SCHEME OF EXAMINATION
RULES & REGULATIONS
AND
SYLLABUS

(for Academic Session 2019-2020)

M.Sc. Chemistry
First & Second Semester Examination
(Common for All Specializations)

Master of Science (M.Sc.)
Chemistry

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

CONTENTS

University of Kota, Kota

M.Sc. Chemistry: Semester wise Consolidated Common Scheme of Examinations

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
1st Year	Paper-1.1	CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
I Semester	Paper-1.3	CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
1st Year	Paper-2.1	CHEM-521	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
II Semester	Paper-2.3	CHEM-523	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
2nd Year	Paper-3.1	CHEM-631	*Common Paper:* Chromatography	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	*Common Paper:* Spectroscopy	3	3	-	4	30	12	70	28	100	40
III Semester	Paper-3.3	CHEM-633	*Specialization Paper-I : Group I / II / III / IV / V*	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	*Specialization Paper-II : Group I / II / III / IV / V*	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	*Specialization Paper-III : Group I / II / III / IV / V*	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
2nd Year	Paper-4.1	CHEM-641	*Common Paper:* Environmental Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	*Common Paper:* Recent Methods of Chemical Synthesis	3	3	-	4	30	12	70	28	100	40
IV Semester	Paper-4.3	CHEM-643	*Specialization Paper-I : Group I / II / III / IV / V*	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	*Specialization Paper-II : Group I / II / III / IV / V*	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	*Specialization Paper-III : Group I / II / III / IV / V*	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**1000**

Groups of Specializations in M.Sc. Chemistry

Year / Sem.	Specialization Papers	Code or ID	Group-I: Inorganic Chemistry	Group-II: Organic Chemistry	Group-III: Physical Chemistry	Group-IV: Analytical Chemistry	Group-V: Industrial Chemistry
2nd Year III Semester	*Specialization Paper-I*	CHEM-633	Bio-inorganic Chemistry	Organic Synthesis	Nuclear Chemistry	Advanced Analytical Techniques	Fundamentals of Industrial Process Calculations
	Specialization Paper-II	CHEM-634	Photo-inorganic Chemistry	Heterocyclic Chemistry	Physical Organic Chemistry	Analysis of Commercial Products	Fuel, Petrochemicals and Energy Technology
	Specialization Paper-III	CHEM-635	Inorganic Chemistry Practical	Organic Chemistry Practical	Physical Chemistry Practical	Analytical Chemistry Practical	Industrial Chemistry Practical
2nd Year IV Semester	*Specialization Paper-I*	CHEM-643	Organotransition Metal Chemistry	Chemistry of Natural Products	Electrochemistry	Instrumental Methods of Analysis	Chemical Process Industries
	Specialization Paper-II	CHEM-644	Polymers	Medicinal Chemistry	Chemical Dynamics	Analysis of Consumers Products	Industrial Management, IPR and Regulatory Affairs
	Specialization Paper-III	CHEM-645	Inorganic Chemistry Practical	Organic Chemistry Practical	Physical Chemistry Practical	Analytical Chemistry Practical	Industrial Chemistry Practical

University of Kota
Kota
M.Sc. Chemistry (Inorganic Chemistry Specialization)
Semester wise Scheme of Examinations

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
1st Year	Paper-1.1	CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
I Semester	Paper-1.3	CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
1st Year	Paper-2.1	CHEM-521	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
II Semester	Paper-2.3	CHEM-523	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-3.1	CHEM-631	Chromatography	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3	3	-	4	30	12	70	28	100	40
III Semester	Paper-3.3	CHEM-633	Bio-inorganic Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	Photo-inorganic Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	Inorganic Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-4.1	CHEM-641	Environmental Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Chemical Synthesis	3	3	-	4	30	12	70	28	100	40
IV Semester	Paper-4.3	CHEM-643	Organotransition Metal Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	Polymers	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	Inorganic Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**840**

University of Kota
Kota
M.Sc. Chemistry (Organic Chemistry Specialization)
Semester wise Scheme of Examinations

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Teaching Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
1st Year	Paper-1.1	CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
I Semester	Paper-1.3	CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
1st Year	Paper-2.1	CHEM-521	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
II Semester	Paper-2.3	CHEM-523	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-3.1	CHEM-631	Chromatography	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3	3	-	4	30	12	70	28	100	40
III Semester	Paper-3.3	CHEM-633	Organic Synthesis	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	Heterocyclic Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	Organic Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-4.1	CHEM-641	Environmental Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Chemical Synthesis	3	3	-	4	30	12	70	28	100	40
IV Semester	Paper-4.3	CHEM-643	Chemistry of Natural Products	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	Medicinal Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	Organic Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**840**

University of Kota
Kota
M.Sc. Chemistry (Physical Chemistry Specialization)
Semester wise Scheme of Examinations

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Teaching Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
1st Year	Paper-1.1	CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
I Semester	Paper-1.3	CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
1st Year	Paper-2.1	CHEM-521	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
II Semester	Paper-2.3	CHEM-523	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-3.1	CHEM-631	Chromatography	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3	3	-	4	30	12	70	28	100	40
III Semester	Paper-3.3	CHEM-633	Nuclear Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	Physical Organic Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	Physical Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-4.1	CHEM-641	Environmental Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Chemical Synthesis	3	3	-	4	30	12	70	28	100	40
IV Semester	Paper-4.3	CHEM-643	Electrochemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	Chemical Dynamics	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	Physical Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**840**

University of Kota
Kota
M.Sc. Chemistry (Analytical Chemistry Specialization)
Semester wise Scheme of Examinations

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
1st Year	Paper-1.1	CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
I Semester	Paper-1.3	CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
1st Year	Paper-2.1	CHEM-521	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
II Semester	Paper-2.3	CHEM-523	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-3.1	CHEM-631	Chromatography	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3	3	-	4	30	12	70	28	100	40
III Semester	Paper-3.3	CHEM-633	Advanced Analytical Techniques	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	Analysis of Commercial Products	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	Analytical Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-4.1	CHEM-641	Environmental Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Chemical Synthesis	3	3	-	4	30	12	70	28	100	40
IV Semester	Paper-4.3	CHEM-643	Instrumental Methods of Analysis	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	Analysis of Consumers Products	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	Analytical Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**840**

University of Kota
Kota
M.Sc. Chemistry (Industrial Chemistry Specialization)
Semester wise Scheme of Examinations

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
1st Year	Paper-1.1	CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
I Semester	Paper-1.3	CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
1st Year	Paper-2.1	CHEM-521	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
II Semester	Paper-2.3	CHEM-523	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-3.1	CHEM-631	Chromatography	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3	3	-	4	30	12	70	28	100	40
III Semester	Paper-3.3	CHEM-633	Fundamentals of Industrial Process Calculations	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	Fuel, Petrochemicals and Energy Technology	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	Industrial Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
2nd Year	Paper-4.1	CHEM-641	Environmental Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Chemical Synthesis	3	3	-	4	30	12	70	28	100	40
IV Semester	Paper-4.3	CHEM-643	Chemical Process Industries	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	Industrial Management, IPR and Regulatory Affairs	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	Industrial Chemistry Practical	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**840**

Rules & Regulations

Objectives of the Course:

Chemistry is an important part of the current revolutions in Science. No educated person today can understand the modern world without a basic knowledge of chemistry. The existence of a large number of industries including pharmaceutical, agrochemical, petrochemical, heavy & fine chemical, fertilizer, polymer, rubber, cement, glass & ceramic, dye & pigment, pulp & paper, soap & detergent, perfumery, sugar, textile, coal, mine industries as well as power plants necessitate chemistry education. Hence, our goal for introducing the M.Sc. Chemistry programme is to educate the students in an effective manner so that the chemistry professionals can serve the fascinating fields of the chemistry.

M.Sc. Chemistry is a unique kind of course dealing with all aspects of chemistry including fundamental ideas about Inorganic, Organic, Physical, and Analytical Chemistry. This course also includes fundamentals of Mathematics, Biology, Computer, Industrial Techniques, *etc.* which are essential to a chemist to develop his/her overall presentation in the pharmaceutical, chemical, and other related industries. The major objectives of M.Sc. Chemistry course are:

- To impart knowledge in fundamental aspects of all branches of the Chemistry with basic ideas of other subjects such as Mathematics, Biology, Computer Applications in Chemistry.
- To acquire basic knowledge in the specialized areas like Organic Chemistry, Heterocyclic Chemistry, Medicinal Chemistry, Pharmaceutical Chemistry, Industrial Chemistry, Green Chemistry, Organic Synthesis, Polymer Chemistry, Bio-inorganic Chemistry, Physical Chemistry, Environmental Chemistry, Photo-inorganic Chemistry, Solid State Chemistry, Supra-molecular Chemistry, Electrochemistry, *etc.*

Duration of the Course:

The course for the degree of Master of Science in Chemistry shall consist of two academic years divided in to four equal semesters. Each semester consist of minimum 120 working days.

Eligibility for Admission in M.Sc. First Semester:

A candidate who has passed any one of the following examination with Chemistry as a major subject from any University recognized by the UGC shall be permitted to take admission in M.Sc. First Semester Chemistry to award M.Sc. degree in Chemistry with specialization in Inorganic Chemistry / Organic Chemistry / Physical Chemistry / Analytical Chemistry / Industrial Chemistry from this University after completion of a course of study of two academic years divided in the four semester scheme of examination:

- B.Sc. under 10+2+3 pattern with Chemistry as a main subject of study, or
- B.Sc. with specialization in any branch of Chemistry such as Industrial Chemistry, Polymer Chemistry, Applied Chemistry, Pharmaceutical Chemistry, Medicinal Chemistry, *etc.* or
- Three / Four year B.Sc. (Hons.) with Chemistry or any branch of Chemistry such as Industrial Chemistry, Applied Chemistry, Medicinal Chemistry, Pharmaceutical Chemistry, Polymer Chemistry, *etc.* or
- Four year Bachelor of Science and Technology (B.Sc.-Tech.) or Bachelor of Science and Education (B.Sc.-B.Ed.) with Chemistry as a paper.

Minimum Marks required in Qualifying Examination:

- Qualifying examination passed from any recognised University which is situated in Rajasthan State:
  - General Category = 55%.
  - SC / ST / OBC / SBC or MBC = Min. Pass Marks
- Qualifying examination passed from any recognised University which is situated at outside the Rajasthan State:
  - All Categories = 60%.

Eligibility for Admission in M.Sc. Third Semester:

A candidate may be promoted in the next academic session (odd semester *i.e.* III semester) if he/she has cleared collectively at least 50% of the papers of both semesters (semester I & II) of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill the above condition will remain as an ex-student and will re-appear in the due papers examinations along with next odd/even semester examinations.

A candidate who has passed B.Ed. examination as a regular course of study after completing first and second semester examinations from this University shall also be eligible to take admission in third semester examination as a regular candidate.

Criteria for Opting Specialization in M.Sc. Third Semester:

In third semester, a student will have an option to choose any specialization (Inorganic Chemistry / Organic Chemistry / Physical Chemistry / Analytical Chemistry / Industrial Chemistry) subject to availability of the specialization and number of seats in a particular specialization in the Department. If number of candidates will be more than seats available in a particular specialization, admission in the specialized course shall be given on the basis of merit (aggregate percentage of first and second semester examination) after receiving option forms with preferences for all available specializations.

Course Structure:

The Master of Science in Chemistry programme will consist of core and advanced courses of theory as well as practical which are compulsory for students. Dissertation(s), project work(s), training(s), field work(s), industrial visit(s), *etc.* (which is/are approved by the concerned Department) may be performed / executed by the students in the government / public / private organization(s), institution(s), industry(ies), firm(s), enterprise(s), *etc.* for advanced learning and more practical exposures.

Course Number, Course Code or ID and Nomenclature:

Number of the course has been given in the Arabic number as Paper-1.1, Paper-1.2, and Paper-1.3 and so on. In the Paper-1.2, 1 represents the semester number and 2 represent the paper number.

To give a code to a particular course, following sequence has been adopted:

"Abbreviation of the programme in upper case + n^{th} number of year of study + n^{th} number of semester of the programme + course number in Arabic number"

According to the above sequence, code of paper-IV of the first semester of postgraduate Chemistry shall be as "CHEM-514". It is noted that the 5 represents here the fifth year of study because it is considered that the student has completed four years of study during his / her undergraduate programme *e.g.* B.Sc. pass course with three or B.Sc. Hons course with three or four years / B.Sc.-B.Ed. / B.Sc.-Tech. / B.Tech. *etc.* with four years. Therefore, the figure 5 represents the fifth year of study.

Nomenclature of the particular course has been given according to the nature or type of contents included in the Unit-I to Unit-V of course of study.

Maximum Marks and Credit Points:

Maximum marks of a theory and practical paper will be decided on the basis of their contact hours per week. One teaching hour per week will carry 25 maximum marks and 1 credit point, therefore, 4 teaching hours per week will carry 100 maximum marks and 4 credit points for each theory paper / course. For practical paper, the maximum marks shall be 100 marks. For calculating of credit points for practical papers, two contact hours per week for laboratory or practical work will be equal to one contact hour per week for theory paper and will carry 1 credit point. Therefore, for 18 contact hours per week for practical work or laboratory work will be equal to 9 contact hours per week for theory paper and will carry 9 credit points.

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Teaching Methodologies:

The classroom teaching would be through conventional lectures or use of OHP or power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually. For the students of slow learners, special attention would be given.

Assessment Pattern:

The assessment of the student shall be divided into two parts in which first part is continuous assessment / mid-term assessment / internal assessment (30% weightage of the maximum marks) and second part is semester assessment / end-term assessment / external assessment (70% weightage of the maximum marks).

(i) Mid-Term / Internal / Continuous Assessment:

(a) The continuous / mid-term / internal assessment (30% weightage of the maximum marks) for each theory paper shall be taken by the faculty members in the Department during each semester. Internal assessment part is further divided in two parts of equal weightage of marks as per the details given below:

S. No.	Internal Assessment	Mode of Internal Assessment	Max. Marks
(i)	Mid-Term / Internal / Continuous Assessment-I	Written Examination.	15 Marks

(ii)	Mid-Term / Internal / Continuous Assessment-II	Seminar / Presentation / Assignment / Dissertation / Quiz / Group Discussion / Viva-voce or any other mode of assessment.	15 Marks

Note: *In the Mid-Term/Internal/Continuous Assessment-I, written examination shall be of one hour duration for each theory paper and shall be taken according to the academic calendar which will be notified by the Department / University. Time duration for Mid-Term/Internal/Continuous Assessment-II is not allotted. It will be decided by the faculty member which will be taking internal assessment.*

(b) For practical papers, there will be only one external or semester or end-term assessment (100% weightage of maximum marks) and there will be no continuous or internal or midterm assessment.

(c) A student who remains absent (defaulter) or fails or wants to improve the marks in the internal assessment may be permitted to appear in the desired paper(s) (only one time) in the same semester with the permission of the concern Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to Head of the Department who may permit the candidate to appear in the internal assessment after production of satisfactory evidence about the reason of his/her absence in the test(s) and deposition of the defaulter / improvement fee. A record of such candidates shall be kept in the Department.

(d) Regular attendance of the student shall be considered in the internal assessment. Marks (equal to 10% of internal assessment) shall be given to the student(s) for regularity who is/are taken classes regularly. If the attendance / regularity factor is similar for all the students, then weightage marks for regularity may be merged in the weightage of second internal assessment (seminar / presentation / assignment / dissertation / quiz / group discussion / viva-voce, *etc.*).

(e) Paper wise consolidated marks for each theory paper and dissertation / seminar (*i.e.* total marks obtained during various modes of internal assessment) obtained by the students (out of the 30% weightage of the maximum marks of the each paper) shall be forwarded by the Head of the Department (in two copies) to the Controller of Examinations of the University within a week from the date of last internal assessment test for incorporation in the tabulation register.

(f) The consolidated marks obtained by the students be also made known to them before being communicated by the concerned Head of the Department to the University for final incorporation in the tabulation register. If any discrepancies are discovered or pointed out by the students, the same shall be looked into by the concerned faculty member and corrections made wherever necessary. The decision of the Head of the Department before the communication of marks to the University shall be final. No corrections shall be made in the internal assessment marks after the declaration of the result by the University.

(g) Consolidated marks of internal assessment obtained out of the 30% weightage of maximum marks of each theory paper which will be communicated to the

University shall be in whole number and not in fraction. Marks awarded for the various internal assessments in each paper shall be added up and then round off to the next whole number to avoid any fraction.

(h) All test copies and other material related to the internal assessment shall also be sent to the Controller of Examinations of the University to keep in record as per the University guidelines.

(i) The concerned Head of the Department shall be responsible for proper conduct of internal assessment tests and for communication of the consolidated marks to the University within the prescribed time.

(j) The Head of the Department shall keep a record of the marks and also notify the same to the candidates immediately so that if any candidate is not satisfied with the award in any test or seasonal work, he / she should represent the matter to the higher authority.

(ii) End-Term / External / Semester Assessment:

(a) The semester or external or end-term assessment (70% weightage of the maximum marks) shall be three hours duration to each theory paper and twelve hours duration (spread over two days with 6 hours per day) for each practical paper and shall be taken by the University at the end of each semester.

(b) The syllabus for each theory paper is divided into five independent units and question paper for each theory will be divided into three sections as mentioned below:

- ***Section-A*** *will carry 10 marks with one compulsory question comprising ten short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

(c) The syllabus of practical paper is divided according to main streams of chemistry including Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Analytical Chemistry, Environmental Chemistry, Heterocyclic Chemistry, Medicinal Chemistry, Organic Synthesis, *etc.* as well as according to various types of industries. Marks shall be awarded on the basis of major & minor experiments, viva-voce, practical record, regularity factor, lab skills and maintain cleanness of workplace.

Question Paper Pattern:

(A) Mid-Term / Internal / Continuous Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks).

(i) Mid-Term / Internal / Continuous Assessment-I:

Department of .....
University / College : .....
Address .....

First Internal Assessment Test 20… - 20….
(Written Examination)

Name of Class/Course :	Max. Marks : 15 Marks
Name of Semester :	Duration of Exam. : 1.00 Hr
No. & Name of Paper :	Date of Exam. :

Q. No. 1. ……..
or
…….
5 Marks
Q. No. 2. ……..
or
…….
5 Marks
Q. No. 3. ……..
or
…….
5 Marks

(ii) Mid-Term / Internal / Continuous Assessment-II:

Department of .....
University / College : .....
Address .....

Second Internal Assessment Test 20… - 20….
(Seminar / Presentation / Assignment / Dissertation / Quiz / Group Discussion / Viva-voce or any other mode of assessment)

Name of Class/Course :	Max. Marks : 15 Marks
Name of Semester :	Mode of Assessment:
No. & Name of Paper :	Date of Assessment :

Format for
Compilation of Marks/Awards of Internal Assessment-I & II

Department of .....
University / College : .....
Address .....

Name of Class/Course : .....
Name of Semester : .....
No. & Name of Paper : .....
Max. Marks : .....

S. No.	Name of Student	Father's Name	Marks Obtained			
			Int. Assess.-I	Int. Assess.-II	Total Marks (in Figure)	Total Marks (in Words)

Name & Signature of the Faculty Member

(B) End-Term / External / Semester Assessment:

70% weightage of Max Marks (70 Marks out of 100 Max Marks).

Duration of Examination: 3 Hours **Max. Marks: 70**

Note: *The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with one compulsory question comprising ten short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

SECTION-A

Q. 1.

Unit-I

(i) …… **1 Mark**
(ii) …… **1 Mark**

Unit-II

(iii) …… **1 Mark**
(iv) …… **1 Mark**

Unit-III

(v) …… **1 Mark**
(vi) …… **1 Mark**

Unit-IV

(vii) …… **1 Mark**
(viii) …… **1 Mark**

Unit-V

(ix) …… **1 Mark**
(x) …… **1 Mark**

SECTION-B

Unit-I

Q. 2. …… **5 Marks**

or

…… **5 Marks**

Unit-II

Q. 3. …… **5 Marks**

or

…… **5 Marks**

Unit-III

Q. 4. …… **5 Marks**

or

…… **5 Marks**

Unit-IV

Q. 5. . …… **5 Marks**

or

…… **5 Marks**

Unit-V

Q. 6. …… **5 Marks**

or

…… **5 Marks**

SECTION-C

Unit-I

Q. 7. …… **15 Marks**

Unit-II

Q. 8. …… **10 Marks**

Unit-III

Q. 9. …… **10 Marks**

Unit-IV

Q. 10. …… **10 Marks**

Unit-V

Q. 11. …… **10 Marks**

Practical / Project Work* Examinations:

Continuous / Mid-Term / Internal Assessment:

Not applicable in Practical / Project Examinations.

Semester / End-Term / External Assessment:

Duration of Exam: 12 Hours **Maximum Marks: 100**

Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Practical Record	05
8.	Laboratory Skills, Regularity, *etc.*	10
9.	Viva-voce	10
	Total Marks	**100**

*Project Work :

Project work will be undertaken by the students in last semester of M.Sc. Chemistry in place of practical work compulsorily for the on campus programme. The project work shall be experimental based and will be evaluated an external expert. A dissertation of project work has to be submitted by the students in the prescribed format along with plagiarism report. A presentation will be made by the students at the time of evaluation of the project work.

Minimum Pass Marks and Rules regarding Determination of Results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of each semester examination shall be worked out separately (even if the candidate has appeared at the paper(s) of the lower semester examination along with the papers of higher semester examination) in accordance with the following conditions:

(i) A candidate, for a semester examination, shall be offered all the papers prescribed for that semester examination and besides he/she also shall be offered paper(s) not cleared by him/her at any of the lower semester examination subject to the limitation that the number of un-cleared papers of the lower semester examinations shall not be exceed the total number of the papers prescribed for any one semester.

(ii) The candidate shall be declared to have passed the examination, if the candidate secures at least 40% marks in each theory paper separately in continuous or internal or mid-term examination & semester or external or end-term examination and 50% marks in each practical / project / dissertation / seminar with 50% aggregate marks of the maximum marks prescribed for each semester examination. There is no minimum pass marks for the practical record / notebook. However, submission of a practical record / notebook is a mandatory during the practical examination. The candidate should compulsorily attend viva-voce / presentation examination to secure pass in practical / project / dissertation / seminar.

(iii) A candidate, who has been declared as failed/absent in one or more theory paper(s) at any odd semester examination shall be permitted to join the courses of study for the next higher semester *i.e.* permitted to join the course of second semester after first semester examination, permitted to join the course of fourth semester after third semester examination, permitted to join the course of sixth semester after fifth semester examination and so on and eligible to re-appear in that paper(s) as due paper(s) along with next higher semester (next year) examination provided that he/she must have cleared at least 50% of the papers (including practical / project / dissertation / seminar as one paper) collectively prescribed for the first and second semester examinations taken together for promotion to the third semester examination.

(iv) A candidate may be promoted in the next semester (odd semester) if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill the this condition will remain in the same semester as an ex-student and will re-appear in the due papers examination along with next odd/even semester examinations.

(v) If any student who is provisionally admitted in higher odd semester but could not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forwarded to the next odd semester of forthcoming academic session.

(vi) A candidate declared as failed in that particular paper he/she can re-appear for that paper in the next year examination as a due paper. However, the internal marks shall be carried forward for the total marks of the due examination.

(vii) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing the two years' postgraduate course will be limited to four years, for three years postgraduate programme up to five years and so on.

(viii) If the number of papers prescribed at the first and second or third and fourth semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers.

(ix) A candidate who passes in 50% or more papers of the first and second semester examination, and thereby becomes eligible for admission to the third semester examination, but chooses not to do so and desires to appear in the remaining papers of first and second semester examination only or to re-appear in all the prescribed papers and practical/dissertation/seminar of the M.Sc. first and second semester examination will be permitted to do so on the condition that in the latter case his previous performance will be treated as cancelled.

(x) If a candidate, who has been promoted to the next semester and wishes to improve his / her performance in the theory paper(s) of previous semester, can be permitted to do so in case of the theory papers only, not in practical / project / dissertation / seminar, belonging to the immediately preceding semester only for one time in these papers in next odd/even semester examinations. In such a case, he/she shall have to appear in these papers along with the papers of his/her own semester.

(xi) A candidate shall be declared as passed after the result of the fourth semester examination, if he/she cleared all papers of the all the four semesters and secure minimum 40% of the aggregate marks of the maximum marks in theory papers and 50% of the aggregate marks of the maximum marks for practical / dissertation / presentation / seminar prescribed for four semesters Master's programme.

(xii) In the case of an ex-student, the marks secured by him/her at his/her last examination as a regular candidate shall be taken into account except in cases where a candidate is re-appearing at the examination as a regular student and in that event he/she shall have to repeat the internal assessment test which will be finally accounted for working out his result.

(xiii) A candidate who has failed at the M.Sc. third and fourth semester examination but has passed in at least 50% of the papers prescribed for the examination shall be exempted from re-appearing in a subsequent year in the papers in which he/she has passed.

(xiv) If a candidate clears any paper(s) prescribed at the first and second semester (previous) and/or third and fourth semester (final) examination after a continuous period of three years, then for the purpose of working out his/her division, only the minimum pass marks shall be taken into account in respect of such paper(s) as are cleared after the aforesaid period provided that in case where a candidate requires more than 40% marks in order to reach the requisite minimum aggregate, as many marks out of those secured by him/her will be taken in to account as would enable him/her to make up the deficiency in the requisite minimum aggregate.

(xv) In case the candidate is not able to clear his/her due paper(s) in the stipulated period as mentioned above (continuous period of three years), he/she may be given last one mercy attempt to clear due paper(s) subjected to approval of the Vice Chancellor or Board of Management.

(xvi) The grace marks scheme shall be applicable as per University norms.

Classification of Successful Candidates:

The classification of successful candidates after last semester examination shall be as:

Description of Marks Obtained	Division / Result
• 80% and above in a particular paper	Distinction in that paper.
• A candidate who has secured aggregate 60% and above marks	First Division
• A candidate who has secured aggregate 50% and above but less than 60% marks	Second Division

Candidates who pass all the examinations prescribed for the course in the first instance and within a period two academic years in four semesters from the year / semester of admission to the course only are eligible for University Ranking. A candidate is deemed to have secured first rank provided he/she

(i) Should have passed all the papers in first attempt itself.

(ii) Should have secured the highest marks in the whole examination of the programme / course, or should have secured the highest cumulative grade point average (CGPA).

..... x ..... x ..... x .....

Syllabus

M.Sc. Chemistry
First Semester Examination

Paper-1.1: CHEM-511: Inorganic Chemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Structure and Bonding in Main Group Compounds: 15-18 L

VSEPR theory and its limitations, Walsh diagrams (tri-atomic molecules), dπ-pπ bonds, Bent rule and energetics of hybridization, general trends in acid-base behaviour of binary oxides.

Unit-II: Metal-Ligand Bonding in Metal Complexes: 15-18 L

Limitations of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π-bonding, η^2, η^3, η^5, η^6 systems with reference to molecular orbital theory.

Unit-III: Metal-Ligand Equilibriums in Solution: 15-18 L

Stepwise and overall formation constants and their interaction, trends in stepwise constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by *p*H-metry and spectrophotometry.

Unit-IV: Symmetry and Group Theory in Chemistry: 15-18 L

Symmetry operations, symmetry elements, definition of group, subgroup, relation between order of a finite group and its subgroup, similarity transformations and classes, molecular point groups and their classification, Schonflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh}, *etc.* groups to be worked out explicitly), characters of a representation, the great orthogonality theorem (without proof) and its importance, properties of character of representation.

Unit-V: Applications of Group Theory in Chemistry: 15-18 L

Introduction of character tables, formation of character tables of C_{2v} & C_{3v} point groups, relationship between reducible and irreducible representations, formation of hybrid orbitals:-σ-bonding in trigonal planar (BF_3), tetrahedral (CH_4), square pyramid (BrF_5) and square planar [$Pt(Cl_4)^{2-}$, XeF_4]; symmetry aspects of molecular vibrations of H_2O, NH_3 in IR and Raman spectroscopy.

Books:

- *Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.*
- *Inorganic Chemistry, J.E. Huhey, Harpes & Row.*
- *Chemistry of the Elements. N.N. Greenwood and A. Earnshow, Pergamon.*
- *Concepts and Models of Inorganic Chemistry, third edition, B. Douglas, D. McDaniel and J. Alexandar, John Wiley.*
- *Magnetio-chemistry, R.L. Carlin, Springer Verlag.*
- *Comprehensive Coordiantion Chemistry eds., Wilkinson, Gillars and Mc Cleverty, Pergamon.*
- *Group Theory, Patel & Patel*
- *Chemical Applications of Group Theory, F. A. Cotton.*
- *Group Theory and its Application, P. Bhattacharya, Himalaya Publication*
- *Group Theory and its Application, Ramashanker & S. C. Ameta, Sadguru Publication*
- *Group Theory and its Application, Ramakrishanan and Swaminathan, Vishal Publication.*

Paper-1.2: CHEM-512: Organic Chemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Nature of Bonding in Organic Molecules: 15-18 L

Delocalized chemical bonding: conjugation, cross-conjugation, resonance, hyper-conjugation, bonding in fullerenes, tautomerism; aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Hűckel's rule, energy level of π-molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity, PMO approach; bonds weaker than covalent bond: addition compounds (crown ether complexes and cryptands) and inclusion compounds (catenanes and rotaxanes).

Unit-II: Structure and Reactivity: 15-18 L

Thermodynamic and kinetic aspects of reactions, isotope effect, effects of structure on reactivity, resonance and field effects, steric effect, quantitative treatment, The

Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Reaction Mechanism:
Types of reaction mechanism, potential energy diagram, transition states and intermediates, methods of determining mechanisms (product analysis, intermediates analysis, isotope effect, kinetic and stereochemical studies).

Reactions Intermediates:
Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.

Unit-III: Stereochemistry: 15-18 L

Conformational analysis of cycloalkanes & decalins, effect of conformation on reactivity, conformation of sugars, strain due to unavoidable crowding, elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis, optical activity in the absence of chiral carbon (biphenyls, allenes and spirane), chirality due to helical shape, invertomers, asymmetric synthesis, determination of configuration (absolute & relative) and conformation.

Unit-IV Aliphatic Nucleophilic Substitution Reactions: 15-18 L

The S_N2, S_N1, mixed S_N1 & S_N2, S_Ni and SET mechanisms, reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium; neighbouring group participation by π- and σ-bonds, classical and non-classical carbocations, phenonium ions, norbornyl systems; rearrangement of epoxides, transannular rearrangement; nucleophilic substitution at vinylic, allylic and aliphatic trigonal carbon; phase transfer catalysis, ambient nucleophiles, regioselectivity.

Aromatic Nucleophilic Substitution Reactions:
S_NAr S_N1, S_NAr S_N2 , benzyne and SR_N1 mechanisms, reactivity effects of substrate structure, leaving group and attacking nucleophile; von Richte, Sommelet-Hauser, and Smiles rearrangements.

Unit-V: Aliphatic Electrophilic Substitution Reactions: 15-18 L

Bimolecular mechanisms SE2, SE1, SEi mechanism, electrophilic substitution accompanied by double bond shifts, effect of substrates, leaving groups and the solvent polarity on the reactivity.

Aromatic Electrophilic Substitution Reactions:
Arenium ion mechanism, orientation and reactivity in benzene ring, energy profile diagrams, ortho/para ratio, ipso attack, orientation and reactivity in other ring systems, quantitative treatment of reactivity in substrates and electrophiles, diazonium coupling, Vilsmeir-Haack reaction, Reimer-Tiemann reaction, Gatterman-Koch reaction, Houben-Hoesch reaction, Fries rearrangement, Bischler-Napieralski reaction.

Books:

- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry, Clayden, Nick Geeves and Staurt Warren, Oxford University Press*
- *Advanced Organic Chemistry: Reactions, Mechanism and Structure, Jerry March, John Wiley.*
- *Advanced Organic Chemistry, Part A and Part B, F.A. Carey and R.J. Sundberg, Plenum.*

- *A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.*
- *Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.*
- *Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan.*
- *Textbook of Organic Chemistry by P S Kalsi, New Age International*
- *Organic Reactions, Stereochemistry and Mechanism (Through Solved Problems) by PS Kalsi, New Age*
- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, TataMcGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*
- *Stereochemisty of Organic Compounds, P.S. Kalsi, New Age International.*
- *Stereochemistry, Conformation and Mechanism by P S Kalsi, New Age International*

Paper-1.3: CHEM-513: Physical Chemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Quantum Chemistry-I: 15-18 L

Introduction to Exact Quantum Mechanical Results: The Schrodinger equation and the postulates of quantum mechanics.

Approximate Methods: The variation theorem, linear variation principle, perturbation theory (first order and non-degenerate), applications of variation method and perturbation theory to Helium atom.

Unit-II: Quantum Chemistry-II: 15-18 L

Angular Momentum: Ordinary angular momentum, generalized angular momentum, Eigen functions for angular momentum, Eigen values of angular momentum, operator using Ladder operators addition of angular momentum.

Molecular Orbital Theory: Hűckel theory of conjugated systems bond and charge density calculations, applications to ethylene, butadiene, cyclopropenyl radical cyclobutadiene, introduction to extended Hűckel theory.

Unit-III: Chemical Dynamics: 15-18 L

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions.

Dynamics of chain reactions (hydrogen-bromine reaction), photochemical reactions (hydrogen-bromine and hydrogen-chlorine reactions), kinetics of enzyme catalyzed

reactions, general features of fast reactions, study of fast reactions (flow method, relaxation method, flash photolysis), dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus).

Unit-IV: Adsorption: 15-18 L

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surfaces, different isotherms, thermodynamics of adsorption.

Micelles:

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilisation, micro emulsion, reverse micelles.

Unit-V: Macromolecules: 15-18 L

Definition & types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization, molecular mass number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion, light scattering and sedimentation methods), chain configuration of macromolecules, calculation of average dimension of various chain structures.

Books:

- *Physical Chemistry, P.W. Atkins, ELBS.*
- *Introduction to Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill.*
- *Quantum Chemistry, R. K. Prasad,*
- *Coulson's Valence, R.Mc Weeny, ELBS.*
- *Chemical Kinetics. K.J. Laidler, McGraw-Hill.*
- *Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.*
- *Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Planum.*
- *Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.*
- *Advanced Physical Chemistry, Gurudeep Raj,Goel Publication House*
- *Adsorption and Catalysis, G. Whitmore, Sarup & Sons Publishers.*

Paper-1.4: CHEM-514: Mathematics for Chemists

(For students without Mathematics in B. Sc.)

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total*

three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Basic Mathematics: 15-18 L

Matrix algebra, determinants, linear equations, basic rules for differentiation, partial differentiations, maxima and minima, basic rules for integration.

Unit-II: Mathematics and Linear Programming Problems: 15-18 L

Basic concept of differential equations, solution of linear differential equation of constant coefficients.

Vectors: definition dot, triple and cross product. Linear programming problems: Formulation, graphical solution.

Unit-III: Basic Operations Research: 15-18 L

Operations research-concept and applications of OR, transportation problem, assignment problems, basic concepts of inventory control.

Unit-IV: Basic Statistics: 15-18 L

Basic concept of statistics, representation of data-histogram, Pie chart, measures of central tendency, deviation, dispersion, skewness and kurtosis, random variables, mathematical expectations. correlation, regression.

Unit-V: Statistical Inference: 15-18 L

Probability theory, probability distribution: discrete (binomial and Poisson), sampling concepts, sampling test for mean, testing of hypothesis-test based on t-distribution (t-test).

Books:

- *Mathematical Statistics-Gupta and Kapoor.*
- *Operations Research-Kanti Swaroop.*
- *The Chemistry Mathematics Book, E. Steiner, Oxford University Press.*
- *Mathematics for Chemistry, Doggett and Sucliffe, Longman.*
- *Mathematical for Physical Chemistry: F. Daniels, Mc Graw Hill.*
- *Chemical Mathematics D.M. Hirst, Longman.*
- *Applied Mathematics for Physical Chemistery, J.R. Barrnte, Prentice Hall.*
- *Basic Mathematics for Chemists, Tebbutt, Wiley.*

OR

Paper-1.4: CHEM-514: Biology for Chemists

(For students without Biology in B. Sc.)

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Cell Structure and Functions: 15-18 L

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparisons of plant and animal cells, overview of metabolic processes: catabolism and anabolism, origin of life: unique properties of carbon, chemical evolution and rise of living systems.

Unit-II: Carbohydrates: 15-18 L

Monosaccharides: Structure, conformation and functions of important derivatives of monosaccharides; structural polysaccharides: cellulose and chitin, storage polysaccharides: starch and glycogen, structure and biological functions of glucosaminoglycans or mucopolysaccharides, glycoproteins and glycolipids, role of sugars in biological recognition.

Unit-III: Lipids: 15-18 L

Fatty acids, structure and function of triacylglycerols, cholesterol, bile acids, liproproteins: composition and function, role in atherosclerosis; properties of lipid aggregates: micelles, bilayers, liposomes; biological membranes, fluid mosaic model of membrane structure, lipid metabolism: β-oxidation of fatty acids.

Unit-IV: Amino-acids and Proteins: 15-18 L

Amino acid metabolism: degradation and biosynthesis of amino acids, sequence determination: chemical / enzymatic / mass spectral, racemization / detection.

Chemical and enzymatic hydrolysis of proteins, secondary structure of proteins, α-helix, β-sheets, tertiary structure of protein: folding and domain structure, quaternary structure.

Unit-V: Nucleic Acids: 15-18 L

Purine and pyrimidine bases of nucleic acids, structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA, chemical and enzymatic hydrolysis of nucleic acids, chemical basis of heredity, an overview of replication, transcription, translation and genetic code.

Books:

- *Principles of Biochemistry, A.L. Lehnigher, Worth Publishers.*
- *Biochemistry, L. Stryer, W.H. Freeman.*
- *Biochemistry, J. David Rawn, Neil Patterson.*
- *Biochemistry, Voet and Voet, John Wiley.*
- *Outlines of Biochemistry E.E. Conn and P.K. Stumpf, John Wiley.*

Paper-1.5: CHEM-515: Practical

Contact Hours / Week : 18 Hours
Duration of Examination: 12 Hours **Maximum Marks :**100 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Practical Record	05
8.	Laboratory Skills, Regularity, *etc*.	10
9.	Viva-voce	10
	Total Marks	**100**

Laboratory Safety, GLP, SOPs and Basic Concepts:

- General instructions for safe working in chemical laboratories.
- Planning of experiments and recording of results.
- Good laboratories practices.
- Sampling and sample preparation.
- Preparation of standard operating procedures (SOPs).
- Hazards in chemical laboratories.
- Apparatus and reaction procedures: Introduction of working with lab ware.
- Solvents and reagents.
- Concept of distillation, crystallization, drying, isolation and purification, determination of physical constants.

Solution Preparation and Standardization:

- Preparation of solutions in terms of molarity, molality, formality, normality, w/w, w/v, v/v, percent, mole ratio, partial pressure and presentation of concentration in g/L, percent, ppt, ppm, ppb.
- Standardization of solutions.

Inorganic Chemistry:

Qualitative Analysis:

Identification of inorganic mixture consisting of eight radicals (cations / anions / less common metal ions):

- Less common metal ions: Ti, Mo, W, Tl, Zr, Th, V, U (two metal ions in cationic / anionic forms)
- Insoluble: Oxides, sulphates and halides
- Interfering anionic radicals

Quantitative Analysis:

Separation and determination of two metal ions Cu-Ag, Cu-Ni, Zn-Cu, Ni-Zn, Cu-Fe, Ca-Fe, Ca-Mg, *etc.* involving volumetric and gravimetric methods

Inorganic Preparation:

Preparation and purification of selected inorganic compounds and their studies by magnetic susceptibility measurements, handling of air and moisture sensitive compounds

- Ferrous ammonium sulphate
- Ferric ammonium sulphate
- Nickel ammonium sulphate
- Bis(acetylacetonato) complexes of Cu, Co, Cr, Mn, and VO
- Prussian Blue, Turnbull's Blue
- $[Cr(NH_3)_6]Cl_3$
- $[Ni(NH_3)_6]Cl_2$
- $Ni(dmg)_2$
- $[Co(NO_2)\ (NH_3)_5]Cl_3$

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Organic Chemistry:

Qualitative Analysis:

Separation, purification and identification of compounds of binary mixture (two solids, one liquid & one solid, two liquids) using TLC, columns chromatography, and chemical tests

Organic Synthesis:

- Aromatic electrophilic substitutions:
  - Synthesis of m-dinitrobenzene from nitrobenzene
  - Synthesis of *p*-nitroacetanilide and *p*-bromoacetanilide.
- Sandmeyer reactuion: p-Chlorotoluene, p-chloronitrobenzene and from p-iodonitrobenzene.
- Cannizzaro reaction: 4-Chlorobenzaldehyde as substrate.
- Aldol condensation: Dibenzal acetone from benzaldehyde.
- Friedel Crafts reaction: β-Benzoyl propionic acid from succinic anhydride and benzene.
- Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
- Oxidation: Benzoic acid from toluene.
- Grignard reaction: Synthesis of triphenylmethanol from benzoic acid**.**
- Grignard reaction: Synthesis of cyclohexylmethanol from cyclohexyl chloride.
- Acetoacetic ester Condensation: Synthesis of ethyl-n-butylacetoacetate by A.E.E. condensation.
- Oxime formation: Synthesis of benzophenone oxime from benzophenone.

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Physical Chemistry:

Distribution Law:

- Distribution coefficient of benzoic acid between toluene and water.
- Distribution coefficient of cinnamic acid between toluene and water
  Distribution coefficient of iodine between CCl_4 and water
- Distribution coefficient of ammonia between chloroform and water.

Chemical Kinetics:

- Determination of the effect of (a) change of temperature (b) change of concentration of reactant and catalyst and (c) ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction.
- Determination of the velocity constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as iodine clock reactions.

Conductometry:

- Determination of the amount of HCl conductometrically by using strong base.
- Determination of the amount of NaOH conductometrically by using weak acid.
- Determination of the amount of NH_4OH conductometrically by using strong acid.
- Determination of the amount of CH_3COOH conductometrically by using weak base.
- Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
- To determine equivalent conductance at several concentration and infinite dilution of strong electrolytes and weak acid by using Kohlrausch Law and dissociation constant for weak acid conductometrically.

Adsorption:

- To study surface tension-concentration relationship for solutions (Gibbs equation).
- Determine the CMC of surface active material by surface tension method.
- Adsorption of acetic acid on charcoal.

Surface tension:

- Determination of surface tension of various liquids by stalagmometric method (drop number / drop weight)
- Determination of percent composition of mixture of liquids by surface tension method
- Determination of parachors of molecules and various groups.
- Determination of surface tension and parachor of liquids using double capillary method.

Viscosity:

- Determination of viscosity of various liquids using viscometer.
- Determination of unknown composition of given liquid mixture by viscosity method.
- Verification of Kendall's relation.
- Verification of Jon Dole's equation.

Polarimetry:

- Measurement specific rotation of sugar (*e.g.* glucose, fructose, sucrose, *etc.*)
- Determination of unknown concentration of sugar solution.
- Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
- Comparison of strengths of two acids by polarimetric study of kinetics of inversion of cane sugar.
- To determine the percentage of two optically active substances (d-sucrose and d-tartaric acid) in a given solution.
- To determine the electron polarization and electron polarizability of a liquid.

Note: *Any other relevant experiments may be added / performed.*

Books:

- *Vogel's Textbook of Quantitative Analysis, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham*
- *Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.*
- *Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health.*

- *Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.*
- *Handbook of Organic Analysis: Qualitative and Quantitative. H. Clark, Adward Arnold.*
- *Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.*
- *Experiments and Techniques in Organic Chemistry, D.P. Pasto, Johnson and Miller, Prentice Hall.*
- *Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.*
- *Findley's Practical Physical chemistry, B.P. Levitt, Longman.*
- *Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.*

..... x ..... x ..... x .....

Syllabus

M.Sc. Chemistry
Second Semester Examination

Paper-2.1: CHEM-521: Inorganic Chemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Reaction Mechanism of Transition Metal Complexes-I: 15-18 L

Energy profile of a reaction, reactivity of metal complex, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage.

Unit-II: Reaction Mechanism of Transition Metal Complexes-II: 15-18 L

Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction, redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

Unit-III: Electro. Spectra and Magnetic Prop. of Transition Metal Complexes: 15-18 L

Spectroscopic ground states, correlation (d^2 and d^3 in octahedral and tetrahedral symmetry), Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^5 states), calculations of Dα, B and β parameters using simplified T-S diagrams, charge transfer spectra, introduction about circular dichroism and optical rotatory dispersion, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Unit-IV: Metal π-Complexes: 15-18 L

Metal carbonyls of Fe, Co & Ni, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal

carbonyls; preparation, bonding structure and important reaction of transition metal nitrosyls, dinitrogen and dioxgen complexes; tertiary phosphine as ligand.

Unit-V: Metal Clusters: 15-18 L

Higher boranes: Wade's rule, styx numbers & structures, carboranes, metalloboranes, metallocarboranes, metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

Books:

- *Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.*
- *Inorganic Chemistry, J.E. Huhey, Harpes & Row.*
- *Chemistry of the Elements. N.N. Greenwood and A. Earnshow, Pergamon.*
- *Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.*
- *Magneto-chemistry, R.L. Carlin, Springer Verlag.*
- *Comprehensive Coordination Chemistry eds., Wilkinson, Gillars and Mc Cleverty, Pergamon.*

Paper-2.2: CHEM-522: Organic Chemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Free Radical Reactions: 15-18 L

Types of free radical reactions, free radical substitution mechanisms, neighbouring group assistance, reactivity for aliphatic and aromatic substrates at a bridgehead carbon, reactivity in the attacking radicals, effect of solvents on reactivity, allylic halogenation (NBS), oxidation of aldehydes to carboyxlic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction, Hunsdiecker reaction, free radical rearrangements.

Elimination Reactions:

E2, E1 and E1cB mechanisms and their spectrum, orientation of the double bond, reactivity effects of substrate structures, attacking base, leaving group and medium; mechanism and orientation in pyrolytic elimination.

Unit-II: Addition to Carbon-Carbon Multiple Bonds: 15-18 L

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio-and chemoselectivity, orientation and reactivity,

addition to cyclopropane ring, hydrogenation of double and triple bonds, hydrogenation of aromatic rings, hydroboration, hydroxylation, Michael reaction, Sharpless asymmetric epoxidation.

Addition to Carbon-Hetero Multiple bonds:
Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles; addition of Grignard reagents, organozinc and organolithium reagents to carbonyl group and unsaturated carbonyl compounds, Wittig reaction, mechanism of condensation reactions: Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin, Stobbe, Dieckmann reactions, Robinson annulations, Reformatsky reaction, hydrolysis of esters and amides, ammonolysis of esters.

Unit-III: Photochemistry-I: 15-18 L

Photochemical reactions, basic principles, types of excitations, energy dissipation, fate of excited molecule, energy transfer, quantum yield, actinometry; photochemistry of alkenes: inter- & intra-molecular reactions of the olefinic bond, addition reactions, cis-trans isomerisation, photo-oxidation reactions, cyclisation reactions, photochemistry of 1,3-, 1,4- and 1,5-dienes; photochemistry of aromatic compounds: excited states of benzene, isomerisations, dimerisation, additions and substitutions, photo-reduction, photo-Fries rearrangement; photochemistry of vision.

Unit-IV: Photochemistry-II: 15-18 L

Photochemistry of carbonyl compounds: photochemical reactions of cyclic and acyclic saturated carbonyl compounds; bond cleavage, photo-reduction, cyclo-addition reactions: dimerisations and oxetane formation; photochemical reactions of α,β-unsaturated carbonyl compounds: hydrogen abstraction reactions, photo-cycloadditions, photodimerization, rearrangements: cyclohexenones and cyclohexadienones; photochemical reactions of β,γ-unsaturated carbonyl compounds: cleavages, rearrangements.

Unit-V: Pericyclic Reactions: 15-18 L

Molecular orbitals and their symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system; molecular orbital symmetry: m-plane and C_2-axis, classification of pericyclic reactions, analysis of reactions: Woodward-Hoffmann correlation diagrams, FMO and PMO approach; electrocyclic reactions: conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems; cycloaddition reactions: antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic reactions; sigmatropic rearrangements: suprafacial and antarafacial shifts of H atom and carbon moieties, 3,3- and 5,5 sigmatropic rearrangements, Claisen, Cope and aza-Cope rearrangements; Ene reaction.

Books:

- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry, Clayden, Nick Geeves and Staurt Warren, Oxford University Press*
- *Advanced Organic Chemistry: Reactions, Mechanism and Structure, Jerry March, John Wiley.*
- *Advanced Organic Chemistry, Part A and Part B, F.A. Carey and R.J. Sundberg, Plenum.*
- *A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.*
- *Organic Chemistry, R. T. Morrison and R. N. Hall, Prentice-Hall.*
- *Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan.*
- *Textbook of Organic Chemistry by P S Kalsi, New Age International*
- *Organic Reactions, Stereochemistry and Mechanism (Through Solved Problems) by P S Kalsi*

- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, TataMcGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*
- *Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.*
- *Pericyclic Reactions, S.M. Mukherjee, McMillan, India*

Paper-2.3: CHEM-523: Physical Chemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: Classical Thermodynamics: 15-18 L

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies, partial molar free energy, partial molar volume and partial molar heat content and their significance, determinations of these quantities, concept of fugacity and determination of fugacity.

Non-ideal Systems:

Activity, activity coefficient, Debye-Hűckel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength.

Unit-II: Statistical Thermodynamics: 15-18 L

Concept of distribution, thermodynamic probability and most probable distribution, ensemble averaging, postulates of ensemble averaging, canonical, grand canonical and micro-canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers), partition functions-translation, rotational, vibrational and electronic partition functions, and calculation of thermodynamic properties in terms of partition, application of partition functions.

Heat Capacity Behaviour of Solids:

Chemical equilibria, equilibrium constant, Fermi-Dirac statistics, distribution law, applications to metals and helium, Bose-Einstein statistics.

Unit-III: Non-equilibrium Thermodynamics: 15-18 L

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (*e.g.* heat flow,

chemical reaction, *etc.*), transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, diffusion, electric conduction, irreversible thermodynamics for biological systems.

Unit-IV: Electrochemistry: 15-18 L

Debye-Huckel-Onsager treatment and its extension, ion-solvent interactions, Debye-Hückel-Jerum mode, thermodynamics of electrified interface equations, derivation of electro-capillarity, Lippmann equations (surface excess), methods of determination, structure of electrified interfaces, Guoy-Chapman, Stern, Bockris, Devanathan models, over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot.

Unit-V: Electrical Double Layer at Metal/Semiconductor-Electrolyte Interface: 15-18 L

Thermodynamics of double layer, determination of surface excess charge and other electrical parameters-electrocapillarity, excess charge capacitance, and relative surface excesses, metal/ water interaction-contact adsorption, its influence on capacity of interface, complete capacity-potential curve, constant capacity region hump, semiconductor/electrolyte interface, capacity of space- charge, Mott-Schottky plot.

Polarography:

Theory, Ilkovic equation, half wave potential and its significance, introduction to corrosion, homogenous theory, forms of corrosion monitoring and prevention methods.

Books:

- *Physical Chemistry, P.W. Atkins, ELBS.*
- *Introduction to Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill.*
- *Quantum Chemistry, Ira N. Levine, Prentice Hall.*
- *Coulson's Valence, R.Mc Weeny, ELBS.*
- *Chemical Kinetics. K.J. Laidler, McGraw-Hill.*
- *Kinetics and Mechanism of Chemical Transformation J.Rajaraman and J. Kuriacose, Mc Millan.*
- *Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.*
- *Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Planum.*
- *Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.*

Paper-2.4: CHEM-524: Computer Applications in Chemistry

Contact Hours / Week	: 4 Hours	Max. Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I: General Introduction: **15-18 L**

Elements of a computer system, block diagram of computer system and function of its components, concept of hardware and software, memory, introduction to operating systems (DOS, Windows).

PC Software:

Word processing: Creating and saving documents, formatting, inserting tables and pictures, mail merge, spread sheets, charts, graphs and use of functions, introduction to presentation packages, graphics and animation.

Unit-II: Report Generation and Presentation: **15-18 L**

MS Office: Introduction to Word, Excel and Power Point; MS Word: Documentation and manipulation, saving and printing, incorporation of graphs, tables pictures and chemical structures into the documents; MS Excel: Spread sheets, report generation, cell manipulation, data based management, graphical representation of tabulated data, Pi-chart, bar and line graphs, surface and 3D graphs; Power Point: Application of power point for the presentation of reports and slides.

Unit-III: Computing and Languages: **15-18 L**

Elements of programming languages, constants and variables, operations and symbol expressions, flow chart, functions and subroutines, graphics, statements, commands, commands for accessing hardware, elements of C language. Windows: Introduction and applications.

Unit-IV: Computer Applications in Chemistry: **15-18 L**

Introduction to CAD: A balance approach to computer aided process design, computer interface with instruments and laboratory information system: computers in fault & true analysis, computers in communication, internet: basic concepts, importance in chemical industries.

Unit-V: Computation in Chemistry: **15-18 L**

Computation in chemistry such as pressure from Van der Waals equation, pH of solution, kinetics, radioactive decay, lattice energy, determination of order of reaction, Pauling's relation, ionic radii, molecular weight of an organic compound, resonance energy, isoelectric point of amino acids, Lambert-Beer's law, bond lengths, bond angles, linear simultaneous equations to solve secular equations within the Hűckel theory.

Books:

- *The Big Basic Book of Window 98: Kraynak-PHI.*
- *Computational Chemistry: A.C. Norris.*
- *Programming in basic problems solving with the true and style: Stewant M. Venit Jaico.*
- *Mastering Windows Special edition: Robert Cowart - BPB Publications.*
- *Computer Fundamental Architecture Organisation: B. Ram - New Age international.*
- *Computers in Chemistry: K.V. Raman - TMH Pub.*
- *Fundamentals of Computer : V. Rajaraman (Prentice Hall)*
- *Computers in Chemistry : K.V. Raman (Tata Mc Graw Hill)*
- *Computer Programming in FORTRAN IV-V Rajaraman (Prentice Hall).*

Paper-2.5: CHEM-525: Practical

Contact Hours / Week : 18 Hours
Duration of Examination : 12 Hours **Maximum Marks :**100 Marks
Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Practical Record	05
8.	Laboratory Skills, Regularity, *etc*.	10
9.	Viva-voce	10
	Total Marks	**100**

Inorganic Chemistry:

Quantitative Analysis:

- Determination of overall and stepwise stability constant of metal chelates by polarographic, pH-metric and conductometric techniques.

Inorganic Preparation:

Preparation and purification of selected inorganic compounds and their studies by magnetic susceptibility measurements, handling of air and moisture sensitive compounds

- $[Ti(urea)_6]I_3$
- $[Co(Py)_2Cl_2]$
- *trans*-$K[Cr(ox)_2(H_2O)_2]$
- *cis*-$K[Cr(ox)_2(H_2O)_2]$
- *Cis*-$[Co(en)_2Cl_2]$
- *Trans*-$[Co(en)_2Cl_2]$
- $[Co(H_2O)(NH_3)_5]Cl_3$
- $[Co(ONO)(NH_3)_5]Cl_2$
- $K_3[Fe(C_2O_4)_3]$

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Organic Chemistry:

Quantitative Analysis:

- Estimation of Nitrogen by Kjeldahl's Method.
- Estimation of Sulphur / Halogen by Messinger / Fusion Method.
- Estimation of glucose by titration using Felhing's solution/Benedict solution.
- Estimation of carbonyl group by using 2,4-dinitrophenylhydrazine
- Determination of the percentage or number of hydroxyl / amine groups in an organic compound by acetylation method.
- Estimation of amines / phenols using bromate-bromide solution or acetylation method.

Organic Synthesis:

- Nitrobenzene → *m*-Nitrobenzene → *m*-Nitroaniline
- Chloroenzene → 2,4-Dintrochlorobenzene → 2,4-Dinitrophenol

- Aniline → 2,4,6-Tribromoaniline →1,3,5-Tribromobenzene
- Aniline → Diazoaminobenzene → *p*-Aminoazobenzene
- Phthalic anhydride → Phtahlimide → Anthanilic acid
- Phthalic anhydride → Flurescein → Eosin
- Phthalic anhydride → *o*-Benzoyl benzoic acid → Anthraquinone
- Aceotophenone → Oxime → Acetanilide
- Benzoic acid → *p*-Nitrobenzoic acid → p-Aminobenzoic acid

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Physical Chemistry:

Distribution Law:

- Determination of the equilibrium constant of the reaction $KI+I_2 \rightarrow [KI_3]$ and hence the concentration of given KI.
- Determination of equilibrium constant of copper-ammonia complex by partition method or coordination number of Cu^{2+} in copper-ammonia complex.

Transition Temperature:

- Determination of K_T of salt hydrate, molar mass of solute, mass of salt hydrate and composition of given sample

Thermochemistry:

- Determine the concentration of given strong acid / base solution by measuring heat change during dilution.
- Determine the lattice energy of $CaCl_2$ from its heat of solution using Born-Haber cycle.
- Thermometric titration of NaOH v/s standard HCl.
- Heat of displacement of copper by zinc.
- Determination of the heat of ionization of acetic acid.
- Determination of partial molar volume of solute (*e.g.* KCl) and solvent in a binary mixture.
- Determination of the temperature dependence of the solubility of a compound in two solvents having similar intra-molecular in interactions benzoic acid in water and in DMSO-water mixture and calculate the partial molar heat of solution.

Phase Equilibrium:

- To study the effect of impurities (KCl / NaCl / succinic acid) on the miscibility temperature of phenol-water system and hence the determine the concentration of given unknown solution
- Determination of congruent composition and temperature of a binary system (*e.g.* diphenylamine-benzophenone, naphthalene-biphenyl, naphthalene-benzophenone systems).
- To construct the phase diagram and determination of the composition of unknown mixture for two and three component system (*e.g.* diphenylamine-benzophenone, naphthalene-biphenyl, naphthalene-*m*-dinitrobenzene, chloroform-acetic acid-water, benzene-acetic acid-water systems).

Ionic Equilibrium:

- Determination of pKa of an indicator (*e.g.* methyl red) in (a) aqueous and (b) micellar media.
- Determination of stoichiometry and stability constant of Ferric isothiocyanation complex ion in solution.

- Determination of rate constant of alkaline bleaching of Malachite green and effect of ionic strength on the rate of reaction.
- Determine stability constant of Fe^{2+} complex ion keeping ionic strength constant

Conductometry:

- Study of relationship between ionic conductance and viscosity, measurement of conductivities of electrolytes in mixed solvents.
- Determination of concentration of sulphuric acid, acetic acid and copper sulphate from their mixture by conductometric titration with standard NaOH.
- Determination of hydrolysis constant and degree of hydrolysis of aniline hydrochloride conductometrically.
- Determination of transition temperature of given salt (*e.g.* $CaCl_2$) conductometrically.
- Determination of the critical micelle concentration of sodium lauryl sulphate from measurement of conductivities at different concentrations in aqueous solutions.

Potentiometry / *p*H metry:

- Determination of temperature dependence of EMF of a cell
- Determination of activity and activity constant of electrolytes.
- Determination of the valency of mercurous ions potentiometrically.
- Determination of the EMF of various $ZnSO_4$ solutions and hence the concentration of unknown $ZnSO_4$ solution.
- Determination of the pKa value of chloroacetic acid, trichloroacetic acid, orthophosphoric acid by potentiometry / pH metry using standard solution of NaOH.
- Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).
- Determine the solubility and solubility product of sparingly soluble salts potentiometrically
- Determination of standard electrode potential (Eo) value of Ag / AgI electrode and the solubility product of AgI and PbI2.
  Analysis of mixture of carbonate and bicarbonate (percent in ppm range) using a pH meter or suitable indicators.

Spectrophotometry & Colorimetry:

- To verify Lambert-Beer law for $KMnO_4$ solution & to determine the concentration of given $KMnO_4$ solution
- Determination of composition of complex by Job's method.
- Study of zirconium-alizarin Red-S complex: Mole-ratio method.
- Determine the pH of solution employing methyl red indicator spectrophotometrically.
- Determination of pKa of an indicator (e.g. methyl red) in (a) aqueous and (b) micellar media.

Polarography:

- To determine half wave potential of a given ion using half height method, differential method and wave equation method
- Identification and estimation of metal ions such as Cu^{2+}, Cd^{2+}, Pb^{2+}, Zn^{2+}, and Ni^{2+} *etc.* polarographically.

- To study the current-potential characteristics of Cd^{2+} ions using DC polarography, sampled DC, cyclic voltammetry and pulse polarographic techniques.
- Study of a metal ligand complex polarographically (using Lingane's Method).
- Determination of (a) Fe and Mo in steel (b) urea and glucose in biological fluids (c) heavy metals in wine samples and petroleum products polarographically.

Refractometry:

- Analysis of sugars by refractometer and polarimeter
- Determination of molar refraction of pure liquids
- Determination of concentration of KCl solution/glycerol solution
- Determination of concentration of KI solution
- Determination of molar refraction of solid KCl
- Determination of solubility of KCl in water
- Study the stoichiometry of potassium iodide-mercuric iodide complex.
- Determination of sugar and its concentration refractometrically.
- To study of quality of fruits, food and food products.
- To study of temperature effect on Brix measurement.
- To study of food and beverages:
    - Determination of soluble solids in fruit products
    - Determination of rancidity in edible oils
    - Determination of moisture in honey and strawberry jam
    - Determination of total solids, water and fat in milk
    - Determination of oil in avocado and olives
    - Determination of fat in chocolate
    - Determination of moisture in meat
- To study of petroleum:
    - Determination of petroleum content in oil sands
    - Determination of olefins, aromatics, parafins
    - Determination of ethylene glycol in coolants
    - To study in agriculture field:
    - Determination of oil content of seeds
    - Determination of sweet corn maturity
    - Determination of salinity

Note: *Any other relevant experiments may be added / performed.*

Books:

- *Vogel's Textbook of Quantitative Analysis, Bassett, R.C. Denney, G.H. Jeffery and J.Mendham, ELBS.*
- *Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.*
- *Experiments and Techniques in Organic Chemistry, Pasto, C. Johnson and M. Miller, Prentice Hall.*
- *Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.*
- *Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.*
- *Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.*
- *Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.*

..... x ..... x ..... x .....

Sample Question Paper

Paper-1.2: CHEM-512: Organic Chemistry

Duration of Exam: 3 Hours **Maximum Marks: 70**

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

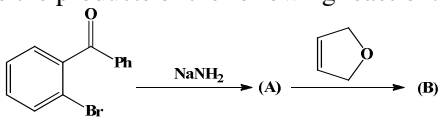
- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.*

SECTION-A

Q. 1.

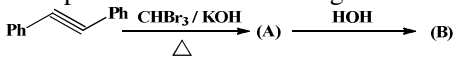
Unit-I

(i) Write the products of the following reaction:



½ + ½ = 1

(ii) Write the products of the following reaction:



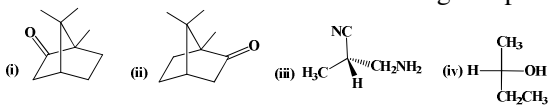
½ + ½ = 1

Unit-II

(iii) Write Fischer projection of D-glucose followed by Howarth formula.

½ + ½ = 1

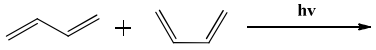
(iv) Write R or S nomenclature for the following compounds:



¼ +¼+¼+¼ = 1

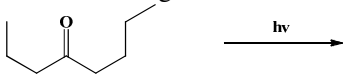
Unit-III

(v) Complete the following reaction:



1

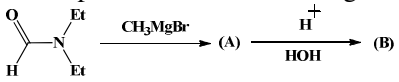
(vi) Complete the following reaction:



1

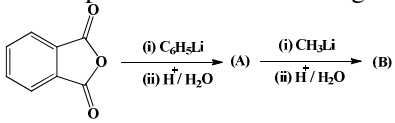
Unit-IV

(vii) Write the products of the following reaction:



½ + ½ = 1

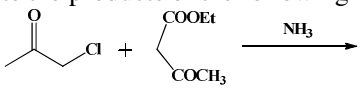
(viii) Write the products of the following reaction:



½ + ½ = 1

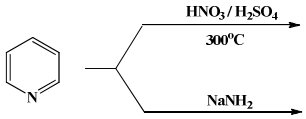
Unit-V

(ix) Write the products of the following reaction:



1

(x) Write the products of the following reaction:



½ + ½ = 1

SECTION-B
Unit-I

Q. 2. Write note on the following (any two):

(i) Resonance
(ii) Tautomerism
(iii) Conjugation
(iv) Aromaticity

2½ + 2½ = 5

OR

Give an account on formation, stability and chemical reactions of the following:

(i) Carbocations
(ii) Carbenes

2½ + 2½ = 5

Unit-II

Q. 3. Draw the conformational structures of n-butane and mono- & di-substituted cyclohexane.

2 + 3 = 5

OR

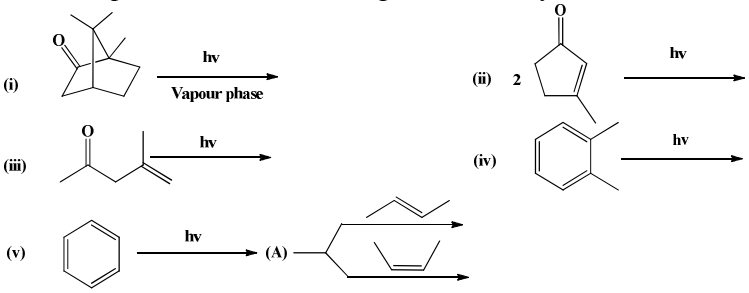
Write note on the following (any two):

(i) Symmetry elements
(ii) Chirality
(iii) Threo & Erythro isomers
(iv) Enantiomers & Diastereomers

2½ + 2½ = 5

Unit-III

Q. 4. Write the products of the following reactions (any four):



1¼+1¼+1¼+1¼ = 5

OR

Discuss in detail:

(i) Paterno-Büchi reaction
(ii) Photochemistry of 1,5-dienes

2½ + 2½ = 5

Unit-IV

Q. 5. Write note on the following:

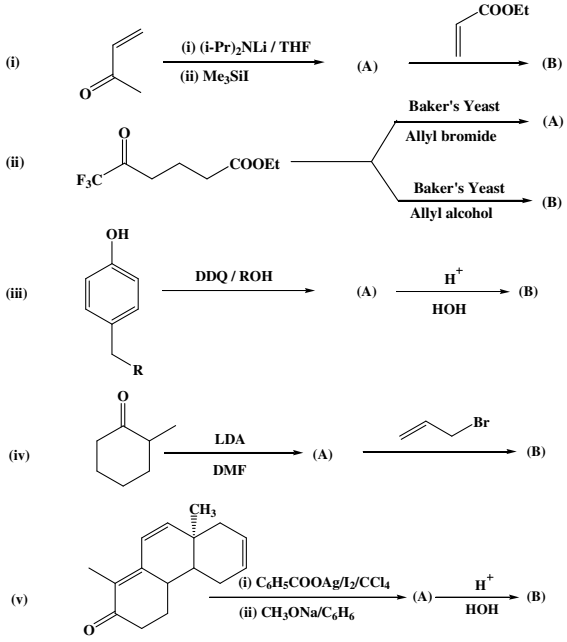
(i) Metal hydrides in organic synthesis

(ii) Phase transfer catalysts

2½ + 2½ = 5

OR

Write the products of the following reactions (any four):



1¼+1¼+1¼+1¼ = 5

Unit-V

Q. 6. Give the plausible mechanisms of the following name reactions:

(i) Fischer-indole synthesis

(ii) Doebner-Miller synthesis

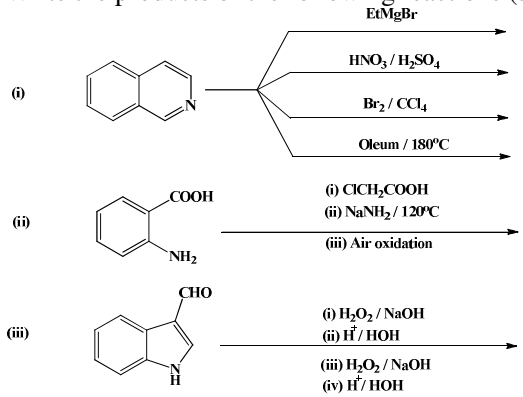
(iii) Bischler-Napieralski synthesis

(iv) Skraup synthesis

1¼+1¼+1¼+1¼ = 5

OR

Write the products of the following reactions (any two):



2½ + 2½ = 5

SECTION-C

Unit-I

Q. 7. Classify the types of organic reactions. How will you identify the mechanism of a particular type of organic reaction? Explain in detail.

2+13 = 15

Unit-II

Q.8. Describe the nomenclature of organic molecules according to R / S & E / Z systems.

5+5 = 10

Unit-III

Q. 9. Give an account on the following:

(i) Photochemistry of β,γ-unsaturated carbonyl compounds.
(ii) Photo-Fries rearrangement
(iii) Barton reaction

5+3+2 = 10

Unit-IV

Q. 10. Discuss the synthesis and chemical reactions of the following:

(i) Pyrimidines
(ii) Pyrones

5+5 = 10

Unit-V

Q. 11. Discuss in detail the use of following reagents in organic synthesis (any two):

(i) Grignard's Reagent
(ii) Wilkinson's Catalyst
(iii) Metal Hydrides

5+5 = 10

..... x ..... x ..... x .....