SHIVIJI UNIVERSITY, KOLHAPUR

M.Sc. Part I Chemistry Syllabus as per New CBCS PATTERN

Including 1st and 2nd semester Applied and Industrial Chemistry

Revised Implemented from 2019-2020

Applicable for University Departments & Affiliated Colleges Centers

M.Sc. Programme structure (CBCS PATTERN) (2019-20)
M.Sc. Part – I

SEMESTER-I (Duration- Six Month)												
	Sr. No.	Course Code	Teaching Scheme			Examination Scheme					
			Theory and Practical			University Assessment (UA)			Internal Assessment (IA) and Practical		
			Lectures (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
CGPA	1	CC-101	4	4	4	80	32	3	20	8	1
	2	CC-102	4	4	4	80	32	3	20	8	1
	3	CC-103	4	4	4	80	32	3	20	8	1
	4	CC-104	4	4	4	80	32	3	20	8	1
	5	CCPR-105	16	16	8	--	--	--	200	80	*
Total (A)			**--**	**--**	**24**	**320**	**--**	**--**	**280**	**--**	**--**
Non-CGPA	1	AEC	2	2	2	--	--	--	20	8	1
SEMESTER-II (Duration- Six Month)											
CGPA	1	CC-201	4	4	4	80	32	3	20	8	1
	2	CC-202	4	4	4	80	32	3	20	8	1
	3	CC-203	4	4	4	80	32	3	20	8	1
	4	CC-204	4	4	4	80	32	3	20	8	1
	5	CCPR-205	16	16	8	--	--	--	200	80	*
Total(B)			**--**	**--**	**24**	**320**	**--**	**--**	**280**	**--**	**--**
Non-CGPA	1	SEC	2	2	2	--	--	--	20	8	1
Total (A+B)					**48**	**640**	**--**	**--**	**560**	**--**	**--**

• Student contact hours per week : **32** Hours (Min.)	• Total Marks for M.Sc.-I : **1200**
• Theory and Practical Lectures : **60** Minutes Each	• Total Credits for M.Sc.-I (Semester I & II) : **48**
• CC-Core Course • CCPR-Core Course Practical • AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course • SEC- Mandatory Non-CGPA compulsory Skill Enhancement Course	• Practical Examination is annual. • Examination for CCPR-105 shall be based on Semester I Practicals. • Examination for CCPR-205 shall be based on Semester II Practicals. • *Duration of Practical Examination as per respective BOS guidelines • ***Separate passing is mandatory for Theory, Internal and Practical Examination***

M.Sc. Programme structure (CBCS PATTERN) (2020-21)
M.Sc. Part – II

SEMESTER-III (Duration- Six Month)												
	Sr. No.	Course Code	Teaching Scheme			Examination Scheme					
			Theory and Practical			University Assessment (UA)			Theory and Practical		
			Lectures (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
CGPA	1	CC-301	4	4	4	80	32	3	20	8	1
	2	DSE-302	4	4	4	80	32	3	20	8	1
	3	CCS-303	4	4	4	80	32	3	20	8	1
	4	CCS-304	4	4	4	80	32	3	20	8	1
	5	CCPR-305	16	16	8	--	--	--	200	80	*
Total (C)			**--**	**--**	**24**	**320**	**--**	**--**	**280**	**--**	
Non-CGPA	1	AEC	2	2	2	--	--	--	20	8	1
	2	EC (SWM MOOC)	Number of lectures and credit shall be as specified on SWAYAM MOOC								
SEMESTER-IV (Duration- Six Month)											
CGPA	1	CC-401	4	4	4	80	32	3	20	8	1
	2	DSE-402	4	4	4	80	32	3	20	8	1
	3	CCS-403	4	4	4	80	32	3	20	8	1
	4	CCS-404	4	4	4	80	32	3	20	8	1
	5	CCPR-405	16	16	8	--	--	--	200	80	*
Total (D)			**--**	**--**	**24**	**320**	**--**	**--**	**280**	**--**	**--**
Non-CGPA	1	SEC	2	2	2	--	--	--	20	8	1
	2	GE	2	2	2	--	--	--	20	8	1
Total (C+D)					**48**	**640**	**--**	**--**	**560**	**--**	**--**

Student contact hours per week : **32** Hours (Min.)	• Total Marks for M.Sc.-II : **1200**
• Theory and Practical Lectures : **60** Minutes Each	• Total Credits for M.Sc.-II (Semester III &IV) : **48**
• CC-Core Course • CCS-Core Course Specialization • CCPR-Core Course Practical • AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course • SEC- Mandatory Non-CGPA compulsory Skill Enhancement Course • EC (SWM MOOC) - Non-CGPA Elective Course • GE-Generic Elective	• Practical Examination is annual. • Examination for CCPR-305 shall be based on Semester III Practicals. • Examination for CCPR-405 shall be based on Semester IV Practicals. • *Duration of Practical Examination as per respective BOS guidelines • ***Separate passing is mandatory for Theory, Internal and Practical Examination***

Total Credits for M.Sc. Program: 96
Total Marks for M.Sc. Program: 2400

I. CGPA course:

1. There shall be 14 Core Courses (CC) per program.
2. There shall be 02 Discipline Specific Elective (DSE) courses of 08 credits per program.
3. There shall be 04 Core Course Specialization (CCS) courses of 16 credits per program.
4. Total credits for CGPA courses shall be of 96 credits per program.

II. Mandatory Non-CGPA Courses:

1. There shall be 02 Mandatory Non-CGPA compulsory Ability Enhancement Courses (AEC) of 02 credits each per program.
2. There shall be 01 Mandatory Non-CGPA compulsory Skill Enhancement Course (SEC) of 02 credits per program.
3. There shall be one Elective Course (EC) (SWAYAM / MOOC). The credits of this course shall be as specified on SWAYAM / MOOC portal.

4. There shall be one Generic Elective (GE) course of 02 credits per program. Each student has to take Generic Elective from the department other than parent department.
5. The total credits for Non-CGPA course shall be of 08 credits + 2 to 4 credits, as specified on the SWAYAM/MOOC portal.
6. The credits assigned to the course and the program shall have no relation with the work-load of the teacher.

M. Sc. Part – I (Inorganic, Organic, Physical, Analytical, Applied and Industrial Chemistry)

Semester I

	Course code	Paper No.		Title of course	
CGPA	CC-101	I	CH.1.1	Inorganic Chemistry - I	All courses are compulsory.
	CC-102	II	CH.1.2	Organic Chemistry - I	
	CC-103	III	CH.1.3	Physical Chemistry - I	
	CC-104	IV	CH.1.4	Analytical Chemistry - I	
	CCPR-105		CHP.1.1	Practical- I	
Non-CGPA	AEC -106				

Semester II

	Course code	Paper No.		Title of course	
CGPA	CC-201	V	CH.2.1	Inorganic Chemistry – II	All courses are compulsory.
	CC-202	VI	CH.2.2	Organic Chemistry – II	
	CC-203	VII	CH.2.3	Physical Chemistry – II	
	CC-204	VIII	CH.2.4	Analytical Chemistry - II	
	CCPR-205		CHP.2.1	Practical -II	
Non-CGPA	SEC - 206				

M. Sc. Part – II (Inorganic Chemistry)

Semester III

	Course code	Paper No.		Title of course	
CGPA Non-CGPA	CC-301	IX	ICH 3.1	Inorganic Chemical Spectroscopy	Compulsory course
	CCS-302	X	ICH 3.2	Coordination Chemistry - I	Compulsory course
	CCS-303	XI	ICH 3.3	Nuclear Chemistry	Compulsory course
	DSE-304(A)	XII(A)	ICH 3.4(A)	Organometallic and Bioinorganic Chemistry	Choose any one
	DSE-304(B)	XII(B)	ICH 3.4(B)	Selected Topics in Inorganic Chemistry	Choose any one
	CCPR-305		ICHP 3.1	Practical -III	Compulsory course
	AEC-306				
	EC(SWMMOOC)-307				

Semester IV

	Course code	Paper No.		Title of course	
CGPA	CC-401	XIII	ICH 4.1	Instrumental Techniques	Compulsory course
	CCS-402	XIV	ICH 4.2	Coordination Chemistry II	Compulsory course
	CCS-403	XV	ICH 4.3	Chemistry of Inorganic Materials	Compulsory course
	DSE-404(A)	XVI(A)	ICH 4.4(A)	Energy and Environmental Chemistry	Choose any one
	DSE-404(B)	XVI(B)	ICH 4.4(B)	Radiation Chemistry	Choose any one
	CCPR-405		ICHP 4.1	Practical –IV	Compulsory course
Non-CGPA	SEC-406				
	GE-407				

M. Sc. Part – II (Organic Chemistry)

Semester III

	Course code	Paper No.		Title of course	
CGPA	CC-301	IX	OCH 3.1	Organic Reaction Mechanism	Compulsory course
	CCS-302	X	OCH 3.2	Advanced Spectroscopic Methods	Compulsory course
	CCS-303	XI	OCH 3.3	Advanced Synthetic Methods	Compulsory course
	DSE-304(A)	XII(A)	OCH 3.4(A)	Drugs and Heterocycles	Choose any one
	DSE-304(B)	XII(B)	OCH 3.4(B)	Polymer Chemistry	Choose any one
	CCPR-305		OCHP 3.1	Practical –III	Compulsory course
Non-CGPA	AEC-306				
	EC(SWMMOOC)-307				

Semester IV

	Course code	Paper No.		Title of course	
CGPA	CC-401	XIII	OCH 4.1	Theoretical Organic Chemistry	Compulsory course
	CCS-402	XIV	OCH 4.2	Stereochemistry	Compulsory course
	CCS-403	XV	OCH 4.3	Chemistry of Natural Products	Compulsory course
	DSE-404(A)	XVI(A)	OCH 4.4(A)	Applied Organic Chemistry	Choose any one
	DSE-404(B)	XVI(B)	OCH 4.4(B)	Bioorganic Chemistry	Choose any one
	CCPR-405		OCHP 4.1	Practical –IV	Compulsory course
Non-CGPA	SEC-406				
	GE-407				

M. Sc. Part – II (Physical Chemistry)

Semester III

	Course code	Paper No.		Title of course	
CGPA	CC-301	IX	PCH 3.1	Advanced Quantum Chemistry	Compulsory course
	CCS-302	X	PCH 3.2	Electrochemistry	Compulsory course
	CCS-303	XI	PCH 3.3	Molecular Structure – I	Compulsory course
	DSE-304(A)	XII(A)	PCH 3.4(A)	Solid State Chemistry	Choose any one
	DSE-304(B)	XII(B)	PCH 3.4(B)	Advanced Chemical Kinetics	Choose any one
	DSE-304(C)	XII(C)	PCH 3.4(C)	Radiation and Photochemistry	
	CCPR-305		PCHP 3.1	Practical –III	Compulsory course
Non-CGPA	AEC-306				
	EC(SWMMOOC)-307				

Semester IV

	Course code	Paper No.		Title of course	
CGPA	CC-401	XIII	PCH 4.1	Thermodynamics and Molecular Modeling	Compulsory course
	CCS-402	XIV	PCH 4.2	Chemical Kinetics	Compulsory course
	CCS-403	XV	PCH 4.3	Molecular Structure - II	Compulsory course
	DSE-404(A)	XVI(A)	PCH 4.4(A)	Surface Chemistry	Choose any one
	DSE-404(B)	XVI(B)	PCH 4.4(B)	Chemistry of Materials	Choose any one
	DSE-404(B)	XVI(C)	PCH 4.4(C)	Biophysical Chemistry	
	CCPR-405		PCHP 4.1	Practical –IV	Compulsory course
Non-CGPA	SEC-406				
	GE-407				

M. Sc. Part – II (Analytical Chemistry) Semester III

	Course code	Paper No.		Title of course	
CGPA	CC-301	IX	ACH 3.1	Advanced Analytical Techniques	Compulsory course
	CCS-302	X	ACH 3.2	Organo Analytical Chemistry	Compulsory course
	CCS-303	XI	ACH 3.3	Electroanalytical Techniques in Chemical Analysis	Compulsory course
	DSE-304(A)	XII(A)	ACH 3.4(A)	Environmental Chemical Analysis and Control	Choose any one
	DSE-304(B)	XII(B)	ACH 3.4(B)	Recent Advances in Analytical Chemistry	Choose any one
	CCPR-305		ACHP 3.1	Practical –III	Compulsory course
Non-CGPA	AEC-306				
	EC(SWMMOOC)-307				

Semester IV

	Course code	Paper No.		Title of course	
CGPA	CC-401	XIII	ACH 4.1	Modern Separation Methods in Analysis	Compulsory course
	CCS-402	XIV	ACH 4.2	Organic Industrial Analysis	Compulsory course
	CCS-403	XV	ACH 4.3	Advanced Methods in Chemical Analysis	Compulsory course
	DSE-404(A)	XVI(A)	ACH 4.4(A)	Industrial Analytical Chemistry	Choose any one
	DSE-404(B)	XVI(B)	ACH 4.4(B)	Quality Assurance and Accreditation	Choose any one

	CCPR-405		ACHP 4.1	Practical –IV	Compulsory course
Non-CGPA	SEC-406				
	GE-407				

12. Scheme of teaching and examination

(Applicable to University Department and University affiliated colleges centers)

- The semester examination will be conducted at the end of each term (both theory and practical examination)
- Theory paper will be of 80 marks each and 20 marks for internal evaluation test conducted in the mid of the term. Two practicals will be of 100 marks each.
- Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus.

Standard of Passing

As per rules and regulation of M.Sc. course.

13. Standard of Passing

As per rules and regulation of M.Sc. course.

14. Nature of Question Paper and Scheme of Marking

Nature of question paper and scheme of marking

Theory question paper: Maximum marks -80

Total No. of question – 7

All questions are of equal marks. Out of these seven questions five questions are to be attempted.

Question No.1 is compulsory and objective. Total number of bits is 16 with one mark each.

Total marks – 16 (which cover multiple choices, fill in the blanks, definition, true or false). These questions will be answered along with other questions in the same answer book.

.Remaining 6 question are divided into two sections, namely section-I and section – II. Four questions are to be attempted from these two section such that not more than two questions from any of the section. Both sections are to be written in the same answer book.

15. Equivalence in Accordance with titles and contents of the papers

M. Sc. Chemistry Semester I and Semester II

(Chemistry, Applied Chemistry and Industrial Chemistry)

Old Course(2012)/Industrial Chemistry(2013)	New Course (2018)
Inorganic Chemistry- I (CH-I)/ General Chemical Technology-I(INDC02)	Inorganic Chemistry- I (CH.1.1)
Organic Chemistry- I (CH-II)/Selected topics in Organic Chemistry(CNDC03)	Organic Chemistry- I (CH.1.2)
Physical Chemistry- I (CH-III)/ Introduction to Chemical Engineering-I (INDC01)	Physical Chemistry- I (CH.1.3)
Analytical Chemistry -I (CH-IV)/ Introduction to Environmental Pollution (INDC04)	Analytical Chemistry - I (CH.1.4)
Inorganic Chemistry- II (CH-V)/ Selected Topics in Inorganic Chemistry (INDC07)	Inorganic Chemistry- II (CH.2.1)

Organic Chemistry- II (CH-VI)/General Chemical Technology-II(INDC06)	Organic Chemistry- II (CH. 2.2)
Physical Chemistry- Ii (CH-VII)/ Introduction to Chemical Engineering-II (INDC05)	Physical Chemistry- II (CH.2.3)
Analytical Chemistry- II (CH-VIII)/ Instrumental Methods of analysis(IND C08)	Analytical Chemistry – II (CH.2.4)

M. Sc. In Inorganic Chemistry Semester III and Semester IV

Old Course(2013)	New Course (2018)
SEMESTER III	
Paper No- ICH-IX : INORGANIC CHEMICAL SPECTROSCOPY	Paper No- IX, ICH 3.1 : INORGANIC CHEMICAL SPECTROSCOPY
Paper No.- ICH -X: COORDINATION CHEMISTRY – I	Paper No. –X, ICH 3.2: COORDINATION CHEMISTRY – I
Paper No.- ICH-XI: NUCLEAR CHEMISTRY	Paper No. –XI, ICH 3.3 : NUCLEAR CHEMISTRY
ELECTIVE PAPERS Paper No.- ICH - XIIA: ENVIRONMENTAL CHEMISTRY	**ELECTIVE PAPERS** Paper No. –XIIA, ICH 3.4(A): ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY
Paper No.- ICH - XIIB: ORGANOMETALLIC CHEMISTRY	Paper No. –XIIA, ICH 3.4(A): ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY

Paper No.- ICH - XIIC: SELECTED TOPICS IN INORGANIC CHEMISTRY	Paper No. –XIIC, ICH 3.4(B) : SELECTED TOPICS IN INORGANIC CHEMISTRY
SEMESTER IV	
Paper No. - ICH - XIII : INSTRUMENTAL TECHNIQUES.	Paper No. –XIII, ICH 4.1 : INSTRUMENTAL TECHNIQUES.
Paper No. - ICH - XIV : COORDINATION CHEMISTRY-II	Paper No. – XIV, ICH 4.2: COORDINATION CHEMISTRY-II
Paper No. - ICH - XV: CHEMISTRY OF INORGANIC MATERIALS	Paper No. –XV, ICH 4.3: CHEMISTRY OF INORGANIC MATERIALS
ELECTIVE PAPERS Paper No. - ICH - XVI(A) : SEPARATION SCIENCE	**ELECTIVE PAPERS** Paper No. –XVI(A), ICH 4.4(A): ENERGY AND ENVIRONMENTAL CHEMISTRY
Paper No.- ICH - XVI(B): RADIATION CHEMISTRY	Paper No. –XVI(B), ICH 4.4(B): RADIATION CHEMISTRY
Paper No. - ICH - XVI(B): APPLIED BIOINORGANIC CHEMISTRY	Paper No. –XVI(A), ICH 4.4(A): ENERGY AND ENVIRONMENTAL CHEMISTRY

M. Sc. In Organic Chemistry Semester III and Semester IV

Old Course(2013)	New Course (2018)
SEMESTER III	
Paper No- OCH-IX: Organic Reaction Mechanism	Paper No-IX,OCH 3.1: Organic Reaction Mechanism
Paper No. - OCH- X: Advanced Spectroscopic Methods	Paper No -X, OCH 3.2: Advanced Spectroscopic Methods
Paper No- OCH- XI: Advanced Synthetic Methods	Paper No-XI, OCH 3.3 : Advanced Synthetic Methods
Paper No- OCH- XII: Drugs and Heterocycles	Paper No-XII(A), OCH 3.4(A): Drugs and Heterocycles
SEMESTER IV	
Paper No. - OCH- XIII: Theoretical Organic Chemistry.	Paper No. –XIII, OCH 4.1: Theoretical Organic Chemistry.
Paper No. - OCH- XIV : Stereochemistry	Paper No. – XIV, OCH 4.2 : Stereochemistry
Paper No. - OCH- XV :Chemistry of Natural Products	Paper No. –XV, OCH 4.3 :Chemistry of Natural Products
ELECTIVE PAPERS Paper No. - OCH- XVI : Applied Organic Chemistry	**ELECTIVE PAPERS** Paper No. –XVI(A), OCH 4.4 : Organic Industrial Chemistry
Paper No- OCH- XVI(A): Bioorganic Chemistry	Paper No. OCH 4.4(B): Bioorganic Chemistry

M. Sc. In Physical Chemistry Semester III and Semester IV

Old Course(2013)	New Course (2018)
SEMESTER III	
Paper No - PCH - IX: ADVANCED QUANTUM CHEMISTRY	**Paper No-IX, PCH 3.1** : ADVANCED QUANTUM CHEMISTRY
Paper No - PCH -X : ELECTROCHEMISTRY	**Paper No-X, PCH 3.2** : ELECTROCHEMISTRY
Paper No - PCH - XI : MOLECULAR STRUCTURE-I	**Paper No-XI, PCH 3.3** : MOLECULAR STRUCTURE-I
Paper No - PCH - XII: SOLID STATE CHEMISTRY	**Paper No-XII(A), PCH 3.4(A)**: SOLID STATE CHEMISTRY
ELECTIVE PAPERS **Paper No - PCH - XII(A)** : ADVANCED CHEMICAL KINETICS	ELECTIVE PAPERS **Paper No-XII(B), PCH 3.4**(B) : ADVANCED CHEMICAL KINETICS
Paper No - PCH - XII (B): RADIATION AND PHOTOCHEMISTRY	**Paper No-XII (C) PCH 3.4(C)** : RADIATION AND PHOTOCHEMISTRY
SEMESTER IV	
Paper No. PCH-XIII : HERMODYNAMICS AND MOLECULAR	**Paper No.-XIII, PCH 4.1** : THERMODYNAMICS AND

MODELING	MOLECULAR MODELING
Paper No. PCH-XIV : CHEMICAL KINETICS	**Paper No –XIV, PCH 4.2**: CHEMICAL KINETICS
Paper No. PCH-VX : MOLECULAR STRUCTURE-II	**Paper No-XV, PCH 4.3**: MOLECULAR STRUCTURE-II
ELECTIVE PAPERS **Paper No. PCH-XVI (A)**: SURFACE CHEMISTRY	ELECTIVE PAPERS **Paper No-XVI (A), PCH 4.4(A)**: SURFACE CHEMISTRY
Paper No. PCH-XVI (B): CHEMISTRY OF MATERIALS	**Paper No-XVI (B), PCH 4.4(B)**: CHEMISTRY OF MATERIALS
Paper No. PCH-XVI (C): BIOPHYSICAL CHEMISTRY	**Paper No-XVI (C), PCH 4.4(C):** BIOPHYSICAL CHEMISTRY

M. Sc. In Analytical Chemistry Semester III and Semester IV

Old Course(2013)	New Course (2018)
SEMESTER III	
Paper No. ACH – IX : General Analytical Techniques	**Paper No** – IX, ACH 3.1: Advanced Analytical Techniques
Paper No. ACH – X : Organo Analytical Chemistry	**Paper No**– X, ACH 3.2 : Organo Analytical Chemistry
Paper No. ACH – XI : Electroanalytical Techniques in Chemical Analysis	**Paper No** – XI, ACH 3.3: Electroanalytical Techniques in Chemical Analysis
ELECTIVE PAPERS **Paper No.** ACH–XII (A) : Environmental chemical analysis and control	**ELECTIVE PAPERS** **Paper No**–XII (A), ACH 3.4(A) : Environmental chemical analysis and control
Paper No. ACH- XII (B) : Recent Advances	**Paper No**- XII (B). ACH 3.4(B) : Recent

in Analytical Chemistry	Advances in Analytical Chemistry
Paper No. ACH- XII : Chemical Analysis in Agro, Food and Pharmaceutical Industries	**Paper No**- XII (B). ACH 3.4(B) : Recent Advances in Analytical Chemistry
SEMESTER IV	
Paper No. ACH – XIII : Modern Separation method in Analysis	**Paper No**– XIII, ACH 4.1: Modern Separation method in Analysis
Paper No. ACH – XIV : Organic Industrial Analysis	**Paper No**– XIV ACH 4.2: Organic Industrial Analysis
Paper No. ACH – XV : Advanced Methods in Chemical Analysis	**Paper No**– XV, ACH 4.3: Advanced Methods in Chemical Analysis
ELECTIVE PAPERS **Paper No.** ACH – XVI (A): Applied Analytical Chemistry	**ELECTIVE PAPERS** **Paper No**– XVI (A), ACH 4.4(A): Industrial Analytical Chemistry
Paper No. ACH – XVI (B): Techniques in Forensic sciences and Microbiological Analysis	**Paper No**– XVI (A), ACH 4.4(A): Industrial Analytical Chemistry
Paper No. ACH – XVI (C): Computational Chemistry	**Paper No**– XVI (A), ACH 4.4(A): Industrial Analytical Chemistry

16. Special instructions, if any: -

17. Detailed title of Papers and Units and Number of Lectures.

M. Sc. Part – I (Semester – I)

Paper- I, Inorganic Chemistry – I(CH.1.1/ APCH.1.1/IND.1.1)

Unit-I: **15L**

Chemistry of transition elements

General characteristic and properties of transition elements, Coordination chemistry of transition metal ions, Stereochemistry of coordination compounds, Crystal field theory for tetrahedral, octahedral, square pyramidal and square planar complexes, Splitting of d- orbital's, Crystal field stabilization energy (CFSE), Factors affecting the crystal field parameters, Strong and weak field complexes, Spectrochemical series, Jahn-Teller effect, Interpretation of electronic spectra including d-d and charge transfer spectra, Nephelauxetic series

UNIT-II: **15L**

Transition metal carbonyls and related compounds

Introduction, Preparation, structure, physical and chemical properties of metal carbonyls, Anionic and cationic carbonyl complexes, Lewis base derivatives of carbonyls, Carbonyl hydrides, Carbonyl halides, Miscellaneous derivatives of metal carbonyls, Nitrosyl complexes of transition metals, complexes of molecular nitrogen, Cynide complexes of transition metals.

UNIT-III: **15L**

Organometallic Chemistry

Synthesis, bonding, structure and reactivity of organometallic compounds, Classification of organometallic compounds based on hapticity and polarity of M-C bond, Nomenclature and general characters, 18 electron rule-applications and exceptions, Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination, Organometallics in homogeneous catalysis: Hydrogenation, hydroformylation, isomerisation and polymerization.

UNIT-IV: **15L**

A) Metal-ligand Equilibrium in solution **8L**

Thermodynamic vs. kinetic stability, Stability constant, Stepwise and overall stability constants with their relation, Trends in stepwise stability constant, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect, Ternary complexes and factors affecting their stabilities, Stability of metal complexes of crown ethers, Determination of stability constants by spectrophotometric methods (Job's and Mole/slope ratio for composition), Bjerrum's PH metric method.

B) Nuclear and radiochemistry **7L**

Nuclear stability and nuclear binding energy, Radioactivity and radioactive decay Radioactive equilibrium, Classification of nuclear reactions, Nuclear reaction cross section, Nuclear fission, Nuclear fusion, Applications of radioactivity in agriculture, medical field, and industry.

Recommended Books

1. A. F. Wells, Structural Inorganic Chemistry – 5th edition (1984
2. J. H. Huheey, Inorganic Chemistry-Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972)
3. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
4. A. R. West, Plenum, Solid State Chemistry and its applications
5. H. J. Emeleus and A. G. Sharpe, Modern Inorganic Chemistry
6. A. R. West, Basic Solid State Chemistry, 2nd edition
7. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
8. A. H. Hanney, Solid State Chemistry, A. H. Publications
9. O. A. Phiops, Metals and Metabolism
10. Cullen Dolphin and James, Biological aspects of Inorganic Chemistry
11. Williams, An Introduction to Bioinorganic Chemistry
12. M. N. Hughes, Inorganic Chemistry of Biological Processes
13. Ochi, Bioinorganic Chemistry
14. F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry
15. Willam L. Jooly, Modern Inorganic Chemistry
16. Manas Chanda, Atomic Structure and Chemical bonding
17. N. N. Greenwood and A. Earnshaw, Chemistry of elements,. Pergamon
18. S. J. Lippard, J.M . Berg, Principles of bioinorganic Chemistry, University Science Books
10. G. L. Eichhron, Inorganic Biochemistry, Vol I and II, Elesevier

20. Progress Inorganic Chemistry , Vol 18 and 38, J. J. Loppard, Wiley
21. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
22. Inorganic Chemistry, P. Atkins, T. Overtone, J. Rourke, M. Weller, F. Armstrong, 5th Eds., Oxoford University Press.
23. Inorganic Chemistry, H.E. House, Elsevier Publishers.

Inorganic Chemistry Practical Course(CHP.1.1/APCHP.1.1/INDP.1.1)

Semester-I, Inorganic Chemistry Practicals

A) Ore Analysis
Determination of Silica and Manganese in pyrolusite
Determination of iron from hematite.

B) Alloy Analysis
Determination of tin & lead from solder
Determination of copper and nickel from monel metal

C) Preparations and purity (Any four)
Potassim trioxalatochromate(III) trihydrate
cis-potassium dioxalatodiaquachromate(III)
Potassion hexathiocyanatochromate(III)
Bis(dimethylglyoximato)nickel(II)
Carbonatotetramminocobalt(III) nitrate
Hexamminocobaltic(III) chloride

D) Determination of concentration of phosphates in water samples colorimetrically

Recommended Books

1 A text book of Quantitative Inorganic Analysis – A. I. Vogel
2 Experimental Inorganic Chemistry - W. G. Palmer
3 The analysis of minerals and ores of the rarer elements – W. R. Schoeller and A.R. Powell, Charles, Griffin and Company Limited.
4 Experimental Inorganic/Physical Chemistry – M.A. Malti, Horwood Series in Chemical Science, Horwood Publishing Chinchster.

Paper – II, Organic Chemistry-I(CH.1.2/APCH.1.2/IND.1.2)

UNIT-I **15L**

A) Reaction Mechanism: Structure and Reactivity **8L**

Types of reactions, strength of acids and bases. Generation, structure, stability and reactivity of carbenes, arynes, nitrenes and effect of structure on reactivity, resonance and field , steric effects. Thermodynamic and Kinetic requirements, Introduction to Kinetic and Thermodynamic control reaction.

B) Aliphatic Nucleophilic substitutions **7L**

The SN2, SN1 and SNi reactions with respects to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. SN reactions at bridge head carbon, competition between SN1 and SN2, Ambident nucleophiles, Neighbouring Group Participation.

UNIT-II **15L**

A) Introduction to aromaticity in Benzenoid and non – Benzenoid compounds. **7L**

Three, four and five membered systems. tropone, tropolone, tropylium salts.

B I] Aromatic Electrophilic Substitutions **8L**

Introduction, the arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in their ring systems. Diazo-coupling, Vilsmeier-Haak reaction, Von Richter rearrangement

II] Nucleophilic aromatic substitution reactions SN1, SN2.

UNIT-III **15L**

A) Elimination Reactions **5L**

The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hofman versus Saytzeff elimination, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions. Pyrolytic elimination reactions.

B) Study of following reactions **10L**

Mechanism of condensation reaction involving enolates, Benzoin, Stobbe, Robinson annulation, Simon-Smith, Vlhmann, Mc-Murry, Dakin, prins,Wurtz-Fittig reaction, Hunsdiecker reaction, Pummerer, , Rupe, Gabriel–Colman,Corey-Chaykovsky reaction, Nef reaction, Passerini reaction, Baylis-Hilman reaction, Mitsunobu Reaction.

UNIT-IV 15L

Stereochemistry: Concept of chirality Prochiral relationship, homotopic, enantiotopic and disteriotopic groups and faces. Recemic modifications and their resolution, R and S nomenclature.Conformational analysis : Cyclohexane derivatives, stability and reactivity,Conformational analysis of disubstituted cyclohexanes. Introduction of optical activity in the absence of chiral carbon (spiranes and allenes)

RECOMMENDED BOOKS

1. A guide book to mechanism in Organic chemistry (Orient-Longmens)- Peter Sykes
2. Organic Reaction Mechanism (Benjamin) R. Breslow
3. Mechanism and Structure in Organic chemistry (Holt Reinh.)E. S. Gould.
4. Organic Chemistry(McGraw-Hill)Hendrikson, Cram and Hammond.
5. Basic principles of Organic Chemistry (Benjamin) J. D.Roberts and M. C. Caserio.
6. Reactive Intermediates in Organic Chemistry (John Wiley)N. S. Issacs.
7. Stereochemistry of Carbon compounds. (McGraw-Hill)E.L.Eliel
8. Organic Stereochemistry (McGraw-Hill) by Hallas.
9. Organic Reaction Mechanism (McGraw-Hill) R. K. Bansal.
10. Organic Chemistry- R. T. Morrison and R. N. Boyd,(Prentice Hall.)
11. Modern Organic Reactions(Benjumin) H. O. House.
12. Principle of organic synthesis- R.O.C. Norman and J. M. Coxon.(ELBS)
13. Reaction Mechanism in Organic Chemistry- S. M. Mukharji and S. P. Singh.
14. Stereochemistry of Organic compoundsc) D. Nasipuri.
15. Advanced Organic Chemistry (McGraw-Hill) J. March.
16. Introduction to stereochemistry(Benjumin) K. Mislow.
17. Stereochemistry by P. S. Kalsi (New Age International)

18. Organic chemistry- Jonathan clayden.

Semester-I, Organic Chemistry Practical Course(CHP.1.1/APCHP.1.1/INDP.1.1)

ORAGNIC CHEMISTY PRACTICALS

A) Preparations

(One stage preparations involving various types of reactions and confirmation of product by TLC)

1. Coumarin Synthesis- 7-OH-4-methyl coumarine from Resorcinol and EAA.
2. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile.
3. Preparation of Hydrantoin.
4. Synthesis of triazoles- Reaction of aldehyde and thiosemicarbazide.
5. preparation of benzimidazole from OPD,
6. Preparation of Orange II
7. Fischer Indole Synthesis-Reaction of phenyl hydrazine and cyclohexanone.

(Any suitable Expt. may be added)

B)Estimations:

1.Estimation of Unsaturation.
2.Estimation of formalin.
3.Colorimetric Estimation of Dyes.
4.Estimation of Amino acids.
5. Estimation of Glycine.

(Any suitable Expt. may be added.)

RECOMMENDED BOOKS

1.A text book of practical organic chemistry- A. I. Vogel.
2.Practical organic chemistry- Mann and Saunders.
3.A handbook of quantitative and qualitative analysis- H. T. Clarke.
4.Organic Synthesis Collective Volumes by Blat.
5. Practical Med. Chem..- Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy.

Paper – III, Physical Chemistry-I (CH.1.3/APCH.1.3/IND.1.3)

UNIT-I: THERMODYNAMICS 15L

Introduction, revision of basic concepts: Entropy and third law of thermodynamics. Methods of determining the practical absolute entropies. Entropies of phase transition. Maxwell relations and its applications, thermodynamic equation of state.

Ideal and non-ideal solutions, Thermodynamics of nonelectrolyte solutions. Raoult's law. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture). Gibbs-Duhem equation and its applications to study of partial molar quantities. chemical potential, variation of chemical potential with temperature & pressure. Henry's law. Excess and mixing thermodynamic properties. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials. Numerical Problems.

UNIT-II: STATISTICAL THERMODYNAMICS 15L

Probability and distribution, Stirling Approximation, Weights and configurations, the most probable configuration, Ensembles, ensemble average and time average of property. Statistical equilibrium, thermodynamic probability, Maxwell-Boltzmann (MB) distribution law.

Partition function and its significance. Rotational, translational, vibrational and electronic partition functions. Relationship between partition function and thermodynamic properties. thermodynamic probability and entropy: Boltzmann – Planck equation, Partition function and third law of thermodynamics, Application to monoatomic gases - Sackur tetrode equation, applications to diatomic molecules, Statistical expression for equilibrium constant, Limitations of Maxwell-Boltzmann statistics, Numerical Problems.

UNIT-III: COLLOIDS AND SURFACE PHENOMENA 15L

Colloidal Systems-Sols, Lyophilic and lyophobic sols, properties of sols, coagulation. Sols of surface active reagents, surface tension and surfactants, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization. Thermodynamics of

micellisation, critical micelle concentration, factors affecting critical micelle concentration (cmc), experimental methods of cmc determination, Micellar catalysis.

Adsorption, adsorption isotherms, methods for determining surface structure and composition, BET equation, surface area determination, Gibbs adsorption equation and its verification. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces. Numerical Problems.

UNIT-IV **15L**

MACROMOLECULES

Macromolecules: Mechanism of polymerization, molecular weight of a polymer (Number and mass average) viscosity average molecular weight, numerical problems. Degree of polymerization and molecular weight, practical significance of polymer molecular weight, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultracentrifugation)

Chemistry of polymerization: Ceiling temperature, Free radical polymerization (Initiation, propagation and termination), kinetics of free radical polymerization, step growth polymerization (Polycondensation), molecular weight distribution, kinetics of step polymerization, cationic and anionic polymerization. Electronically conducting polymers, thermodynamics of polymer solutions: Flory-Huggins Theory. Glass transition temperature and molecular weight, factors influencing Glass transition temperature, determination of glass transition temperature

Recommwnded Books

1. Physical Chemistry – P. W. Atkins, Oxford University press, 8th edition, 2006.
2. Text book of Physical Chemistry – S. Glasstone.
3. Principles of Physical Chemistry – Marron and Pruton.
4. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.
5. Thermodynamics for Chemists – S. Glasstone, D. Van Nostrand , 1965.
6. Thermodynamics: A Core Course- R. C. Srivastava, S. K. Saha and A. K. Jain, Prentice-Hall of India, IInd edition, 2004.

7. Elements of statistical thermodynamics - L. K. Nash, 2nd Ed. Addison Wesley 1974.
8. Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists - S. Glasstone, D. Van Nostrand Company, Inc., 1944.
9. An Introduction to Statistical Thermodynamics – T.L. Hill, Addison-Wesley. 1960.
10. Statistical Mechanics – Donald A. McQuarrie, 2000.
11. Physical chemistry of surfaces – A. W. Adamson, 4th Ed. John Wiley, 1982.
12. Introduction to Colloid and Surface Chemistry – D. Shaw, Butterworth Heinemann, 1992.
13. Surface Activity: Principles, Phenomena and Applications (Polymers, Interfaces and Biomaterials) – K. Tsujii, 1st Ed. Academic Press, 1998.
14. Physical Chemistry of macromolecules- D. D. Deshpande, Vishal Publications.
15. Polymer Chemistry- F. W. Billmeyer Jr, John-Wiley & Sons, 1971.

Semester-I, Physical Chemistry Practical Course(CHP.1.2/APCHP.1.2/INDP.1.2)

Physical Chemistry Practicals

Students are expected to perform at least 8 experiments of three and half hours duration.
Experiments are to be set up in the following techniques.

Potentiometry:

1. Determination of solubility and solubility product of silver halides.
2. Determination of binary mixture of weak and strong acid.

Conductometry:

3. Determination of mixture of acids and relative strength of weak acids.
4. Determination of solubility of lead sulphate.
5. Determination of CMC and ΔG of sodium dodecyl sulphate.

Refractometry:

6. Determination of molecular radius of molecule of organic compound.

7. Determination of concentration of sugar in unknown sample.

Polarimetry:

8. Kinetics of inversion of cane sugar in presence of strong acid.

pH- metry:

9. Determination of dissociation constant of dibasic acid.

Chemical Kinetics:

10. Kinetics of reaction between bromate and iodide.

Adsorption:

11. Study of adsorption of acetic acid on charcoal.

Viscosity:

12. Determination of molecular weight of polymers

(New experiments may be also be added)

Books recommended for Practicals:

1. Findlay's Practical Chemistry – Revised by J.A. Kitchner (V edition)
2. Text Book of Quantitative inorganic analysis : A.I. Vogel.
3. Experimental Physical Chemistry : R. C. Das and B. Behera
4. Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
5. Experimental Physical Chemistry :V.D. Athawale and Parul Mathur.
6. Systematic Experimental Physical Chemistry :S.W. Rajbhoj and T.K. Chondhekar
7. Advanced practicals in physical chemistry-Datar and Doke
8. Practical Physical Chemistry- B. D. Khosla, V. C. Garg, A. Gulati

Paper - IV Analytical Chemistry –I(CH.1.4/APCH.1.4/IND.1.4)

UNIT-I **15L**

Basics of Analytical Chemistry, Errors, treatments and statistics

Analytical Chemistry, Chemical analysis, instrumental methods, Analytical methods, Techniques of analysis, classification of analytical techniques, Classification of instrumental methods, factors affecting choice of analytical methods, interferences.

Types and sources of error, determinate and indeterminate errors, accuracy and precision Absolute and relative errors, Minimisation of errors, Significant figures, Mean, median and standard deviation, Least square method.
Sampling, Types of sampling, Techniques of sampling of gases, fluids, solids, and particulates.
Good Laboratory Practices
Problems.

UNIT-II **15L**

Fundamentals of Quantitative Analysis

Introduction, general terms in volumetric analysis, indicators, indicator theory, choice of indicators. Acid-base titrations, titration curves with example, Buffer solutions, acid-base equllibria in- polyprotic acids, amino acids, carbonates, bicarbonates, mixture of two acids.
Complexometric titrations-stability of complexes, metal-ion buffer, titrations involving unidentate and multidentate ligands.
Precipitation titrations and solubility equilibria, indicators, factors affecting solubility, applications of precipitation titrations.
Oxidation-reduction equilibria and applications, Nernst equation, titration curves, redox indicators, applications with respect to $KMnO_4$, $K_2Cr_2O_7$, Iodine, and Potassium bromate.
Gravimetric Analysis: Introduction, general terms used in gravimetry, steps in gravimetric analysis, conditions for precipitation, purity of the precipitate – Co-precipitation and Post-precipitation, precipitation from homogenous solution, organic precipitants. Advantages and disadvantages of gravimetric analysis. Determination of iron gravimetrically form iron ore, determination of lead gravimetrically from Galena ore, determination of Pb gravimetrically from type metal alloy.
Problems.

UNIT-III **15L**

Chromatographic methods

General principle, classification of chromatographic methods, migration rates of solutes, chromatographic behaviour of solutes, band broadening, column efficiency and resolution.
Thin layer chromatography, basic principle, coating materials, solvent-solvent system, analytical and preparative TLC, methods of detection, applications and advances in TLC including modern TLC techniques.
Column chromatography: Principle and theory, adsorption and partition methods, stationary and mobile phase, columns and preparation of the columns, solvent systems, normal phase, reverse phase, detection methods and applications. Possible hyphenations- Advantages and limitations.
Gas Chromatography: Basic Principle, Instrumentation, detectors, Applications, Advantage and disadvantages.
HPLC: Basic Principle, Instrumentation, detectors, applications, advantage and disadvantages.
Ion exchange chromatography: Introduction and basic principles, instrumentation, types of exchangers, synthesis of ion exchangers, mechanism of ion exchange, exchange theories, methodology, applications.

Problems.

UNIT-IV **15L**

Electro Analytical Techniques

Polarography: Introduction, Instrumentation, Ilkovic equation and its verification. Polarographic measurements, Dropping mercury electrode, Determination of half wave potential, qualitative and quantitative applications.

Amperometry: Basic principles, instrumentation, Amperometric titration curves, Amperometric indicators, procedure for Amperometric titrations, Evaluation of amperometry in research and analytical applications.

Voltametry: Voltammetric methods of analysis, basic principles, instrumentation, voltammetric measurements, voltametric techniques, current in voltammetry, shape of voltammograms, quantitative and qualitative aspects of voltammetry, quantitative applications, characterization applications, Evaluation of CV in research and analytical applications.

Problems.

References:

1. Analytical Chemistry: (J.W) G. D. Christain.
2. Instrumental Methods of analysis (CBS)- H.H . Willard, L.L. Merrit, J.A. Dean
3. Quantitative analysis, R.A. Day and A.L. Underwood, Prentice-Hall of India Pvt Ltd, New Delhi
4. Instrumental Methods of Analysis: Chatwal and Anand
5. Instrumental Methods of Inorganic Analysis (ELBS) : A.I. Vogel
6. Chemical Instrumentation: A Systematic approach- H.A. Strobel
7. Physical Chemistry – P.W. Atkins
8. Principal of Instrumental Analysis- D. Skoog and D.West
9. Treatise on Analytical Chemistry: Vol Ito VII – I.M. Kolthoff
10. Instrumental methods of chemical analysis, H. Kaur
11. Principles of Instrumental analysis, Holler, Skoog, Crouch
12. Chromatographic methods- H. Kaur
13. Analytical Chemistry-Alka Gupta
14. Analytical Chemistry-H. Kaur
15. Advanced Practical Inorganic Chemistry, Gurdeep Raj

Semester-I, Analytical Chemistry Practical Course(CHP.1.2/APCHP.1.2/INDP.1.2)

Analytical Chemistry Practicals

1. To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample Spectrophotometrically
2. To determine the iron potentiometrically by titrating with potassium dichromate
3. To determine the solubility of Calcium oxalate in presence of different concentration of KCl
4. To determine the solubility of Calcium oxalate in presence of different concentration of HCl
5. Analysis of pharmaceutical tablets for ibuprofen content
6. To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically/spectrophotometrically.
7. To estimate the amount of D-glucose in given solution colorimetrically.
8. To determine the acid value of given oil
9. Determination of standard deviation from the results obtained by redox titration of iron solution against standard potassium dichromate solution
10. Determination of sodium from the fertilizer sample using cation exchange chromatography
11. Determination of calcium from given drug sample.
12. Determination of hardness, alkalinity and salinity of water sample
13. Separation and estimation of Cd^{2+} and Zn^{2+} by ion exchange chromatography for given Cd^{2+} and Zn^{2+} mixture.
    (Any other experiments may be added)

Recommended Books

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.)
9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd.
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.

M. Sc. Part – I (Semester – II)

Paper- V, Inorganic Chemistry – II(CH.2.1/APCH.2.1/IND.2.1)

Unit I **15L**

Chemistry of Non-transition Elements and their compounds

General discussion on the properties of the non–transition elements, Polymorphism in carbon, phosphorous and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur–nitrogen compounds, peroxo compounds of boron, carbon, sulphur, structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, interhalogens, psudohalides

Unit II **15L**

A) Stereochemistry and bonding in Main group compounds **8L**

Hybridization and structure of molecules, VSEPR Theory, pπ-pπ and pπ-dπ bonds, Bent rule, Walsh Diagram, Back bonding, Some simple reactions of covalently bonded molecules (atomic inversion, Berry Pseudorotation, Nucleophilic displacement, free radical reaction).

B) Non-aqueous solvents **7L**

Classification of solvents, Characteristics of solvents, Types of reactions in solvents, Physical and chemical properties of the non-aqueous solvents such as liquid ammonia, sulphur dioxide, dinitrogen tetroxide, anhydrous sulphuric acid and molten salts.

UNIT-III **15L**

Chemistry of f-block elements (Lanthanides and Actinides) Occurrence, properties of the f-block elements, colour, oxidation state, Spectral and magnetic properties of lanthanides and actinides, lanthanide contraction, Use of lanthanide compounds as shift reagents, compounds of lanthanides, Photoluminescence properties of lanthanide compounds, Modern methods of separation of lanthanides and actinides, Applications of lanthanide and actinide compounds in Industries.

UNIT-IV **15L**

A) Solid state chemistry **8L**

Crystal structure, Crystal types, Crystal defects, Electronic structure of solids, Band theory, Theory of Metals, Semiconductors and Insulators, Superconductivity, optical and magnetic properties, Solid state reactions, AB [Nickel arsenide (NiAs)], AB_2 [fluorite (CaF_2) and anifluorite], layer structure [cadmium chloride and iodide ($CdCl_2$ & CdI_2)]

B) Bioinorganic Chemistry **7L**

Role of metal ions in biological processes, structure and properties of metalloproteins, porphyrines, metalloenzymes, oxygen transport, electron transfer reactions, cytochromes, ferrodoxins and iron sulphur proteins, ion transport across membranes, Nitrogen fixation-nitrogenase, metal complexes in medicines.

Recommended Books

1. A. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)

2. J. H. Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972)

3. J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London

4. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP

5. Jones , Elementary coordination Chemistry

6. Martell, Coordination Chemistry

7. T. S. Swain and D. S. T. Black, organometallic Chemistry

8. John Wulff, structure and properties of materials, vol – 4, electronic properties, Wiley Eastern

9. L. V. Azoroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill

10. F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry

11. Willam L. Jooly, Modern Inorganic Chemistry

12. Manas Chanda, Atomic Structure and Chemical bonding

13. P. L. Pauson, Organometallic Chemistry

14. H. S. Sisler, Chemistry in non – aqueous solvents, Reinhold Publishing Corporation, USA, 4th edition (1965)

15. H. J. Arnikar, Essentials of Nuclear Chemistry

16. Friedlander, Kennedy and Miller, Nuclear and Radiochemistry.

17. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.

18. Inorganic Chemistry, P. Atkins, T. Overtone, J. Rourke, M. Weller, F. Armstrong, 5th Eds., Oxoford University Press.

19. Inorganic Chemistry, H.E. House, Elsevier Publishers.

Semester-II, Inorganic Chemistry Practical Course (CHP.2.1/APCHP.2.1/INDP.2.1)

Inorganic Chemistry Practicals

A) Ore Analysis

Determination of calcium and magnesium from Dolomite

Determination of copper and iron from chalcopyrite

B) Alloy Analysis

Determination of copper and zinc from brass alloy

Determination of iron & chromium from steel.

C) Preparations and purity (Any four)

Tris(acetylacetonato)cobalt(III) trihydrate

Pentaaquachlorochromium(III) chloride

Hexathioureaplumbus(II) nitrate

Bis(acetylacetonato)copper(II)

Diaquabis(ethylediammine)copper(II) iodide

Copper ferrite

D) Separation of Fe2+ Cu2+ Ni2+ by anion exchange

Recommended Books

1 A text book of Quantitative Inorganic Analysis – A. I. Vogel

2 Experimental Inorganic Chemistry- W. G. Palmer

3 The analysis of minerals and ores of the rarer elements – W. R. Schoeller

4 A. R. Powell, Charles, Griffin and Company Limited

Paper-VI, Organic Chemistry-II (CH.2.2/APCH.2.2/IND.2.2)

UNIT-I **15L**

A) Study of following rearrangements **5L**

Curtius, Lossen, Witting, Neber, Ortaon, Hofmann-Martius and Demjanov reaction.

B) Photochemistry **10L**

Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearragements of 1,4 and 1,5-dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α, β-unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions, dimerisation and oxitane formation, photochemistry of aromatic compounds, photo fries reactions of anilides, photo fries rearrangements. Singlet molecular oxygen reactions.

UNIT-II **15L**

A) Hydroboration **4L**

Various hydroborating agents their mechanism and synthetic applications *viz* 9-borabicyclo-[3.3.1]nonane (9-BBN), thexylborane, H B diisoamylborane. (Sia2BH) BH3•SMe2. (BMS), Borane as reducing agent.

B) Enamins **4L**

Formation,reactivity and synthetic applications of enamines

C) Oxidation **7L**

Applications of oxidizing agents like chromium trioxide, manganese dioxide, Woodward-Prevost hydroxylation, Chloranil, hydrogen peroxide. Swern oxidation. PCC(Corey's reagent), PDC(Cornforth reagent), Baeyer-Villiger oxidation.

UNIT-III **15L**

A) Reductions **9L**

Study of following reductions- Catalytic hydrogenation using homogeneous and heterogeneous catalysts. Study of following reducing reagents and reactions: Wolff-Kishner, Birch, Sodium cyano borohydride, Sodium in alcohol, Fe in HCl, Adam's catalyst, Lindlar catalyst, TBTH.

B) Protection of functional group **6L**

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

UNIT-IV **15L**

A) Study of Organometallic compounds **8L**

Organo-lithium, Use of lithium dialkyl cuprate, their addition to carbonyl and unsaturated carbonyl compounds. Study of coupling reactions *viz* Heck, Suzuki, Stille, Nigeshi and Sonogashira coupling.

B) Methodologies in organic synthesis **7L**

Ideas of synthones and retrones, Functional group transformations and inter conversions of simple functionalities.

RECOMMONDED BOOKS

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West.
6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg.
9. Tetrahydron reports in organic chemistry- Vol.1, No. 8.
10. Organic Synthesis-(Prentice Hall)R. E. Ireland.
11. Homogeneous Hydrogenation-(J. K.) B. R. James.
12. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
13. Organic reactions- various volumes- R. Adams.
14. Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.
15. Organic chemistry- Jonathan clayden.

Semester-II, Organic Chemistry Practical Course (CHP.2.1/APCHP.2.1/INDP.2.1)

Organic Chemistry Practicals

1.Qualitative analysis:
Separation and identification of the two component mixtures using
Chemical and physical methods.
2.Thin layer chromatography (TLC).
3.Column chromatography and steam distillation techniques.
4.Determination of percentage of Keto-enol form.
5.Estimation of Ibuprofen.
6.Estimation of Aspirin.

7. Verify Beer-Lamberts Law by Colorimetric method.
(Any other suitable experiments may be added).

RECOMMENDED BOOKS

1.A text book of practical organic chemistry- A. I. Vogel.
2.Practical organic chemistry- Mann and Saunders.
3.A handbook of quantitative and qualitative analysis- H. T. Clarke.
4.Organic Synthesis Collective Volumes by Blat.

Paper-VII, PHYSICAL CHEMISTRY – II (CH.2.3/APCH.2.3/IND.2.3)

UNIT-I: QUANTUM CHEMISTRY **15L**

Introduction: Wave particle duality of material and De Broglie's hypothesis, uncertainty principle, Schrodinger equation, wave function, conditions for acceptable wave functions and its interpretation, properties of wave functions, Operators and related theorems, algebra of operators, commutator, linear operators, Normalization and orthogonality, Eigen functions and Eigen values, postulate of quantum mechanics. Solutions of wave equation for a free particle and particle in a box problem, Transition dipole moment integral and selection rules, particle in a box application to electronic spectra of conjugated linear organic molecules.

Linear and angular momentum operators, eigen function and eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin angular momenta, symmetric and antisymmetric wavefunctions, Pauli Exclusion Principle, spectroscopic term symbols.

UNIT-II: PHOTOCHEMISTRY **15L**

Absorption of light, laws of photochemistry, electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, construction of Jablonski diagram, electronic transition, Frank Condon principle, selection rules, intensity of absorption bands, nature of electronic spectra and primary process, photo-dissociation, pre-dissociation, Photo physical phenomena: photo-

physical pathways of excited molecular system (radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, collisional quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and applications in chemical analysis. Photochemical reactions, photo-oxidation, photoreduction, photo-dimerization, photoisomerization and photosensitized reactions. Photochemistry of environment: Greenhouse effect.

UNIT-III: ELECTROCHEMISTRY 15L

Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex. Acid and alkaline storage batteries, Abnormal ionic conductance of hydroxyl and hydrogen ions.

Electrokinetic phenomena: Electrical double lever, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

UNIT-IV: CHEMICAL KINETICS 15L

Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO_2 and F_2, decomposition of ozone, and nitrogen pentoxide. Ionic reaction: Primary and secondary salt effect,

Catalysis: Classification of catalysis, mathematical expression of autocatalytic reactions, Michaelis–Menten enzyme catalysis, Homogeneous catalysis: acid and base catalyzed reactions, Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics, Catalyzed hydrogen-deuterium exchange reaction.

Recommended books:

1. Introductory Quantum Chemistry - A. K. Chandra. Tata McGraw-Hill. 1988.

2. Physical Chemistry: A molecular Approach – Donald A. McQuarrie and John D. Simon, Viva Books, New Delhi, 1998.
3. Quantum Chemistry – Donald A. McQuarrie, Viva Books, New Delhi, 2003.
4. Physical Chemistry – P. W. Atkins, Oxford University press, VIth edition, 1998.
5. Quantum Chemistry - W. Kauzmann, Academic press.
6. Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists - S. Glasstone, D. Van Nostrand Company, Inc., 1944.
7. Quantum Chemistry - R.K. Prasad, New Age International, New Delhi.
8. Physical Chemistry – R.S. Berry, S.A. Rice, J. Ross, 2nd Ed., Oxford University Press, New York, 2000.
9. Photochemistry – J. G. Calverts and J. N. Pitts, John-Wiley & Sons
10. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
11. Introduction to Photochemistry-Wells
12. Photochemistry of solutions-C. A. Parker, Elsevier
13. An Introduction to Electrochemistry by S. Glasstone
14. Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy.
15. Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959
16. Chemical Kinetics-K. J. Laidler, Pearson Education,2004
17. Kinetics and Mechanism - A. A. Frost and R. G. Pearson.
18. Electrochemistry- S. Glasstone, D. Van Nostrand , 1965

19. Advanced Physical Chemistry- Gurdeep Raj, Goel Publishing House

20. Basic chemical Kinetics- G. L. Agarwal, Tata-McGraw Hill

21. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.

Semester-II, Physical Chemistry Practical Course (CHP.2.2/APCHP.2.2/IND.2.2)

Physical Chemistry Practicals

Students are expected to perform at least 8 experiments of three and half-hours duration. Experiments are to be set up in the following techniques.

Potentiometry:

1. Determination formal redox potential of system (Fe^{2+}, Fe^{3+})
2. Determination of binary mixture of halides.
3. Dissociation constant of acetic acid.

Conductometry:

4. Titration of ternary acid mixture of acids.
5. Verification of Onsagar Equation for 1:1 type strong electrolyte.
6. Determination of ΔG, ΔH, ΔS of silver benzoate by solubility product method.

Refractometry:

7. Determination of atomic refractions of H, C and Cl atoms.
8. Determination of composition of mixture of liquids.

Cryoscopy:

9. Determination of apparent weight and degree of dissociation a strong electrolyte

Chemical kinetics:

10. Kinetics of iodination of acetone in presence of strong acid

Phase Equilibrium:

11. To construct phase diagrams for ternary system.

Viscosity:

12. Determination of radius of sucrose molecules.

(New experiments may be also be added)

Recommended Books

1. Findlay's Practical Chemistry – Revised by J.A. Kitchner (Vedition)

2. Text Book of Quantitative inorganic analysis : A.I. Vogel.

3. Experimental Physical Chemistry : By F. Daniels and J. Williams

4. Experimental Physical Chemistry : R.C Das and B.Behera

5 Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan

6. Advanced practicals in physical chemistry-Datar and Doke

7 Practical Physical Chemistry- B. D. Khosla, V. C. Garg, A. Gulati

Paper –VIII, Analytical Chemistry –II (CH.2.4/APCH.2.4/IND.2.4)

UNIT-I **15L**

UV-Vis and IR Molecular Spectroscopy

a) Ultraviolet and visible spectrophotometry (UV-Vis) Introduction, Beer Lambert's law, instrumentation, calculation of absorption maxima of dienes, dienones and polyenes, applications.

b) Infrared Spectroscopy (IR) Introduction, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups. Factors affecting frequencies, applications.

c) Luminescence, Chemiluminescence, Fluorimetry and phosphorimetry: Instrumentation, Reporting spectra, applications and comparison.
Problems: Simple structural problems based on UV-Vis and IR

UNIT-II **15L**

Advanced Analytical Tools

a) Nuclear Magnetic Resonance (NMR) Magnetic and non magnetic nuclei, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, chemical shift, anisotropic effect, spin spin coupling, coupling constant, applications to simple structural problems

b) Mass spectrometry (MS), Basic principle, working of mass spectrometer, ionization, types of ionization and classification of MS based on ionization, analyzers (magnetic sector, quadrupole, ion-trap, time of flight, formation of different types of ions, Mclafferty rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications.
Problems: Simple structural problems based on IR, UV, NMR and MS.

UNIT-III **15L**

Thermal Analysis

Introdcution to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase transformation etc. and general thermal analysis applications, advantages and disadvantages.

a) Thermogravimetry analysis (TGA), principle, instrumentation, working, types of TGA, factors influencing TGA, curve to show nature of decomposition reactions, the product and qualities of compounds expelled, TGA in controlled atmosphere, TGA curves, analysis, research and analytical implications of TGA.

b) Differential thermal analysis (DTA) and differential scanning calorimetry (DSC), instrumentation, methodology, application and research implications. Thermometric titrations method and applications
Problems: Simple problems based on TG, DTA and DSC.

UNIT-IV **15L**

Atomic Spectroscopy

a) Atomic Absorption Spectroscopy Introduction, Principal, difference between AAS and FES, Advantages of AAS over FES, advantages and disadvantages of AAS, Instrumentation, Single and double beam AAS, detection limit and sensitivity, Interferences, applications. Graphite furnace atomic absorption spectroscopy, general description, advantages and disadvantages. Flame photometry, Cold Vapor Mercury, Hydride Generation, Spark emission, challenges and limitations.

b) Inductively Coupled Plasma Spectroscopy Introduction, Nebulisation Torch, Plasma, Instrumentation, Interferences, and Applications.
Problems: Simple problems based on FES, AAS, GFAS, ICP

RECOMMENDED BOOKS

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.)
9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd.
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.

Semester-II, Analytical Chemistry Practical Course (CHP.2.2/APCHP.2.2/INDP.2.2)

Analytical Chemistry Practicals

1. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent.
2. To determine the solubility of PbI_2 in presence of different concentration of KNO_3
3. To determine the solubility of PbI_2 in presence of different concentration of KCl
4. Potentiometric estimation of bleaching powder.
5. Determination of capacity of cation exchanger
6. Determination of capacity of anion exchanger
7. Determination of turbidity of water sample using nephalometer
8. To determine the iron content from soap sample
9. Determination of sulphate by nephalometry/tubidimetry
10. Determination of isoniazid from pharmaceutical tablet
11. Determination of caffeine from tea powder
12. Determination of iron from iron tablet samples
13. Estimation of fatty acid from soap sample

14. (Any other experiments may be added)

Recommended Books

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.)
9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd.
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.

M. Sc. Part I and II, Chemistry

(Inorganic, Organic, Physical, Analytical, Applied and Industrial Chemistry)

1. Nature of the theory Question Papers:

1. There shall be 7 questions carrying 16 marks each.
2. Question No. 1 is compulsory. It consists of fill in the banks, objective or answer in one sentence type questions.
3. The remaining question No. 2 to 7 are divided into two sections (Section I and II).
4. Section I consists of question No 2, 3 and 4.
5. Section II consists of question No 5, 6 and 7.
6. Questions 2 to 6 consists of 2 or 3 sub questions.
7. Question No 7 consists of sub questions in which students have to write short notes on any three or four sub questions among the given options.