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.

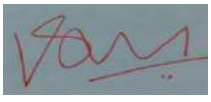
Undergraduate programmes were traditionally conceived as preparation for post graduation. Since decades its structure remained unchanged and was long due for an overhaul. The rigidity in choosing subjects through fixed combinations had to be reconsidered. The aspects of all-round development of the students, 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 I 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, DarlingKindersley (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 structure Layer 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 its drawbacks, 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

B. Sc., Chemistry Syllabus

I to VI Semesters
(w. e. f. 2014)

Department of Chemistry
Central College Campus
Bangalore - 560 001

FOREWORD

As per the directive from the Bangalore University, the Chemistry syllabus for the B. Sc., degree course (CBCS) had to be prepared. Guidelines for this were provided by the University.

In the Department of Studies in Chemistry, Central College, with the help of the Chemistry Teachers' Forum, a Core Group involving the Teachers of the University Department and affiliated colleges was constituted. This Core Group participated in work-shops held on 22.04.2014, 30.04.2014 and 19.05.2014, keeping in view the aims of the UGC Model Curriculum in developing interdisciplinary skills in students linking general studies with professional courses and allowing both vertical and horizontal mobility and also catering to local needs the syllabus was prepared.

Teachers of different branches of Chemistry, namely Inorganic, Organic, Physical and Biochemistry had separate and joint brainstorming sessions and arrived at a Draft Syllabus in Chemistry for SIX semesters. The Chemistry Teachers' Forum played a pivotal role during the drafting of the syllabus. The Draft Syllabus in chemistry was brought to the attention of a wider group of Teachers for further refinement on 23th May 2014. The final draft incorporating the suggestions was placed before the Department Council on 02. 6. 2014 and then the Board of Studies in Chemistry (UG) on 07. 6. 2014 for approval.

CHAIRMAN
Department of Studies in Chemistry
Central College Campus
Bangalore University
Bangalore-560 001

Members of the Committee for the Preparation of the Chemistry Syllabus for the B. Sc., Degree Course (Semester Scheme)

Chemistry Teachers' Forum: Bangalore University, Bangalore

Physical Chemistry Section

Dr. Girija C R	SSMRV College, Bangalore
Mr. Sripathi	Vivekananada College, Bangalore
Dr. Vasundara D E	BMS College, Bangalore
Ms. Malathi M	Rural College , Kanakapura
Mr. S. Uday Kumar	Rural College, Kanakapura

Inorganic Chemistry Section

Mr. H B Mallesh	GFGC, Channapatna
Mr. Vijaya Babu B.	GFGC, Vijayanagar
Mr. Ramanna	Kongadiappa College, Doddaballapura
Dr. Muddu Krishna K R.	Govt. First Grade College, Varthur, Bangalore
Ms. Hamsini S	GFGC Chickaballapur.
Ms. Vanitha G K	GFGC, Doddaballapur
Mr. G R Rangappa	GFGC, Kolar
C Sanjeevarayappa	GFGC, Yelahanka

Organic Chemistry Section

Dr. Shylaja S	GFGC, K R Puram, Bangalore
Dr. Rekha S	VVS First Grade College, Bangalore
Dr. Shashikala Devi K	Maharani Science College, Bangalore
Dr. Prathima Rao	Vivekananda College, Bangalore
Ms. Shamsiya Rizwana	M E S College, Bangalore
Mr. Sridhar B T	Maharani Science College, Bangalore

Biochemistry Section

Dr. Nanda N	BMS College for Women, Bangalore
Ms. Radhika R	GFGC, Channapatna
Ms. Kathyayini	National College, Gowribidanur.

Proceedings of the Meeting of Board of Studies in Chemistry (UG) held on 7th June 2014 at 10.30 am in the Department of Chemistry, Central College Campus, Bangalore-560 001.

The Chairman welcomed the members of the Board to the meeting and placed the agenda before them for discussion.

Agenda: 1. *Scrutiny and approval of the Syllabus for the B. Sc., Degree, Chemistry Course (Semester Scheme)*.

2. *Preparation of the BOE (UG) and Professional Courses for the Academic Year 2014-15.*

The Chairman informed the members that, as per the directive from the Bangalore University, the Chemistry syllabus for the B. Sc., degree has been prepared with the help of the Chemistry Teachers' Forum which constituted a Core Group form affiliated Colleges, is proposed to be introduced from 2014 onwards. In this connection, the Core Group participated in workshops held on three days: 22. 04. 2014, 30. 04. 2014 and 19. 05. 2014 and prepared a Draft syllabus. The syllabus was then finalized in a workshop conducted on 23th May 2014 in the presence of a wider group of Teachers represented by most of the colleges offering Chemistry at UG level. The draft syllabus was then placed before the Department Council on 2. 6. 2014 for approval, the approved syllabus is now placed before the Board for Scrutiny and approval.

The Board of Studies (UG) approved the Syllabus after some modifications.

The Board also prepared the BOE (UG) Chemistry and BOE Professional Course (BE., Chemistry).

The meeting ended with the vote of thanks by the Chairman.

The following members were present.

1. Dr. Shaheen Taj
2. Sri. R. Vinay Kumar
3. Sri. S. Vijay Kumar
4. Sri. H. B. Mallesh
5. Sri. G. Siddalingaiah
6. Smt. M. Malathi
7. Dr. Venkatesha, B. M (External Member)
8. Dr. Nanjundaswamy, N (External Member)
9. Dr. M. A. Pasha Chairman, (BOS, UG)

SCHEME OF EXAMINATION

Title of the paper	Contact hours/Week	Exam. hours	IA	Marks	Total Marks	Credits
First Semester						
Chemistry-I	4	3	30	70	100	2
Chemistry Practical-I	3	3	15	35	50	1
Second Semester						
Chemistry-II	4	3	30	70	100	2
Chemistry Practical-II	3	3	15	35	50	1
Third Semester						
Chemistry-III	4	3	30	70	100	2
Chemistry Practical-III	3	3	15	35	50	1
Fourth Semester						
Chemistry-IV	4	3	30	70	100	2
Chemistry Practical-IV	3	3	15	35	50	1
Fifth Semester						
Chemistry-V	3	3	30	70	100	2
Chemistry- VI	3	3	30	70	100	2
Chemistry Practical-V	3	3	15	35	50	1
Chemistry Practical-VI	3	3	15	35	50	1
Sixth Semester						
Chemistry-VII	3	3	30	70	100	2
Chemistry VIII	3	3	30	70	100	2
Chemistry Practical-VII	3	3	15	35	50	1
Chemistry Practical-VIII	3	3	15	35	50	1

B. Sc., – I Semester
Paper- I

UNIT-I

Mathematical Concepts for Chemistry **4 hours**

Logarithmic relations: Definition, some important relations like log*(m+n)*, $\log\left(m/n\right)$, *log* m^n, change of base ($\log_e 2 \rightarrow \log_e x$). Application in the calculation of pH.

Curve sketching: How a cure is sketched with a set of points: linear and non-linear (asymptotic) with a set of points, sketching both linear and non-linear curves. Calculation of slope in the case of linear curve.Extrapolation of linear curve and arriving at a limiting value.

Parabolic curve- maximum and minimum. *Differentiation*: Meaning and derivative of functions like e^x, log *x, sin x, cos x,* $1/x$, x^2, $x^x$and $\sqrt{n}$, $\frac{dy}{dx} = 0$ at maximum and minimum.

2^{nd} *order differentiation*: for maximum and minimum (derivation from first principles not required). Rules of differentiation for $y = u + v$, $y = uv$, $y = \frac{u}{v}$ and $y = ku$, where *k* is constant.

Partial differentiation: Explanation, applications using the equation, H = U + PV and G = H − TS.

Integration: Meaning and integrals of functions like, *x, dx,*x^2, $1/x$, $1/x^2$, $1/x^3$, x^n, e^x, *sin x* and *cos x*. simple problems from I and II order kinetics.

Exact and inexact differentials: Examples from internal energy and enthalpy. *Definite integrals*.

Probability: some definitions, examples from atomic orbitals, wave functions and entropy.

Gaseous state **9 hours**

***Introduction*:** Need for Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule-explanation of the terms only. Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems.

Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c, P_c and V_c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c. Amagat's mean density method for V_c. Problems on the calculation of T_c, P_c and V_c, *a* and *b*.

Law of corresponding states-statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

UNIT-II

Photochemistry **4 hours**

Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. 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. Photosensitization, photostationary

equilibrium. Singlet and triplet states. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors.

Beer-Lambert's law and its applications. Numerical problems on absorption coefficient and molar extinction coefficient.

Liquids and Solutions **9 hours**

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them.

Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it.

Surface Tension-Definition, mathematical expression, effect of temperature and solute on it

Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions.

Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples.

Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system.

Immiscible liquids-Steam distillation and its applications.

Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction

Dilute solutions- Review of colligative properties and concentration terms

Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method (π); (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems.

UNIT-III

Periodic Table and Periodic properties **9 hours**

Review of the modern periodic table (with respect to classification of elements based on outer electronic configuration)

Periodic properties: Atomic and ionic radii, ionisation energy, electron affinity and electronegativity. Trends in the periodic properties. Applications in predicting and explaining chemical behaviour. Factors affecting the values of ionisation energy. Determination of electronegativity by Pauling's method. Diagonal relationship between beryllium and aluminium. Comparitive study of elements of alkali and alkalline earth metals, chalcogens and halogens with respect to electronic configuration, atomic and ionic radii, ionisation energy, and elecronegativity. Halides, oxides and carbonates of alkali and alkalline earth metals. Hydrides of chalcogens and halogens.

Analytical Chemistry **4 hours**

Errors: Classification, minimization of determinate errors, accuracy and precision. Significant figures and their computations.

Equivalent weights of acids, bases, salts, oxidising and reducing agents. Methods of expressing concentration of solutions in terms of Normality and Molarity. Numerical problems.

UNIT-IV

Basic concepts in organic chemistry **4 hours**

Bond cleavage – homolytic and heterolytic. Types of reagents – electrophilic and nucleophilic reagents. Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes – explanation for stability and reactivity based on inductive, resonance and hyperconjugation effects.

Types of reactions - addition, substitution and elimination. Concept of isomerism - structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral center – definition and examples. Tautomerism (keto – enol).

Aliphatic Hydrocarbons **9 hours**

Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits.

Conformational analysis of n-butane - Sawhorse and Newman projection formulae to be used - Energy profile diagram.

Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds.

Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4.Ozonolysis- mechanism and importance.

Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride.

Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with $KMnO_4$, acidic nature of terminal alkynes.

B. Sc., – II Semester
Paper- II

UNIT-I

Quantum Mechanics and Atomic Structure **13 hours**

Review of Bohr's atomic model:
Derivation of expressions of for radius, energy and ionisation energies of hydrogen like atoms. Numerical Problems.
Limitations of classical mechanics. Wave particle duality, Uncertainty principle.
New quantum mechanics-Sinusoidal wave (Explain sinusoidal wave.) equation (classical wave mechanics); Schrodinger wave equation- derivation. Postulates of quantum mechanics.
Significance of terms- (i) Hamiltonian operator; (ii) eigen function Ψ (significance of ψ and ψ^2); (iii) eigen values.
Application of Schrodinger equation: (i) to particle in one dimensional box (derivation required); (ii) to the hydrogen atom (detailed solution not required)
Expressing the solution as a product of $\psi_{n,\,l.\,m}\,(r, \theta, \phi) = \psi_{n,\,l.\,(r)}\psi_{\,l.\,m(\theta,\,\phi)}$
Explanation of quantum numbers (only qualitative). Radial probability distribution and angular probability distribution. Orbitals

UNIT-II

Chemical bonding **13hours**

Ionic bond: Lattice energy, Born-Haber cycle, Born-Lande equation (derivation not required, problems on Born-Lande expression to be worked out). Calculation of lattice energies of NaCl and MgO,effect of lattice energy on solubility of ionic compounds.
Covalent bond: Valence bond approach: hybridization and directional characteristics of sp, sp^2, sp^3, sp^2d, sp^3d^2. Shapes of $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6.VSEPR theory: shapes of CH_4, NH_3, NH_4^+, H_2O, BrF_3, ICl^{2-}.Molecular orbital theory: H_2, He^{2+}, Be_2, N_2, O_2, O^{2-}, O_2^{2-}, O^{2+} and CO (bond order, stability and magnetic properties to be discussed). Polarization concept, Fazan's rule, bond length, bond angle and bond energy, polar and non-polar molecules, dipole moment.
Weak interactions: i). Hydrogen bond: Intra molecular and Intermolecular types, anomalous properties of HF, H_2O, NH_3, alcohols, carboxylic acids, nitro phenols and bio molecules.
ii) van der Waal's forces: Noble gases and molecular crystals (dry ice, Iodine and solid SO_2)
Metallic bond: Band theory, electrical properties of metals, semiconductors and insulators.

UNIT-III

Silicates **2hours**

Structure of SiO_4^{4-}, Classification of silicates based on the structure. Zeolites: their structure and applications.

Noble gases **3hours**

Introduction, isolation of Helium from Natural gas, applications of Noble gases. Preparation properties and structures of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4).

General study of d and f block elements. **8hours**

Transition elements: electronic configuration, atomic and ionic radii, ionisation 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.

UNIT-IV

Aromatic hydrocarbons **9 hours**

Nomenclature. Structure of benzene - using molecular orbital theory. Criteria for aromaticity-Huckel's rule (Examples: cyclopentadienyl anion, cycloheptatrieneylcation, benzene, naphthalene, anthracene and phenanthrene). Antiaromaticity.

General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol.

Aromatic nucleophilic substitution *via* benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction.Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene.

Alkenyl benzenes: Styrene, *cis*- and *trans*-stilbenes and their preparations.
Biphenyl: Preparation-Ullmann reaction.

Organic halogen compounds **4 hours**

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - S_N1 andS_N2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups,(ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on S_N1 and S_N2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

B. Sc., –III Semester
Paper III

UNIT-I

Chemical Kinetics **7 hours**

Review of terms –Rate, Order and Molecularity.

Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.

Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems.

Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis.

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.

Thermodynamics I **6 hours**

Exact and inexact differentials. Review of terms, I law of Thermodynamics.

Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used).

Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems.

Spontaneous and non-spontaneous processes.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency (η). Change in entropy in reversible and irreversible processes (derivations required) . Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity. Problem on Phase transitions

UNIT-II

Thermodynamics II **4 hours**

Gibb's free energy: Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation-Derivation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G^\circ = -RT\, ln K_p$ Problems.

Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. Its applications to ΔT_b and ΔT_f determination (thermodynamic derivation not required).

Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.

Surface chemistry **4hours**

Review of surface phenomena.

Theories of adsorption . Adsorption isotherms and BET equation (derivation included), Adsorption indicators. Surface film on liquids.

Catalysis –Types and theories ((intermediate compound theory and adsorption theory).

Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions. Autocatalysis.

Organic and Inorganic Polymers **3hours**

Differences between inorganic and organic polymers.

Polymerisation: types: addition and condensation polymerisation

Molecular weight of Polymers: Expression for Weight average and Number average (experimental determination is not required)

Preparation and applications of the following types of polymers

1. Plastics: i)thermosetting plastics(Phenol-formaldehyde)
   ii) thermo softening plastics(PVC)
2. Fibers: Acrylic, polyamide, polyester types: one example for each
3. Rubber: Neoprene,
4. Fluoro Carbons: Teflon
5. Silicones.

Compounds of some Nonmetals. **2hours**

i) Boron and its compounds: Synthesis, structure and applications of Diborane, Borazole and Boron trifluride.

ii) Halogens and its Compounds: Bleaching powder: manufacture and its applications.

UNIT-III

Metallurgy **5 hours**

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.

Alcohols and Thiols **8 hours**

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 $LiAlH_4$); (iii) From alkenes (by hydroboration-oxidation with alkaline peroxide); (iv) hydration of alkenes. Reactions of alcohols: Acidic nature, esterification, oxidation of alcohols with $KMnO_4$. 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 mechanisms. 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.

UNIT-IV

Phenols **3 hours**

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, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions.
Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

Ethers and Epoxides **4 hours**

Ethers: Methods of preparation – (i) dehydration of alcohols, (ii) Williamson's ether synthesis. Reactions – Ethers as Lewis bases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method.

Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1,2-disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with $LiAlH_4$.

Fertilizers **4hours**

Introduction(need of fertilizers), functions of essential plant nutrients(N,P,K),
Classification of fertilizers with examples. Nitrogeneous, Phosphatic and mixed fertilizers with suitable examples. Manufacture of urea and Super phosphate of lime, and their uses.
Fertilizer industries in India.

Organometallic compounds **2 hours**

Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.

B.Sc., IV -Semester
Paper –IV

UNIT-I

Phase Equilibria 7 hours

Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Derivation of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water–potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Patterson's method).

Solid state 6 hours

Crystalline state, Laws of crystallography. Symmetry elements in crystals, crystal systems.Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation, . Problems
Liquid crycstals-Types with examples. Applications
Superconducting solids-High temperature superconductors. Applications.

UNIT-II

Water Technology 3hours

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) Demineralisation of water by Ion exchange method.
ii) by reverse Osmosis method.

Nuclear and Radiochemistry. 8hours

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.

Powder metallurgy 2hours

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

UNIT-III

Steel 5hours

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.

Aldehydes and Ketones 8hours

Nomenclature. Preparation of aldehydes: from acid chlorides (Rosenmund reaction), Gattermann-Koch aldehyde synthesis. Preparation of Ketones: From nitriles, from carboxylic acids with alkyl lithium, from acid chlorides with metal alkyls.
Mechanisms of: Aldol condensation, Perkin condensation, Knoevenagel condensation, Benzoin condensation and Acetal formation. General mechanism of condensation with ammonia and its derivatives (NH_2-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-IV

Carboxylic acids and their derivatives. 5 hours

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism.

Acidic strength (pK_a values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids ; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid)

Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Decarboxylation and reduction (using $LiAlH_4$). (already included under preparation of alcohols from acid)

Di and tri carboxylic acids: Action of heat on dicarboxylic acids (Oxalic to Adipic acids)

Reactions of tartaric acid and citric acid. (action of heat, reduction with HI).

Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates) .Acid anhydrides (hydrolysis, reaction with alcohol, ammonia).Esters (alkaline hydrolysis, ammonolysis and alcoholysis).Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalysed (acyl O-cleavage: $B_{AC}2$, $A_{AC}2$; alkyl O-cleavage: $A_{AL}1$ mechanisms).

Tautomerism and Enolates 4 hours

Tautomerism in carbonyl compounds – Keto-Enol tautomerism. Acidity of α-hydrogen atoms in aldehydes, ketones and active methylene compounds (example diethyl malonate, ethyl acetoacetate and acetyl acetone). Preparation of (from acetic acid) and synthetic applications of diethyl malonate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid - Adipic acid, unsaturated acids - cinnamic acid, ketones - butanone, cyclic compounds - barbituric acid)

Preparation of ethyl acetoacetate (from ethyl acetate). Synthetic applications of ethyl acetoacetate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid –succinic acid, unsaturated acids - crotonic acid, ketones - butanone).

Environmental Chemistry 4hours

Depletion of ozone in the stratosphere. causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

B.Sc., - V Semester
Paper V

UNIT-I

Stereochemistry **8hours**

Elements of symmetry in chiral and achiral molecules, chirality, stereogenic centre. Fischer projection formulae.

Enantiomers: Optical activity; use of +/–, *d/l* and D/L notations. Properties of enantiomers, chiral and achiral molecules with two stereogenic centers. Meso compounds. Cahn-Ingold-Prelog sequence rules: R, S system of nomenclature.

Diastereomers: Threo and Erythro isomers.

Racemisation and resolution. Relative and absolute configuration.

Optical isomerism due to restricted rotation about single bonds- diphenyl systems.

Geometric isomerism: Determination of configuration of geometric isomers. Cis & trans, E, Z system of nomenclature. Geometric isomerism in oximes.

Alicyclic compounds: Conformations of four to eight membered cycloalkanes and disubstituted cyclohexanes.

Bicylic systems: Nomenclature and conformations of decalins and norbornane.

UNIT-II

Amines **5hours**

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimde synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles – Methylation, quarternary salts, Hoffmann elimination with mechanism. Distinguishing reactions of 1°, 2° and 3° amines.

Diazotization and synthetic applications of diazonium salts.Sandmeyer's reaction. (conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (*p*-hydroxyazobenzene and 1-phenylazo-2-naphthol).

Heterocyclic compounds **4hours**

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.

UNIT-III

Chemistry of Natural Products **10hours**

Carbohydrates: Introduction and classification.

Monosaccharides: 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, interconversion 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-IV

Spectroscopy of Organic compounds **8 hours**

UV-Visible spectroscopy: Introduction. Chromophores and auxochormes; blue shift and red shift. Graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Influence of conjugation on UV absorption-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 (δ values), 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. E*xamples*: 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.

Industrial Organic chemistry **5 hours**

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.

B. Sc., - V Semester
Paper VI

UNIT-I

Electrochemistry I **10 hours**

Review of electrolytes and Conductance related terms

Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.

Kohlrausch's law and its applications: (i) evaluation of Λ_∞ from Λ_+ and Λ_-(ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of $\Lambda_\infty$of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Problems based on these.

Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation.

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

UNIT-II

Electrochemistry II **5 hours**

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.

Ionic equilibria **3 hours**

Hydrolysis of salts of weak acids and weak bases.Ionic product of water. Relationship between K_h, K_w, K_a and K_b. Degree of hydrolysis and its relationship with K_h. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems.

Common-ion effect, buffers, buffer action and buffer capacity. pH of buffers. Henderson's equation and its derivation. Solubility product and ionic product in precipitation and in qualitative analysis.

Analytical and biological applications of buffers.

Theories of indicators.

UNIT-III

Physical properties and Molecular structures **5 hours**

Polarization 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).

Magnetic properties-paramagnetic, diamagnetic and ferromagnetic systems. Electrical properties of solids: types of solids-metals, insulators and semiconductors. Pyroelectricity, piezoelectricity, ferroelectricity, inverse piezoelectricity. Thomson effect, Seebeck effect and Peltier effect-definition with examples.

Chemical Spectroscopy I **5 hours**

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.

UNIT-IV

Chemical Spectroscopy II **4 hours**

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 CO_2 and H_2O molecules.

Raman spectroscopy: **3 hours**

Concept of polarisability. 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.

Electroanalytical Methods **5 hours**

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.

B.Sc., - VI Semester
Paper VII

UNIT-I

Coordination and Organometallic compounds I **10 hours**

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 $[Fe(\eta^5\text{ - }C_5H_5)_2]$,

UNIT-II

Coordination and Organometallic compounds II **4 hours**

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.

Industrial Materials I **6 hours**
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 glass, 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.

UNIT-III

Industrial Materials II **7 hours**
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.

Bioinorganic Chemistry **3 hours**
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-B_{12}coenzyme) in living systems.

UNIT-IV

Chemistry of Newer materials **10hours**
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.
Super conductors: Introduction, definition, type1, type 2 and atypical. Preparation of high temperature super conductor-$\mathbf{Y_1Ba_2Cu_3O_{x\pm\delta}}$, BCS theory (qualitative treatment only) and general applications of high temperature super conductors.
Fullerenes: Introduction, definition, preparation and isolation of C_{60}. Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of $C_{60.}$Commercial uses of $C_{60.}$Carbon nanotubes-Introduction, definition, examples and structure.
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.

B.Sc., - VI SEMESTER
Paper – VIII

UNIT-I

INTRODUCTION TO BIOCHEMSITRY **2hours**

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).

CARBOHYDRATES **4hours**

Structure and biological importance of derivatives of monosaccharides.

Amino sugars : β-D-glucosamine, galactosamine and their N-acetylated forms: N-acetylmuramic 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, Fructose-1,6-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 **4hours**

Introduction, Classification.

Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples

Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides- acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides.

Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol.

Cholesterol – definition, types (HDL, LDL and VLDL)

Sphingolipids–structure and biological significance of ceramide.

UNIT-II

PROTEINS **5hours**

***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.

Levels of organizations of Protein: Primary structure, Secondary structure (α-helix, triple helix eg., Collagen and β-pleated sheet), tertiary structure and forces stabilizing it, quaternary structure.
Denaturation and renaturation: Thermal renaturation-Aufinsen's experiment with ribonuclease.
Classification of proteins based on structure, composition and biological function (enzymes, hormones, transport agents, antibodies, structural materials with examples).

NUCLEIC ACIDS **3hours**
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.

HORMONES **2hours**
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.

UNIT-III

ENZYMES **4hours**
Introduction, Holo enzyme (apo enzyme and co enzyme).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, noncompetitive and uncompetitive inhibition with one example for each.

BIOLOGICAL OXIDATION **4hours**
Bioenergetics- Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between $\triangle G$ 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 electrotransport chain, oxidative phosphorylation. Substrate level phosphorylation.

BIOCHEMICAL TECHNIQUES **2hours**

Principle and applications of:

- Paper chromatography and TLC.
- Electrophoresis–cellulose acetate membrane electrophoresis and PAGE.

UNIT-IV

METABOLISM **6hours**

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.

MOLECULAR BIOLOGY **4hours**

Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation.

DNA finger printing – Definition and its applications.

SUGGESTED BOOKS

Inorganic Chemistry

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. Environmental Chemistry
   A. K. De, Wiley Eastern Ltd., 1999.
6. Nuclear and Radiation Chemistry
   Sharma B. K, Goel Publishing House, 1987.
7. Modern Inorganic Chemistry
   W. L. Jolly, McGraw Hill Co.
8. Principles of Inorganic Chemistry
   B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
9. Inorganic Chemistry, 3rd Edition (ISE)
   A G Sharpe, Addison Wesley, 1989.
10. Basic Inorganic Chemistry, 3rd Edition
    F. A. Cotton, G. Wilkinson, P. L. Gaus-John Wiley & Sons, 1995.
11. Essential Chemistry, International Edition
    R. Chang, McGraw Hill Co, 1996.
12. University Chemistry, 4th Edition (ISE)
    B. H. Mahan & R. J. Myers, Addison Wesley, 1989.
13. Essential Trends in Inorganic Chemistry
    C. M. P. Mingos, Oxford Univ Press, 1998
14. Chemistry, 3rd Edition
    P. Atkins &L.Jones, W. H. Freeman & Company, 1997.
15. Modern Chemistry, 4th Edition
    D. W. Oxicby, H. P. Gills & N. H. Nachtrieb, Saunders College Publishing, 1998.
16. Fundamental Concepts of applied Chemistry,
Jayashree Ghosh, S Chand Publications.
17. Industrial Chemistry,
    B. K. Sharma, Goel Publishing House

Organic Chemistry

1. Organic Chemistry, Paula YurkanisBruice, Prentice Hall, 2005.
2. Advanced Organic Chemistry
   F. A. Carey and R. J. Sundberg, Plenum, 1990.

3. Organic Chemistry, Vol I & II
I. L. Finar, ELBS, 1986, 1991, 2005
4. Organic Chemistry
R. T. Morrison and R. N. Boyd, Prentice Hall, 1991
5. Organic Chemistry, Maitland Jones, Jr., W. W. Norton & Company
6. Advanced Organic Chemistry
O. S. Bahl and A. Bahl., S. Chand & Co. 1995
7. Advanced Organic Chemistry
J. March, John Wiley & Sons, 2008.
8. Understanding Organic Reaction Mechanisms
A. Jacobs, CambridgeUniv Press, 1998.
9. Organic Chemistry
M. K. Jain, Nagin& Co., 1987
10. A Guide to Mechanism in Organic Chemistry
P. Sykes, Orient Longman, 2005.
11. Organic Spectroscopy
V. R. Dani, Tata McGraw Hill, 1998.
12. Organic Spectroscopy
W. Kemp, ELBS IV Edition, 1998.
13. Synthetic Drugs
G. R. Chatwaal, Himalaya Publications, 2000.
14. Steriochemistry of Organic Compounds ,
Ernest L. Eliel, Samuel H. Wilen, Wiley India Edition,1994

Physical Chemistry

1. Physical Chemistry, 7th Edition
P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
2. The Elements of Physical Chemistry, 3rd Edition
Peter Atkins, OxfordUniv. Press, 2000.
3. Physcial Chemistry – A molecular Approach
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7. Outlines of Biochemistry
Conn E. E and Stumpf P. K., John Wiley & Sons, 1978.
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Chemistry Practicals for B. Sc., Course

I Semester: Practical 1 (General Chemistry) 3 hours per week

1. Calibration of glass wares: (i) Pipette (ii) Burette (iii) Volumetric flask
2. Estimation of potassium permanganate using standard sodium oxalate solution.
3. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with potassium ferricyanide as an external indicator.
4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with diphenyl amine as an internal indicator. (Change to ferroin indicator?)
5. Estimation of sodium thiosulphate using standard potassium dichromate solution.
6. Estimation of iodine using sodium thiosulphate and standard potassium dichromate solution.
7. Determination of the percentage of available chlorine in the given sample of bleaching powder.
8. Determination of percentage of manganese dioxide from pyrolusite ore.
9. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).
10. Estimation of chloride by Volhard's method.
11. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
12. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
13. Estimation of carbonate and bicarbonate in a given mixture.

Note: ***Standard solutions to be prepared for experiments 2 to 6***.

II Semester: Practical II (Physical Chemistry) 3 hours per week

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of percentage composition of a binary liquid mixture by viscosity method.
3. Determination of molar mass of polymer by viscosity method.
4. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
5. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
6. Determination of degree of dissociation of an electrolyte by ebullioscopic method.
7. Determination of transition temperature of a salt hydrate by thermometric method.
8. Determination of distribution coefficient of acetic acid between water and butanol.
9. Determination of distribution coefficient of benzoic acid between water and toluene.
10. Effect of surfactants on the surface tension of water (Stock solution to be given).

III Semester: Practical III (Organic Chemistry) 3 hours per week

Preparation and purification of organic compounds

1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
3. Purification of solids by sublimation.

One stage preparation

(Preparation, recrystallization and melting point determination of the recrystallised sample)

4. Preparation of aspirin from salicylic acid.
   (*Note: Acetic anhydride is to be prepared freshly by distilling acetyl chloride and sodium acetate mixture*).
5. Preparation of paracetamol from *p*-aminophenol.
6. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
7. Preparation of *p*-aminobenzoic acid from *p*-nitrobenzoic acid.
8. Preparation of *m*-dintrobenzene from nitrobenzene.
9. Preparation of benzoic acid from benzaldehyde.

Two stage preparations

10. Preparation of *p*-bromoaniline from acetanilide.
11. Preparation of *p*-nitroaniline from acetanilide.
12. Preparation of *m*-nitrobenzoic acid from methyl benzoate.
13. Preparation of methyl orange/methyl red by diazotization and coupling.

Chromatography

14. **Paper chromatography**: Extraction of spinach (using 1 : 1 alcohol and Whatmann filter paper)
15. **Thin layer chromatography**: Separation of green leaf pigments/separation of a mixture of two organic compounds.
16. **Column chromatography**: Separation of a mixture of two organic compounds

IV Semester: Practical IV (Inorganic Chemistry) 3 hours per week

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (with no interfering radicals).
2. Separation of metal ions (Cu^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+})using paper chromatography and calculation of R_f values (To be performed by the students)
3. Separation of Mg(II) and Fe(II) by solvent extraction technique.
4. Effluent analysis.

V Semester: Practical V (Organic Chemistry) 3 hours per week

1. Organic qualitative analysis of mono functional organic compounds through functional group analysis. Determination of physical constant. Preparation and characterization of a suitable derivative.
2. Isolation of lycopene from tomatoes.
3. Isolation of caffeine from tea leaves.

V Semester: Practical VI (Physical Chemistry) 3 hours per week

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate ($a = b$).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pK_a of a weak acid by pH metric method.
10. To construct the phase diagram of two component system (Ex. diphenylamine-benzophenone) by cooling curve method.
11. Determination of percentage of sodium chloride by miscibility temperature method.
12. Estimation of Cu^{2+} colorimetrically and verification of Beer-Lambert's law.
13. Determination of Oxidation and Reduction potential of $K_4Fe(CN)_6/K_3Fe(CN)_6$ system by cyclic voltammetry.

VI Semester: Practical VII (Inorganic Chemistry) 3 hours per week

1. Estimation of percentage of iron in haematite using bariumdiphenylamine sulphonateas an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of copper in brass.
4. Estimation of zinc using EDTA.
5. Estimation of total hardness of water using EDTA.
6. Gravimetric estimation of barium as barium sulphate.
7. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
8. Preparation of cuprammoniumsulphate and determination of λ_{max} and hence CFSE.
9. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
10. Estimation of nickel using EDTA and standard zinc sulphate.
11. Preparation of ferrous oxalate and its analysis (both iron and oxalate).

VI Semester: Practical VIII (Biochemistry) 3 hours per week

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-Somyogi'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.
8. Estimation of α-amino acids using ninhydrin by colorimetric method.
9. Determination of blood group.
10. Separation of α-amino acids by paper chromatography.
11. Isolation of DNA from onions.
12. Estimation of cholesterol by colorimetric method.

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