol.

Introduction to Green Chemistry: Principles of Green chemistry and its application to the synthesis of paracetamol.

Spectroscopy of Organic compounds **10h**

UV-Visible spectroscopy: Introduction. Chromophores and auxochromes; blue shift and red shift. Graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Influence of conjugation on UVabsorption- Comparison of UV spectra of acetone and methyl vinyl ketone. IR spectroscopy: Introduction. Stretching frequencies of−OH (free and H-bonded), alkyl −C−H, C -C, C=C, C−C, C=O and C−O groups (by taking suitable examples). Graphical representation of IR spectra of benzoic acid and methyl benzoate.

NMR spectroscopy: Basic principles of proton magnetic resonance: Nuclear magnetic spin quantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Nuclear magnetic resonance. Chemical shift (δvalues), uses of TMS as reference. Nuclear shielding and deshielding effects. Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values. Spin-spin splitting and spin-spin coupling (qualitative treatment only).

Applications of NMR spectroscopy including identification of simple organic molecules. Examples: Shielding and deshielding effects for(i) methane (ii) CH_3-Cl (iii) CH_2Cl_2(iv) $CHCl_3$. Spin-spin coupling in (i)Cl_2CHCHO (ii)1,1,2- trichloroethane (iii) CH_3CH_2Cl.

PHYSICAL CHEMISTRY IV:

UNIT-III

Chemical Dynamics **11h**

Macroscopic and Microscopic kinetics, Review of theories of reaction rate- Collision theory and Transition State theory. Comparison of transition state theory with collision theory. Arrhenious equation- characteristics, Significance of energy of activation, Temperature coefficient and its evaluation, Thermodynamical formulation of reaction rates (Wyne-jones and Eyring treatment), Reaction between ions in solutions - Influence of ionic strength on reaction rates (primary and secondary salt effects).

Concept of Steady state kinetics, Chain reactions - chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane.

Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.

Kinetics of homogeneous catalysis-kinetics of auto catalytic reactions, Comparison of enzyme catalysed and chemical catalysed reactions, Mechanism (Lock and Key theory), Kinetics of enzyme catalysed reactions - Henri-Michaelis- Menten mechanism, Significance of Michaelis-Menten constant, Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity.

Electroanalytical Methods **4h**

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME. Ilkovic equation and its applications. Current –potential relation for a cathodic process – half wave potential. Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

UNIT-IV

Spectroscopy **15h**

Polarisation and orientation of dipoles in an electric field. Dipole moment. Induced dipole moment (experimental determination of dipole moment not included). Clausius-Mossotti equation (only statement). Dipole moment and structure of molecules (planar and non-planar).

The interaction of radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular spectra: Born-Oppenheimer approximation. Rotational spectra of diatomic molecules: Relationship between internuclear distance and moment of inertia. Expression for rotational energy. Numerical problems. Criterion for absorption of radiation-selection rule.

Vibrational spectroscopy: Hooke's law- Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero-point energy., numerical problems. Degree of freedom of polyatomic molecules– modes of vibration for CO2 and H2O molecules.

Raman spectroscopy: Concept of polarizability. Pure rotation, vibration, qualitative study. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Potential energy curves for bonding and antibonding molecular orbitals. Electronic transitions –qualitative description of non-bonding orbitals and transitions between them. Selection rules and Franck-Condon principle.

Electron Spin Resonance (ESR) Spectroscopy: Introduction, principle, criteria for the molecules to be ESR active and applications.

DSC LAB 7; Chemistry Practicals-VII:
Organic and Physical Chemistry Practicals

ORGANIC CHEMISTRY PRACTICALS

Qualitative analysis: Systematic analysis and identification of organic compounds.

PHYSICAL CHEMISTRY PRACTICALS

1. Conductometric titration of weak acid versus weak base.
2. Determination of Critical Micellar Concentration (CMC) by conductivity method
3. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
4. Determination of single electrode potential of Cu2+/Cu and estimate the given unknown concentration using potentiometric titration.
5. Determination of single electrode potential of Zn2+/Zn and estimate the given unknown concentration using potentiometric titration.
6. Titration of weak acid against a strong base using quinhydrone electrode and calculation of pKa and Ka of the weak acid.
7. Determination of Oxidation and Reduction potential of K4Fe(CN)6/K3Fe(CN)6 system by cyclic voltammeter

Pedagogy:

Practically learning; Assignments; Seminars/ Presentations; Viva-voce; Quiz; ICT (online) learning.

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

COs \ POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	3	2	2	**3**	2	3	**2**		**3**	**1**	**2**
CO 2	3	**2**	3	2	1	**3**	2	3	1	3	2	2
CO 2	3	3	2		3		1	2	1			1
CO 3	2	**1**	**2**	3	**1**	2	3	**2**	**3**	**2**	**3**	**3**
CO 3	3	1	**2**	3	3	**1**	2	3	1	2	1	2

Note: H = 3 ; M = 2; and L = 1.

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1. Findlays practical physical chemistry revised by P. B. Levi. Z, Longman's London (1966).
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill InternationalEdn. (1966)
3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
5. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
6. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
7. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983)
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10. Textbook of Quantitative Organic Analysis- A. I. Vogel, (1996).

DISCIPLINE CORE COURSE SEMESTER – VI (NEP)

DSC-8; Chemistry-VIII: Inorganic and Biological Chemistry

Contact hours- 60 **Credit point-4**

Workload-4 h/week **Each unit: 15h**

COURSE OBJECTIVES

1. To encourage research and innovation in materials science, exploring new materials, applications, and sustainable practices.
2. To develop the ability to select appropriate materials for specific engineering applications based on their properties, performance requirements, and cost considerations.
3. To understand the principles of heat treatment, including annealing, quenching, and tempering, and their effects on the structure and mechanical properties of metals.
4. To understand the role of transition metals as catalysts in various chemical reactions.
5. To identify practical applications of conducting polymers in electronics, sensors, and energy storage devices.
6. The Concepts of thermodynamics and the mechanism of energy transfer in ETC
7. The knowledge of mechanism of DNA Replication, Transcription, Genetic code and Translation Process
8. Greater ideas about Vitamins and the knowledge in the quantitative and qualitative estimation of biomolecules

COURSE SPECIFIC OUTCOMES

After the completion of this course, the students would be able to

1. Grasp the role of fuels in energy production, such as in power generation and transportation, and the importance of energy efficiency and renewable energy sources.
2. Apply metallurgical principles to the production, processing, and selection of materials in various industries.
3. Understand the fundamentals of powder metallurgy and its advantages in producing complex-shaped parts with controlled properties. Also to recognize the importance of transition metals in various chemical processes and industries.
4. Apply knowledge of doping and processing to tailor the performance of conducting polymers.
5. To make them able to express ideas persuasively in written and oral form to develop their leadership qualities. Also to demonstrate professional and ethical attitude with enormous responsibility to serve the society.

INORGANIC CHEMISTRY IV:

UNIT-I

Bioinorganic Chemistry **2h**

Essential and trace elements in biological systems with reference to Na^+, K^+, Ca^{2+}, Fe^{2+}, P, Cu, V and Ni. Metallo-porphyrins with special reference to haemoglobin, myoglobin and chlorophyll. Role of cobalamin (vitamin-B12 coenzyme) in living systems.

Metallurgy **5h**

Ellingham's diagrams: Salient features. Selection of reducing agents using Ellingham's diagrams.

Extraction of the following metals.

i) Nickel from sulphide ore

ii) Thorium from Monazite sand

iii) Uranium from Pitch blende

iv) Plutonium from Nuclear waste

Powder metallurgy **2h**

Advantages of powder metallurgy and its applications. Methods of production of metal powders. production of Tungsten powder from Wulframite.

Steel and Alloys **6h**

Steel: Iron-Carbon Phase diagram, Austenite, Ferrite, Cementite and Pearlite phases.

Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of Steel.

Ferro alloys: Production of ferro chrome, ferro manganese, and ferro silicon and their applications. Carbon steel: classification. Heat treatment: hardening, case hardening, carbiding, nitriding, tempering and annealing.

UNIT-II

General study of d and f block elements **6h**

Transition elements: electronic configuration, atomic and ionic radii, ionization energy, oxidation states, redox potentials, spectral and magnetic properties, catalytic activity, interstitial compound formation.

Lanthanides and Actinides: Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences. Oxidation states, spectral and magnetic properties, comparison of oxidation states, complex formation and magnetic properties of d and f block elements. Ion exchange method for separation of Lanthanides.

Chemistry of Newer materials **5h**

Conducting polymers: Introduction, definition, and examples-polyaniline, polyacetylene. Mechanism of conduction. Qualitative treatment of doping, Properties: elasticity with high electrical conductivities, Engineering, and biological applications.

Nanomaterials: Introduction, definition, and electronic structure. Different methods of production: Sol gel synthesis, inert gas condensation, mechanical alloying (ball milling), plasma synthesis, electrodeposition, and general applications.

Water Technology **4 h**

Types of impurities present in water. Causes for the hardness of water. Permissible levels of ions present in water. Treatment of water for domestic and Industrial purposes by the following methods.

i) Demineralization of water by Ion exchange method.

ii) By reverse Osmosis method.

BIOLOGICAL CHEMISTRY II

UNIT III

Biological oxidation **7h**

Bioenergetics- Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between G and Keq. High energy phosphates–definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation of ATP). Examples of high energy phosphates other than ATP. Energy coupling in biological reactions (explain the concept with suitable examples). Biological oxidation – comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH). Mitochondrial electron transport chain, oxidative phosphorylation. Substrate level phosphorylation.

Metabolism **8h**

Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic. Gluconeogenesis–definition, synthesis of glucose from lactate. Fatty acid metabolism–activation of fatty acids, role of carnitine, β- oxidation pathway, energetics. Protein metabolism–general aspects of amino acid degradation– transamination, deamination and decarboxylation. Urea cycle.

UNIT IV

Molecular biology **7h**

Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation. DNA finger printing – Definition and its applications.

Vitamins **8h**

Classification and Nomenclature of vitamins. Fat soluble vitamins and water-soluble vitamins Sources, deficiency diseases, Vitamin B complex and Vitamins of E group. Structure of Vitamin A1andA2, mechanism of vision, structures of Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.

LAB 8; Chemistry Practicals-VIII:

Inorganic and Biological Chemistry Practicals

INORGANIC CHEMISTRY PRACTICALS

1. Preparation of cis and trans-potassiumdioxalatodiaquachromium (III) complex
2. Preparation of cuprammoniumsulphate.
3. Preparation of tri-oxalato ferrate(III).
4. Preparation of hexamminecobalt(III) chloride.
5. Preparation of pentaamminecobalt(III) chloride.

BIOLOGICAL CHEMISTRY PRACTICALS

1. Estimation of α-amino acids using ninhydrin by colorimetric method.
2. Determination of blood group.
3. Separation of α-amino acids by paper chromatography.

4. Isolation of DNA from onions.
5. Estimation of cholesterol by colorimetric method.
6. Determination of pKa of amino acid (glycine).
7. Qualitative analysis of carbohydrates.

Pedagogy:

Practically learning; Assignments; Seminars/ Presentations; Viva-voce; Quiz; ICT (online) learning.

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

COs \ POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	2	3	2	**1**	3	3	**2**		**3**	**1**	**1**
CO 2	2	**2**		2	2	**3**		3	1	3	2	1
CO 2	3	2	2		3		1	2	1			1
CO 3	3	**3**	**2**	3	**1**		3	**2**		**2**	**3**	**1**
CO 3	3	3	**2**		3	**1**		3	2	2	1	1

Note: H = 3 ; M = 2; and L = 1.

REFERENCES (Theory)

1. Advanced Inorganic Chemistry, 6th Edition F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
2. Concise Inorganic Chemistry, 5th Edition J. D. Lee, Blackwell Science, 2001.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford,

Oxford Univ. Press 2002.
5. Modern Inorganic Chemistry W. L. Jolly, McGraw Hill Co.
6. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
7. Inorganic Chemistry, 3rd Edition (ISE) A G Sharpe, Addison Wesley, 1989.
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10. University Chemistry, 4th Edition (ISE) B. H. Mahan & R. J. Myers, Addison Wesley, 1989.
11. Essential Trends in Inorganic Chemistry C. M. P. Mingos, Oxford Univ Press, 1998
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14. Concise Textbook of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000.
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19. Biochemistry COSIP -ULP, Bangalore University, 1981.Outlines of Biochemistry Conn E. E and Stumpf P. K., John Wiley & Sons, 1978.

(Practicals)

1. Vogel's Textbook of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's textbook of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

ASSESSMENT: WEIGHTAGE FOR ASSESSMENT

Common for both V and VI semesters

TYPE OF ASSESSMENT	SUMMATIVE (MARKS)	FORMATIVE (MARKS)
THEORY	60	40
PRACTICAL	25	25

SCHEME OF INTERNAL ASSESSMENT MARKS: THEORY PAPERS

Common for both V and VI semesters

Sl N	PARTICULARS	MARKS
1	Attendance	10
2	Assignments/ Seminars	10
3	Internal Tests (Average of two tests)	20
TOTAL		40

PRACTICALS

Common for both V and VI semesters

SL NO	PARTICULARS	MARKS
1	Attendance	05
2	Record writing	05
3	Internal Tests (Average of two tests)	15
TOTAL		25

END PAGE