SCHEME OF EXAMINATION

RULES & REGULATIONS

AND

SYLLABUS

(for Academic Session 2026-2027)

B.Sc. Chemistry

Third Semester Examination, December 2026
Fourth Semester Examination, June 2027

as per

National Education Policy (NEP)-2020 &
Choice Based Credit System (CBCS)

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

INDEX

S. No.	Particulars	Page No.
1.	Scheme of Examination	
	B.Sc. (Pass Course) Biology Group *with Botany, Chemistry, Zoology (BCZ)*	3
	B.Sc. (Pass Course) Mathematics Group *with Physics, Chemistry, Mathematics (PCM)*	5
	B.Sc. (Pass Course) Chemistry: *Consolidated Scheme of Chemistry Paper Only*	7
	B.Sc. (Pass Course) Chemistry: Semester wise Summary of Theory and Practical Contents	8
2.	Course Learning Objectives	9
3.	Course Learning Outcomes	9
4.	Course Duration	9
6.	Eligibility for Admission	9
7.	Minimum Marks required in the Qualifying Examination	9
8.	Attendance	10
9.	Course Number, Course Code or ID and Nomenclature	10
10.	Maximum Marks and Credit Points	10
11.	Course Structure	10
12.	Teaching Methodologies	11
13.	Assessment Pattern	11
	• Continuous / Mid-Term / Internal Assessment	11
	• Semester / End-Term / External Assessment	12
14.	Question Paper Pattern	13
	• Continuous / Mid-Term / Internal Assessment	13
	▪ For Collegiate (Regular) Students	13
	o Continuous / Mid-Term / Internal Assessment-I	13
	o Continuous / Mid-Term / Internal Assessment-II	13
	▪ For Non-collegiate (Private) Students	14
	o Continuous / Mid-Term / Internal Assessment-I	14
	o Continuous / Mid-Term / Internal Assessment-II	14
	• Semester / End-Term / External Assessment	15
15.	Practical Examinations	16
	• Duration of Examination	16
	• Distribution of Maximum Marks	16
16.	Minimum Pass Marks and Rules regarding Determination of Results	16
17.	Classification of Successful Candidates	17
18.	Syllabus	20
	• B.Sc. Third Semester (Pass Course) Chemistry	20
	• B.Sc. Fourth Semester (Pass Course) Chemistry	26

Bachelor of Science (B.Sc.): Biology Group

Subject Combination: Botany, Chemistry, Zoology (BCZ)

Semester Scheme of Examination

Year / Semester	Number, Code and Nomenclature of Paper				Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number of Paper	Code of Paper	Code for Examination	Nomenclature of Paper		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
1st Year I Semester	1.1	GHIN-101-T	15001	General Hindi	1.5 Hrs	2	--	2	--	50	50	--	20
	1.2	CHE-132-T	15503	Chemistry-I	3 Hrs	4	--	4	30	70	100	12	28
	1.3	CHE-132-P	15504	Chemistry Practical-I	6 Hrs	--	4	2	--	50	50	--	25
	1.4	BOT-133-T	15505	Botany-I	3 Hrs	4	--	4	30	70	100	12	28
	1.5	BOT-133-P	15506	Botany Practical-I	6 Hrs	--	4	2	--	50	50	--	25
	1.6	ZOO-134-T	15507	Zoology-I	3 Hrs	4	--	4	30	70	100	12	28
	1.7	ZOO-134-P	15508	Zoology Practical-I	6 Hrs	--	4	2	--	50	50	--	25
				Total (I Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
1st Year II Semester	2.1	GENG-102-T	15002	General English	1.5 Hrs	2	--	2	--	50	50	--	20
	2.2	CHE-232-T	15523	Chemistry-II	3 Hrs	4	--	4	30	70	100	12	28
	2.3	CHE-232-P	15524	Chemistry Practical-II	6 Hrs	--	4	2	--	50	50	--	25
	2.4	BOT-233-T	15525	Botany-II	3 Hrs	4	--	4	30	70	100	12	28
	2.5	BOT-233-P	15526	Botany Practical-II	6 Hrs	--	4	2	--	50	50	--	25
	2.6	ZOO-234-T	15527	Zoology-II	3 Hrs	4	--	4	30	70	100	12	28
	2.7	ZOO-234-P	15538	Zoology Practical-II	6 Hrs	--	4	2	--	50	50	--	25
				Total (II Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
				Total (I and II Semesters)	**57.0 Hrs**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**
2nd Year III Semester	3.1	GEC------	-----	Environmental Studies	1.5 Hrs	2	--	2	--	50	50	--	20
	3.2	CHE----T	-----	Chemistry-III	3 Hrs	4	--	4	30	70	100	12	28
	3.3	CHE----P	-----	Chemistry Practical-III	6 Hrs	--	4	2	--	50	50	--	25
	3.4	BOT----T	-----	Botany-III	3 Hrs	4	--	4	30	70	100	12	28
	3.5	BOT----P	-----	Botany Practical-III	6 Hrs	--	4	2	--	50	50	--	25
	3.6	ZOO----T	-----	Zoology-III	3 Hrs	4	--	4	30	70	100	12	28
	3.7	ZOO----P	-----	Zoology Practical-III	6 Hrs	--	4	2	--	50	50	--	25
				Total (III Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
2nd Year IV Semester	4.1	GEC------	-----	Elementary Computer Applications	1.5 Hrs	2	--	2	--	50	50	--	20
	4.2	CHE----T	-----	Chemistry-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.3	CHE----P	-----	Chemistry Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
	4.4	BOT----T	-----	Botany-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.5	BOT----P	-----	Botany Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
	4.6	ZOO----T	-----	Zoology-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.7	ZOO----P	-----	Zoology Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
				Total (IV Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
				Total (III and IV Semesters)	**57.0 Hrs**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Year / Semester	Number, Code and Nomenclature of Paper				Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number of Paper	Code of Paper	Exam. Code	Nomenclature of Paper		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total	Internal Assess.	Sem. Assess.
3rd Year V Semester	5.1(a)	BOT-------	-----	Botany-V(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	5.1(b)	BOT-------	-----	Botany-V(b): Elective									
	5.1(c)	BOT-------	-----	Botany-V(c): Elective									
	5.2(a)	BOT-------	-----	Botany Practical-V(a)	6 Hrs	--	4	2	--	50	50	--	25
	5.2(b)	BOT-------	-----	Botany Practical-V(b)									
	5.2(c)	BOT-------	-----	Botany Practical-V(c)									
	5.3(a)	CHE ---- T(a)	-----	Chemistry-V(a): Inorganic Chemistry	3 Hrs	4	--	4	30	70	100	12	28
	5.3(b)	CHE ---- T(b)	-----	Chemistry-V(b): Organic Chemistry									
	5.3(c)	CHE ---- T(c)	-----	Chemistry-V(c): Physical Chemistry									
	5.4(a)	CHE ---- P(a)	-----	Chemistry Practical-V(a): Inorganic Chemistry Practical	6 Hrs	--	4	2	--	50	50	--	25
	5.4(b)	CHE ---- P(b)	-----	Chemistry Practical-V(b): Organic Chemistry Practical									
	5.4(c)	CHE ---- P(c)	-----	Chemistry Practical-V(c): Physical Chemistry Practical									
	5.5(a)	ZOO------	-----	Zoology-V(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	5.5(b)	ZOO------	-----	Zoology-V(b): Elective									
	5.5(c)	ZOO------	-----	Zoology-V(c): Elective									
	5.6(a)	ZOO------	-----	Zoology Practical-V(a)	6 Hrs	--	4	2	--	50	50	--	25
	5.6(b)	ZOO------	-----	Zoology Practical-V(b)									
	5.6(c)	ZOO------	-----	Zoology Practical-V(c)									
	5.7	VAC------	-----	Value Added Course	1.5 Hrs	2	--	2	--	50	50	--	20
	Total (V Semester)				**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
3rd Year VI Semester	6.1(a)	BOT-------	-----	Botany-VI(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	6.1(b)	BOT-------	-----	Botany-VI(b): Elective									
	6.1(c)	BOT-------	-----	Botany-VI(c): Elective									
	6.2(a)	BOT-------	-----	Botany Practical-VI(a)	6 Hrs	--	4	2	--	50	50	--	25
	6.2(b)	BOT-------	-----	Botany Practical-VI(b)									
	6.2(c)	BOT-------	-----	Botany Practical-VI(c)									
	6.3(a)	CHE ---- T(a)	-----	Chemistry-VI(a): Inorganic Chemistry	3 Hrs	4	--	4	30	70	100	12	28
	6.3(b)	CHE ---- T(b)	-----	Chemistry-VI(b): Organic Chemistry									
	6.3(c)	CHE ---- T(c)	-----	Chemistry-VI(c): Physical Chemistry									
	6.4(a)	CHE ---- P(a)	-----	Chemistry Practical-VI(a): Inorganic Chemistry Practical	6 Hrs	--	4	2	--	50	50	--	25
	6.4(b)	CHE ---- P(b)	-----	Chemistry Practical-VI(b): Organic Chemistry Practical									
	6.4(c)	CHE ---- P(c)	-----	Chemistry Practical-VI(c): Physical Chemistry Practical									
	6.5(a)	ZOO------	-----	Zoology-VI(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	6.5(b)	ZOO------	-----	Zoology-VI(b): Elective									
	6.5(c)	ZOO------	-----	Zoology-VI(c): Elective									
	6.6(a)	ZOO------	-----	Zoology Practical-VI(a)	6 Hrs	--	4	2	--	50	50	--	25
	6.6(b)	ZOO------	-----	Zoology Practical-VI(b)									
	6.6(c)	ZOO------	-----	Zoology Practical-VI(c)									
	6.7	SEC------	-----	Skill Enhancement Course	1.5 Hrs	2	--	2	--	50	50	--	20
	Total (VI Semester)				**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
Total (V and VI Semesters)					**57.0 Hrs**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Grand Total of Three-Year B.Sc. Degree Programme (I to VI Semesters)	**171.0 Hrs**	**84**	**72**	**120**	**540**	**2460**	**3000**	**216**	**1074**

Bachelor of Science (B.Sc.): Mathematics Group

Subject Combination: Physics, Chemistry, Mathematics (PCM)

Semester Scheme of Examination

Year / Semester	Number, Code and Nomenclature of Paper				Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number of Paper	Code of Paper	Code for Examination	Nomenclature of Paper		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
1st Year I Semester	1.1	GHIN-101-T	15001	General Hindi	1.5 Hrs	2	--	2	--	50	50	--	20
	1.2	PHY-131-T	15501	Physics-I	3 Hrs	4	--	4	30	70	100	12	28
	1.3	PHY-131-P	15502	Physics Practical-I	6 Hrs	--	4	2	--	50	50	--	25
	1.4	CHE-132-T	15503	Chemistry-I	3 Hrs	4	--	4	30	70	100	12	28
	1.5	CHE-132-P	15504	Chemistry Practical-I	6 Hrs	--	4	2	--	50	50	--	25
	1.6	MAT-137-T	15511	Mathematics-I	3 Hrs	4	--	4	30	70	100	12	28
	1.7	MAT-137-P	15512	Mathematics Practical-I	6 Hrs	--	4	2	--	50	50	--	25
				Total (I Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
1st Year II Semester	2.1	GENG-102-T	15002	General English	1.5 Hrs	2	--	2	--	50	50	--	20
	2.2	PHY-231-T	15521	Physics-II	3 Hrs	4	--	4	30	70	100	12	28
	2.3	PHY-231-P	15522	Physics Practical-II	6 Hrs	--	4	2	--	50	50	--	25
	2.4	CHE-232-T	15523	Chemistry-II	3 Hrs	4	--	4	30	70	100	12	28
	2.5	CHE-232-P	15524	Chemistry Practical-II	6 Hrs	--	4	2	--	50	50	--	25
	2.6	MAT-237-T	15531	Mathematics-II	3 Hrs	4	--	4	30	70	100	12	28
	2.7	MAT-237-P	15532	Mathematics Practical-II	6 Hrs	--	4	2	--	50	50	--	25
				Total (II Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
				Total (I and II Semesters)	**57.0 Hrs**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**
2nd Year III Semester	3.1	PHY-------	-----	Physics-III	3 Hrs	4	--	4	30	70	100	12	28
	3.2	PHY-------	-----	Physics Practical-III	6 Hrs	--	4	2	--	50	50	--	25
	3.3	CHE ---- T	-----	Chemistry-III	3 Hrs	4	--	4	30	70	100	12	28
	3.4	CHE ---- P	-----	Chemistry Practical-III	6 Hrs	--	4	2	--	50	50	--	25
	3.5	MAT------	-----	Mathematics-III	3 Hrs	4	--	4	30	70	100	12	28
	3.6	MAT------	-----	Mathematics Practical-III	6 Hrs	--	4	2	--	50	50	--	25
	3.7	GEC------	-----	Environmental Studies	1.5 Hrs	2	--	2	--	50	50	--	20
				Total (III Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
2nd Year IV Semester	4.1	PHY-------	-----	Physics-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.2	PHY-------	-----	Physics Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
	4.3	CHE ---- T	-----	Chemistry-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.4	CHE ---- P	-----	Chemistry Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
	4.5	MAT------	-----	Mathematics-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.6	MAT------	-----	Mathematics Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
	4.7	GEC------	-----	Elementary Computer Applications	1.5 Hrs	2	--	2	--	50	50	--	20
				Total (IV Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
				Total (III and IV Semesters)	**57.0 Hrs**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Year / Semester	Number, Code and Nomenclature of Paper				Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number of Paper	Code of Paper	Exam. Code	Nomenclature of Paper		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total	Internal Assess.	Sem. Assess.
3rd Year V Semester	5.1(a)	PHY-------	-----	Physics-V(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	5.1(b)	PHY-------	-----	Physics-V(b): Elective									
	5.1(c)	PHY-------	-----	Physics-V(c): Elective									
	5.2(a)	PHY-------	-----	Physics Practical-V(a): Elective	6 Hrs	--	4	2	--	50	50	--	25
	5.2(b)	PHY-------	-----	Physics Practical-V(b): Elective									
	5.2(c)	PHY-------	-----	Physics Practical-V(c): Elective									
	5.3(a)	CHE ---- T(a)	-----	Chemistry-V(a): Inorganic Chemistry	3 Hrs	4	--	4	30	70	100	12	28
	5.3(b)	CHE ---- T(b)	-----	Chemistry-V(b): Organic Chemistry									
	5.3(c)	CHE ---- T(c)	-----	Chemistry-V(c): Physical Chemistry									
	5.4(a)	CHE ---- P(a)	-----	Chemistry Practical-V(a): Inorganic Chemistry Practical	6 Hrs	--	4	2	--	50	50	--	25
	5.4(b)	CHE ---- P(b)	-----	Chemistry Practical-V(b): Organic Chemistry Practical									
	5.4(c)	CHE ---- P(c)	-----	Chemistry Practical-V(c): Physical Chemistry Practical									
	5.5(a)	MAT------	-----	Mathematics-V(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	5.5(b)	MAT------	-----	Mathematics-V(b): Elective									
	5.5(c)	MAT------	-----	Mathematics-V(c): Elective									
	5.6(a)	MAT------	-----	Mathematics Practical-V(a):	6 Hrs	--	4	2	--	50	50	--	25
	5.6(b)	MAT------	-----	Mathematics Practical-V(b):									
	5.6(c)	MAT------	-----	Mathematics Practical-V(c):									
	5.7	VAC------	-----	Value Added Course	1.5 Hrs	2	--	2	--	50	50	--	20
				Total (V Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
3rd Year VI Semester	6.1(a)	PHY-------	-----	Physics-VI(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	6.1(b)	PHY-------	-----	Physics-VI(b): Elective									
	6.1(c)	PHY-------	-----	Physics-VI(c): Elective									
	6.2(a)	PHY-------	-----	Physics Practical-VI(a): Elective	6 Hrs	--	4	2	--	50	50	--	25
	6.2(b)	PHY-------	-----	Physics Practical-VI(b): Elective									
	6.2(c)	PHY-------	-----	Physics Practical-VI(c): Elective									
	6.3(a)	CHE ---- T(a)	-----	Chemistry-VI(a): Inorganic Chemistry	3 Hrs	4	--	4	30	70	100	12	28
	6.3(b)	CHE ---- T(b)	-----	Chemistry-VI(b): Organic Chemistry									
	6.3(c)	CHE ---- T(c)	-----	Chemistry-VI(c): Physical Chemistry									
	6.4(a)	CHE ---- P(a)	-----	Chemistry Practical-VI(a): Inorganic Chemistry Practical	6 Hrs	--	4	2	--	50	50	--	25
	6.4(b)	CHE ---- P(b)	-----	Chemistry Practical-VI(b): Organic Chemistry Practical									
	6.4(c)	CHE ---- P(c)	-----	Chemistry Practical-VI(c): Physical Chemistry Practical									
	6.5(a)	MAT------	-----	Mathematics-VI(a): Elective	3 Hrs	4	--	4	30	70	100	12	28
	6.5(b)	MAT------	-----	Mathematics-VI(b): Elective									
	6.5(c)	MAT------	-----	Mathematics-VI(c): Elective									
	6.6(a)	MAT------	-----	Mathematics Practical-VI(a): Elective	6 Hrs	--	4	2	--	50	50	--	25
	6.6(b)	MAT------	-----	Mathematics Practical-VI(b): Elective									
	6.6(c)	MAT------	-----	Mathematics Practical-VI(c): Elective									
	6.7	SEC------	-----	Skill Enhancement Course	1.5 Hrs	2	--	2	--	50	50	--	20
				Total (VI Semester)	**28.5 Hrs**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
				Total (V and VI Semesters)	**57.0 Hrs**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**
				Grand Total of Three-Year B.Sc. Degree Programme (I to VI Semesters)	**171.0 Hrs**	**84**	**72**	**120**	**540**	**2460**	**3000**	**216**	**1074**

University of Kota, Kota

Bachelor of Science (B.Sc.): Mathematics (PCM) and Biology (BCZ) Groups

B.Sc. Chemistry

Semester Scheme of Examination

Year / Semester	Number, Code and Nomenclature of Paper				Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number of Paper	Code of Paper	Exam Code	Nomenclature of Paper		Lecture (L)	Practical (P)	Credits (C)	Internal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
1st Year I Semester	1.3	CHE-132-T	15503	Chemistry-I	3 Hrs	4	--	4	30	70	100	12	28
	1.4	CHE-132-P	15504	Chemistry Practical-I	6 Hrs	--	4	2	--	50	50	--	25
1st Year II Semester	2.3	CHE-232-T	15523	Chemistry-II	3 Hrs	4	--	4	30	70	100	12	28
	2.4	CHE-232-P	15524	Chemistry Practical-II	6 Hrs	--	4	2	--	50	50	--	25
2nd Year III Semester	3.3	CHE ----T	-----	Chemistry-III	3 Hrs	4	--	4	30	70	100	12	28
	3.4	CHE ---- P	-----	Chemistry Practical-III	6 Hrs	--	4	2	--	50	50	--	25
2nd Year IV Semester	4.3	CHE ---- T	-----	Chemistry-IV	3 Hrs	4	--	4	30	70	100	12	28
	4.4	CHE ---- P	-----	Chemistry Practical-IV	6 Hrs	--	4	2	--	50	50	--	25
3rd Year V Semester	5.3(a)	CHE ---- T(a)	-----	Chemistry-V(a): Inorganic Chemistry	3 Hrs	4	--	4	30	70	100	12	28
	5.3(b)	CHE ---- T(b)	-----	Chemistry-V(b): Organic Chemistry									
	5.3(c)	CHE ---- T(c)	-----	Chemistry-V(c): Physical Chemistry									
	5.4(a)	CHE ---- P(a)	-----	Chemistry Practical-V(a): Inorganic Chemistry Practical	6 Hrs	--	4	2	--	50	50	--	25
	5.4(b)	CHE ---- P(b)	-----	Chemistry Practical-V(b): Organic Chemistry Practical									
	5.4(c)	CHE ---- P(c)	-----	Chemistry Practical-V(c): Physical Chemistry Practical									
3rd Year VI Semester	6.3(a)	CHE ---- T(a)	-----	Chemistry-VI(a): Inorganic Chemistry	3 Hrs	4	--	4	30	70	100	12	28
	6.3(b)	CHE ---- T(b)	-----	Chemistry-VI(b): Organic Chemistry									
	6.3(c)	CHE ---- T(c)	-----	Chemistry-VI(c): Physical Chemistry									
	6.4(a)	CHE ---- P(a)	-----	Chemistry Practical-VI(a): Inorganic Chemistry Practical	6 Hrs	--	4	2	--	50	50	--	25
	6.4(b)	CHE ---- P(b)	-----	Chemistry Practical-VI(b): Organic Chemistry Practical									
	6.4(c)	CHE ---- P(c)	-----	Chemistry Practical-VI(c): Physical Chemistry Practical									

B.Sc. Chemistry (Biology and Mathematics Groups): Semester Wise Summary of Theory and Practical Contents

Sem	Course Type	Unit	Contents Inorganic Chemistry + Organic Chemistry + Physical Chemistry
I	Discipline Centric Core (DCC) Course	I	Atomic Structure, Electronic Configuration
		II	Periodic Table, Periodic Properties
		III	Basics of Organic Chemistry
		IV	Stereochemistry
		V	Gaseous State
		Practical	Laboratory Safety and Working. Inorganic Chemistry: Semimicro Analysis Organic Chemistry: MPs and BPs, Purifications, Stereochemistry, Qualitative Analysis Physical Chemistry: Calibration and use of apparatus, Solution Preparation, Surface Tension, Viscosity
II	Discipline Centric Core (DCC) Course	I	Ionic Bonding, Metallic Bonding, Weak Interaction Forces
		II	Covalent Bonding
		III	Alkanes, Cycloalkanes
		IV	Liquid State, Solid State
		V	Chemical Kinetics, Catalysis
		Practical	Inorganic Chemistry: Semimicro Analysis Organic Chemistry: Qualitative Analysis, Paper Chromatography Physical Chemistry: Chemical Kinetics, Volumetric Analysis
III	Discipline Centric Core (DCC) Course	I	Chemistry of *s*-Block Elements
		II	Alkenes, Dienes, Alkynes
		III	Arenes and Aromaticity, Alkyl and Aryl Halides
		IV	Chemical Thermodynamics
		V	Solutions, Colligative Properties
		Practical	Inorganic Chemistry: Quantitative Analysis, Chromatography Organic Chemistry: Qualitative Analysis, Thin Layer Chromatography Physical Chemistry: Thermochemistry, Transition Temperature
IV	Discipline Centric Core (DCC) Course	I	Chemistry of *p*-Block Elements
		II	Coordination Compounds
		III	Nitroalkanes and Nitroarenes, Alkyl and Aryl Amines
		IV	Alcohols and Phenols, Ethers and Epoxides
		V	Chemical Equilibrium, Ionic Equilibrium
		Practical	Inorganic Chemistry: Gravimetric Analysis, Inorganic Preparations Organic Chemistry: Organic Synthesis, Column Chromatography Physical Chemistry: Ionic Equilibrium, Molecular Weight Determination

Sem	Course Type	Unit	Elective: V(a): Inorganic Chemistry	Elective: V(b): Organic Chemistry	Elective: V(c): Physical Chemistry
V	Discipline Specific Elective (DSE) Course	I	Chemistry of *d*-Block Elements, Part-I: • Chemistry of I, II and III Transition Series	Carbonyl Compounds	Phase Equilibrium
		II	Chemistry of *d*-Block Elements, Part-II: • Metal-Ligand Bonding in Transition Metal Complexes • Thermodynamic & Kinetic Aspects of Metal Complexes	Carboxylic Acids & their Derivatives, Organic Synthesis via Enolates	Electrochemistry-I
		III	Chemistry of *d*-Block Elements, Part-III: • Magnetic & Electronic Properties of Transition Metal Complexes	Synthetic Polymers, Synthetic Dyes, Fats and Lipids	Electrochemistry-II
		IV	Chemistry of *f*-Block Elements • Chemistry of Lanthanides, Chemistry of Actinides	Amino Acids, Peptides, Proteins	Surface Chemistry, Micelles
		V	Chemistry of Noble Gases, Inorganic Polymers	Enzymes	Photochemistry
		Practical	Complexometric Titrations, Iodo/Iodimetric Titrations, Acid-Base Titrations, Redox Titrations	Oils and Fats, Amino acids and Proteins, Organic Synthesis	Distribution Law, Phase Equilibrium, Conductometry, Electrochemistry
Sem	**Course Type**	**Unit**	**Elective: VI(a): Inorganic Chemistry**	**Elective: VI(b): Organic Chemistry**	**Elective: VI(c): Physical Chemistry**
VI	Discipline Specific Elective (DSE) Course	I	Acids and Bases, Hard and Soft Acids and Bases, Non-aqueous Solvents, Oxidation-Reduction	Heterocyclic Compounds	Quantum Chemistry-I
		II	Organometallic Compounds-I	Carbohydrates, Nucleic Acids	Quantum Chemistry-II
		III	Organometallic Compounds-II	Ultraviolet Spectroscopy, Infrared Spectroscopy	Principles of Spectroscopy, Rotational Spectroscopy
		IV	Nuclear Chemistry	NMR Spectroscopy	Vibrational Spectroscopy, Raman Spectroscopy
		V	Bioinorganic Chemistry	Mass Spectrometry, Structure Elucidation	Electronic Spectroscopy, Atomic Spectroscopy
		Practical	Instrumentation, Colorimetry, Spectrophotometry, Flame Photometry	Estimation, Carbohydrates, Enzymes, Spectroscopy	Potentiometry, Refractometry & Polarimetry, Adsorption, UV-VIS.

Note: If a student opts any one paper out of Inorganic Chemistry, Organic Chemistry and Physical Chemistry in the V semester then it is mandatory that student will opt the same paper only in the VI semester, it means, if a student opts Inorganic Chemistry in the V semester, then he/she will opt Inorganic Chemistry only in the VI semester or if a student opt Organic Chemistry in the V semester, then he/she will opt Organic Chemistry only in the VI semester or if a student opt Physical Chemistry in the V semester, then he/she will opt Physical Chemistry only in the VI semester.

Rules & Regulations

Course Learning Objectives:

Bachelor of Science (B.Sc.) course with chemistry as a subject is a pioneer model of the University. Objectives of the course is to provide thorough theoretical and experimental knowledge of all the branches of the chemistry including inorganic chemistry, organic chemistry, physical chemistry, environmental chemistry, *etc.* along with communication and presentation skills of the students.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to understand basic facts and concepts of chemistry including atomic structure, electronic configuration, chemistry of elements, stereochemistry, organic compounds, matter states, chemical kinetics, catalysis, thermodynamics, solutions, colligative properties, equilibrium, semimicro analysis, qualitative analysis, qualitative analysis, gravimetric analysis, purifications, chromatography, inorganic and organic synthesis, solution preparation, surface tension, viscosity, thermochemistry, *etc*. The students shall be eligible to take admission for higher studies in different branches of the chemical sciences and able to do research in the different areas of chemical sciences or allied fields and shall be placed in different organizations / institutions where skilled chemical science professionals are required.

Course Duration:

The course Bachelor of Science (B.Sc.) Pass Course shall consist of three academic years divided in to the six semesters. B.Sc. (Pass Course) degree shall be awarded to the candidates after successful completion of the six-semester programme of study.

Eligibility for Admission:

- **B.Sc. (Pass Course) Biology Group:**
  A candidate who has passed qualifying examination *i.e.* 10+2 or equivalent examination with Physics, Chemistry and Biology or Physics, Chemistry and Mathematics with Biology as additional subject from any recognized board shall be permitted to take admission in B.Sc. First Semester to award B.Sc. (Pass Course) degree in Biology group from this University.

- **B.Sc. (Pass Course) Mathematics Group:**
  A candidate who has passed qualifying examination *i.e.* 10+2 or equivalent examination with Physics, Chemistry and Mathematics or Physics, Chemistry and Biology with Mathematics as additional subject from any recognized board shall be permitted to take admission in B.Sc. First Semester to award B.Sc. (Pass Course) degree in Mathematics group from this University.

Minimum Marks required in the Qualifying Examination:

- Qualifying examination passed from Rajasthan State or Bonafide Resident of Rajasthan:
  - General Category = 48%.
  - SC/ST/OBC/SBC or MBC = Minimum Pass Marks
- Qualifying examination passed from other state than Rajasthan or not a Bonafide Resident of Rajasthan:
  - All Categories = 60%.

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%.

Course Number, Course Code or ID and Nomenclature:

The course code for UG course may be fixed by taking the first three alphabets of the subject, following by the four numerical digits of examination paper code and T/P. T and P correspond to theoretical nature and practical nature of the subject respectively. For example, if the course is B.Sc. Chemistry theory paper, then the course code will be CHE9604T and if the course is B.Sc. Chemistry practical paper, then the course code will be CHE9604P.

Maximum Marks and Credit Points:

Maximum marks of a theory and practical paper shall be decided on the basis of their contact hours / per week. One teaching hour per week shall equal to one credit and carry 25 maximum marks. Therefore, 4 teaching hours/week having 4 credit points shall carry 100 maximum marks for each theory paper/course. While two contact hours per week for a laboratory or practical work shall be equal to one credit point. Therefore, 4 contact hours / week shall equal to 2 credit points and shall carry 50 maximum marks.

Course Structure:

The B.Sc. (Pass Course) course consists of discipline centric core, discipline specific electives along with ability enhancement course, generic elective course, value aided course and skill enhancement course under Choice Based Credit System (CBCS) as per the details of the course structure given below:

S. No.	Nature of Paper / Course	Semesters Wise Papers/Course along with Credits of Theory and Practical Components						Total Credits
		I	II	III	IV	V	VI	
1.	Discipline Centric Core (DCC) Course	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	--	--	**24** **24** **24** **…….** **72**
2.	Discipline Specific Elective (DSE) Course	--	--	--	--	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	**12** **12** **12** **…….** **36**
3.	Ability Enhancement Compulsory (AEC) Course	General Hindi / General English (2 Cr)	General English / General Hindi (2 Cr)	--	--	--	--	**04**
4.	Generic Elective Course (GEC)	--	--	Environmental Science (2 Cr)	Elementary Computer Applications (2 Cr)	--	--	**04**

5.	Value Added Course (VAC)	--	--	--	--	Mulya Pravah (2 Cr)	--	**02**
6.	Skill Enhancement Course (SEC)	--	--	--	--	--	Skill Enhancement Course (2 Cr)	**02**
Total Credits		**20**	**20**	**20**	**20**	**20**	**20**	**120**

Teaching Methodologies:

The classroom teaching would be through conventional lectures by using blackboards or use of OHPs or LCDs for 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 students shall be divided into two parts in which first part is continuous or mid-term or internal assessment (30% weightage of the maximum marks) and second part is semester or end-term or external assessment (70% weightage of the maximum marks).

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

(a) The continuous or mid-term or internal assessment 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:

Continuous Assessment	**Modes of Assessments**		**Max. Marks**
	Collegiate (Regular) Students	**Non-collegiate (Private) Students**	
Cont. Assess-I	Written Examination	Report Writing	20
Cont. Assess-II	Assignment / Project Report / Seminar / Presentation / Quiz / GD / Viva-voce	Viva-voce	10

Note: *In the Continuous/Mid-Term/Internal 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. Time duration for Continuous/Mid-Term/Internal Assessment-II is not allotted. It will be decided by the faculty member which will be taking second internal assessment.*

(b) For practical papers, there will not be continuous or mid-term or internal assessment. There will be only one external or end-term or semester assessment having 100% weightage of maximum marks.

(c) A student, who remains absent (defaulter) or fails or wants to improve the marks in the continuous or mid-term or internal assessment, may be permitted to appear in the desired paper(s) in same semester and one time only with the permission of the concern Head of the Department. Defaulter/improvement fee of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such student by the Head of the Department, who may permit the such candidates to appear in the continuous or mid-term or 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, shall be sent to the concerned teacher to take the continuous or mid-term or internal assessment of such candidates. 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) may 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 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) Semester / End-Term / External Assessment:

(a) The semester or end-term or external assessment (70% weightage of the maximum marks) shall be 03 hours duration to each theory paper and 06 hours duration 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.

Question Paper Pattern:

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

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

For Collegiate (Regular) Students

(i) Continuous / Mid-Term / Internal Assessment-I (Max. Marks: 20):

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

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

Name of Class/Course :	Max. Marks : 20 Marks
Name of Semester :	Duration of Exam. : 1.00 Hr
No. & Name of Paper :	Date of Exam. :

Q. No. 1. …… 05 Marks
or
……

Q. No. 2. …… 05 Marks
or
……

Q. No. 3. …… 05 Marks
or
……

Q. No. 4. …… 05 Marks
or
……

(ii) Continuous / Mid-Term / Internal Assessment-II (Max. Marks: 10):

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

Second Internal Assessment Test 20… - 20….
(Seminar / Presentation / Project Report / Quiz / GD / Viva-voce)

Name of Class/Course:	Max. Marks : 10 Marks
Name of Semester :	Mode of Assessment :
No. & Name of Paper:	Date of Assessment :

Format for Compilation of Marks/Awards of Continuous/Mid-Term/Internal Assessment-I & II for Collegiate (Regular) Students

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			
			Internal Assessment-I (Written Examination)	Internal Assessment-II (Assignment / Project Report / Seminar / Presentation / Quiz / GD / Viva-voce)	Total Marks (in Figure)	Total Marks (in Words)
1.						

Name & Signature of the Faculty Member

For Non-collegiate (Private) Students

(i) Continuous / Mid-Term / Internal Assessment-I (Max. Marks: 20):

Report Writing

Each private student of UG program will prepare a report on any topic of each course in minimum 1000 words from the prescribed syllabus of the concerned theory paper/course. The student needs to report the Concerned Department / College at the time prescribed by the College/University to submit the report and the College will arrange a Viva-voce on that report. It is proposed that the engaged teacher will be paid at the rate of per answer book per student charges. The examination section will generate an option of bill when the teacher fills the continuous assessment marks on examination portal (same as for external answer book evaluation). The various components of the report may be:

- Name of Course/Class :
- Name of Student :
- Father's/Husband Name :
- Examination Form No. :
- Enrollment No. :
- Name of College (Center) :
- Name of Paper :
- Title of Topic :
- No. of Unit of Topic (as per prescribed syllabus):
- Introduction about the Topic :
- Details/Analysis about the Topic :
- Conclusion of the Topic :
- References :

(ii) Continuous / Mid-Term / Internal Assessment-II (Max. Marks: 10):

Only Viva-voce will be taken by the concerned faculty member at Department level.

Format for Compilation of Marks/Awards of Continuous/Mid-Term/Internal Assessment-I & II for Non-collegiate (Private) Students

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			
			Internal Assessment-I (Report Writing)	Internal Assessment-II (Viva voce)	Total Marks (in Figure)	Total Marks (in Words)
1.						

Name & Signature of the Faculty Member

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

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

Question Paper Pattern for Semester Examination

[Common for Collegiate (Regular) and Non-collegiate (Private) Students]

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

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

- ***Section-A*** *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*
- ***Section-B*** *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Section-A

Q. No. 1: Comprising 10 Short Answer Type Questions

Unit-I

(i) …… 02 Marks
(ii) …… 02 Marks

Unit-II

(iii) …… 02 Marks
(iv) …… 02 Marks

Unit-III

(v) …… 02 Marks
(vi) …… 02 Marks

Unit-IV

(vii) …… 02 Marks
(viii) …… 02 Marks

Unit-V

(ix) …… 02 Marks
(x) …… 02 Marks

Section-B

Unit-I

Q. No. 2: …….. 10 Marks

Or

……

Unit-II

Q. No. 3: …….. 10 Marks

Or

……

Unit-III

Q. No. 4: …….. 10 Marks

Or

……

Unit-IV

Q. No. 5: …….. 10 Marks

Or

……

Unit-V

Q. No. 6: …….. 10 Marks

Or

……

Practical Examinations:

Continuous / Mid-Term / Internal Assessment:

Not applicable in Practical Examinations.

Semester / End-Term / External Assessment:

Common for Collegiate (Regular) and Non-collegiate (Private) Students

Duration of Exam: 6 Hours **Maximum Marks: 50**

Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

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 he/she has appeared at the paper of the lower semester along with the papers of higher semester) in accordance with the following conditions:

(a) The candidate shall be declared as pass in a semester examination, if he/she secures at least 40% marks in each theory paper separately in continuous/internal and semester / external examinations and 50% marks in each practical paper/project/dissertation with 40% aggregate marks in that semester.

(b) A candidate declared as fail/absent in one or more papers at any odd semester examination shall be permitted to take admission in the next higher semester (even semester) of the same academic session.

(c) A candidate may be promoted in the next academic session (odd semester), if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session. 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.

(d) 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.

(e) If a candidate, who is declared as pass, wants to improve his/her performance in the theory papers of just previous semester, he/she may re-appear only one time in these theory papers in next odd/even semester examinations.

(f) Candidate shall not be permitted to re-appear or improve the marks obtained in the external examination of practical/dissertation in any condition.

(g) If the number of papers prescribed in a semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers for considering the student pass/fail.

(h) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing for three years undergraduate programme up to five years and so on.

(i) The marks secured in the General Hindi, General English, Computer Applications and Environment Science shall not be counted in awarding the division to a candidate. The candidate shall have to clear the compulsory papers/subjects in the additional three chances and non-appearance or absence in the examination of compulsory papers/subjects shall be counted as chance and shall be declared fail in that examination.

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

Classification of Successful Candidates:

(a) Each student shall be awarded a final letter grade at the end of the semester of the particular course. The letter grades and their corresponding grade points are given as:

Percentage of Marks Obtained	Performance	Grade Letter	Grade Point
90.00 – 100.00	Outstanding	O	10
80.00 – 89.99	Excellent	A^+	9
70.00 – 79.99	Very Good	A	8
60.00 – 69.99	Good	B^+	7
50.00 – 59.99	Above Average	B	6
45.00 – 49.99	Average	C	5
40.00 – 45.99	Below Average / Pass	P	4
00.00 – 39.99	Fail	F	0
--	Absent	AB	0
--	Unfair Means	UM	0
--	Withdrawn	W	0

(b) A candidate who remains absent for any semester examination shall be assigned a letter grade AB along with corresponding grade point zero. He/she will have to re-appear for the said examination in due paper/course.

(c) Semester Grade Point Average (SGPA): Performance of a student in a semester is indicated by a number called 'Semester Grade Point Average' (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the student during the semester. For example, if a student takes five papers (theory/practical) in a semester with credits C_1, C_2, C_3, C_4 and C_5 and the student's grade points in these courses are P_1, P_2, P_3, P_4 and P_5 respectively, then students' SGPA is calculated as:

$$SGPA = \frac{C_1P_1 + C_2P_2 + C_3P_3 + C_4P_4 + C_5P_5}{C_1 + C_2 + C_3 + C_4 + C_5} = \frac{\sum_{i=1}^{n} C_iP_i}{\sum_{i=1}^{n} C_i}$$

Where:

C_i: Number of credits earned in the i^{th} paper/course of semester for which SGPA is to be calculated.

P_i: Grade point earned in i^{th} paper/course.

i = 1, 2, 3, 4, ……..n : Represents the number of papers/courses in which a student has appeared in End of Semester Evaluation (EoSE).

The SGPA is calculated, as per example given below, up to two decimal points:

Paper/Course	**Credit (C)**	**Grade Letter**	**Grade Point (P)**	**Credit Point (CP)**	**SGPA**
Physics-I	4	A	8	4 x 8 = 32	$= \frac{\Sigma CP}{\Sigma C}$
Physics Practical-I	2	B^+	7	2 x 7 = 14	
Chemistry-I	4	A	8	4 x 8 = 32	
Chemistry Practical-I	2	B^+	7	2 x 7 = 14	$= \frac{146}{20}$
Mathematics-I	4	A	8	4 x 8 = 32	
Mathematics Practical-I	2	B	6	2 x 6 = 12	
General Hindi	2	C	5	2 x 5 = 10	
Total	**20**	**--**	**--**	**146**	**= 7.30**

It should be noted that, the SGPA for any semester shall take into consideration the F and AB grade awarded in that semester. For example, if a student has a F or AB grade in paper/course 4, the SGPA shall then be computed as:

$$SGPA = \frac{C_1P_1 + C_2P_2 + C_3P_3 + C_4 \text{ x ZERO} + C_5P_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

(d) Cumulative Grade Point Average (CGPA): The CGPA is calculated with the SGPA of all the semesters up to two decimal points and is indicated in final grade report card / final transcript showing the grades of all the semesters and their papers/courses. The CGPA shall reflect the failed status in case of F grade(s), till the paper(s)/course(s) is/are passed. When the paper(s)/course(s) is/are passed by obtaining a pass grade on subsequent examination(s), the CGPA shall only reflect the new grade and not the fail grades earned earlier. The CGPA is calculated as:

$$CGPA = \frac{C_1S_1 + C_2S_2 + C_3S_3 + C_4S_4 + C_5S_5 + C_6S_6}{C_1 + C_2 + C_3 + C_4 + C_5 + C_6} = \frac{\sum_{i=1}^{n} C_iS_i}{\sum_{i=1}^{n} C_i}$$

Where:

C_1, C_2, C_3, … is the total number of credits for I, II, III, …. Semesters and S_1, S_2, S_3, … is the SGPA of I, II, III, …. Semesters.

The CGPA is calculated, as per example given below, up to two decimal points:

Semester	**Credit (C)**	**SGPA**	**C x SGPA (CS)**	**CGPA**
Semester-I	20	7.30	20 x 7.30 = 146.0	$\frac{\Sigma CS}{\Sigma C}$ = $\frac{925.80}{120}$ = **7.71**
Semester-II	20	7.69	20 x 7.69 = 153.8	
Semester-III	20	7.23	20 x 7.23 = 144.6	
Semester-IV	20	7.86	20 x 7.86 = 157.2	
Semester-V	20	8.12	20 x 8.12 = 162.4	
Semester-VI	20	8.09	20 x 8.09 = 161.8	
Total	**120**	**--**	**925.80**	

(e) The classification of successful candidates after last semester examination shall be as under:

Description of Marks Obtained	**Division / Result**	**CGPA**
• 75% and above marks in a paper with Distinction	First Class with Distinction	CGPA 7.50 and above
• A candidate who has secured aggregate 60% and above marks	First Class/Division	CGPA 6.00 to 7.49
• A candidate who has secured aggregate 50% and above but less than 60% marks	Second Class/Division	CGPA 5.00 to 5.99
• A candidate who has secured aggregate 40% and above but less than 50% marks	Pass	CGPA 4.00 to 4.99
• A candidate who has secured aggregate below to the 40% marks	Fail	CGPA below 4.00

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

Syllabus

B.Sc. (Pass Course) Biology and Mathematics Groups

Third Semester Examination

Paper-3.3: CHE.....T
Chemistry-III

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 3 Hours

Total Maximum Marks : 100 Marks
Continuous Assessment : 30 Marks
Semester Assessment : 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I **Chemistry of *s*-Block Elements:**

Inert-pair effect, relative stability of different oxidation states, melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group, allotropy and catenation, reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water; common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, super-oxides, carbonates, nitrates, sulphates; complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium; solutions of alkali metals in liquid ammonia and their properties.

Unit-II **Alkenes:**

General methods of preparations, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration, the Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes, physical properties, chemical reactions of alkenes: mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikof's and anti-Markownikof's rule, hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes, allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Dienes:

Classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of preparation, polymerization. Chemical reactions: 1,2- and 1,4-additions, Diels-Alder reaction.

Alkynes:

Structure and bonding, general methods of preparation, chemical reactions of alkynes, acidity of alkynes, mechanisms of electrophilic and nucleophilic addition

reactions, hydroboration-oxidation, metal-ammonia reduction, oxidation and polymerization.

Unit-III Arenes and Aromaticity:

Nomenclature of benzene derivatives. The aryl groups. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure, stability and carbon-carbon bond lengths of benzene, resonance structure and MO picture. Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions with suitable examples. electrophilic aromatic substitution: General pattern of the mechanism, role of π- and σ-complexes, mechanisms of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating & deactivating substituents, directive effects of groups, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. methods of formation and chemical reactions of alkylbenzene, alkynyl benzene and biphenyl.

Alkyl Halides:

Methods of preparation, chemical reactions, mechanism of nucleophilic substitution reactions of alkyl halides, S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent, etc. nucleophilic substitution vs. elimination, Polyhalogen compounds: chloroform and carbon tetrachloride.

Aryl Halides:

Methods of preparation of aryl halides, nuclear and side chain reactions. The addition, elimination and elimination-addition mechanism of nucleophilic aromatic substitution reactions S_NAr. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Synthesis and uses of DDT and BHC.

Unit-IV Chemical Thermodynamics:

Intensive and extensive variables; state and path functions; types of systems; zeroth law of thermodynamics.

First law: Concept of heat (q), work (w), internal energy (U), and statement of first law; enthalpy (H), relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions, standard states, enthalpy of formation of molecules and ions and enthalpy of neutralization, combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy, thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Carnot's cycle and its efficiency, Carnot theorem.

Third Law: Statement of third law, Nernst's heat theorem, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient

and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-V Solutions:

Ideal and non-ideal solutions and their properties, methods of expressing concentrations of solutions, activity and activity coefficient, Roult's and Henry's laws, Azeotropes: HCl-H_2O and C_2H_5OH-H_2O systems. Lower upper consolute temperatures. Effect of impurity on consolute temperature, Nernst Distribution Law: Thermodynamic derivation and applications. Dilute solutions.

Colligative Properties:

Introduction to colligative properties. Relative lowering of vapour pressure, molecular weight determination. Elevation of boiling point. Depression in freezing point. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't hoff factor, degree of dissociation and association of solutes.

Paper-3.4: CHE.....P
Chemistry Practical-III

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 6 Hours
Maximum Marks : 50 Marks
Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: Inorganic Chemistry	10
2.	Exercise No. 2: Organic Chemistry	10
3.	Exercise No. 3: Physical Chemistry	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Inorganic Chemistry:

Quantitative Analysis:

- Determination of dissolved oxygen (DO).
- Determination of chemical oxygen demand (COD).
- Determination of biological oxygen demand (BOD).
- Determination of total alkalinity of water samples (CO_3^{-2}, HCO_3^-) using double titration method
- Determination of dissolved CO_2.
- Determination of pH of the aerated drinks, fruit juices, shampoos and soaps
- Determination of pH of soil.
- Determination of total soluble salts in soil.

Chromatography:

Paper chromatographic separation

- Fe^{3+} and Al^{3+}
- Ni^{2+} and Co^{2+}
- Fe^{3+}, Al^{3+} and Cr^{3+}.

Organic Chemistry:

Qualitative Analysis:

Separation and identification a binary organic mixture containing two solid components using water, $NaHCO_3$, NaOH and preparation of suitable derivatives.

Thin Layer Chromatography:

Separation of a mixture of organic compounds and reporting of the R_f values:

- Separation of active ingredients of plants, flowers and juices.
- Preparation and separation of 2,4-Dinitrophenyl hydrazones of acetone, 2-butanone, hexan-2 and 3-one using toluene and light petroleum (40:60)
- Separation of a mixture of dyes like Sudan yellow and Sudan Red using cyclohexane and ethyl acetate (8.5:1.5)

Physical Chemistry:

Thermochemistry:

- Determination of heat capacity of calorimeter for different volumes using change of enthalpy data of a known system.
- Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide
- Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts
- Determination of enthalpy of neutralization of a weak acid verses strong acid and vice-versa and determine the enthalpy of ionization of the weak acid/weak base.
- Determination of enthalpy of hydration of copper sulphate.
- Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
- To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle.
- Study of the solubility of benzoic acid in water at different temperature and determination of ΔH.

Transition Temperature:

- Determination of the transition temperature of the given substance by thermometric/dilatometric method (e.g. $MnCl_2.4H_2O$/$SrBr_2.2H_2O$).

Suggested Books for Theory Papers:

Inorganic Chemistry:

- *Basic Inorganic Chemistry: F. A. Cotton and G. Wilkinson, Wiley Eastern*
- *Chemistry of the Elements, N.N. Greenwood and A. Earnshaw*
- *Shriver & Atkins' Inorganic Chemistry*
- *Concise Inorganic Chemistry: J. D. Lee, ELBS*
- *Theoretical Inorganic Chemistry, ACS Publications. M.C. Day and J. Selbin*
- *Advanced Inorganic Chemistry, Vol I & II. Satya Prakash, G.D. Tuli, S.K. Basu and R.D. Madan*
- *Principles of Inorganic Chemistry: B. R. Puri and L. R. Sharma*
- *Fundamentals of Inorganic Chemistry, Vol. I, Das, CBS Publications, 2nd Ed.*
- *Bioinorganic Chemistry-Bertini*
- *Biological Inorganic Chemistry-An Introduction-Robert R. Crichton*
- *The Organometallic Chemistry of Transition Metals, 4e-Robert H Crabtree*
- *Organometallic Chemistry, Mehrotra and Singh. New Age International Publishers, 2ndEdn.*
- *Basic Organometallic Chemistry, 2ndEdn., Gupta B. D. and Elias A. J., University Press.*

Organic Chemistry:

- *Organic Chemistry, Claydon, Nick Greeves and Stuart Warren, Oxford University Press*
- *Organic Chemistry, Graham Solomons, John Wiley & Sons, Inc.*

- *Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.*
- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry (Volume 1), I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry (Volume 2): Stereochemistry and the Chemistry of Natural Products, I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry, Vol. I, II & III. Jag Mohan, R. Chand & Company*
- *Organic Chemistry, (Vol. I, II & III. S. M. Mukherji, S. P. Singh and R. P. Kapoor*
- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, Tata McGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*
- *Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.*
- *A Textbook of Organic Chemistry: P S Kalsi, New Age International*
- *A Text Book of Organic Chemistry: B. S. Bahl and Arun Bahl*
- *A Text Book of Organic Chemistry: P. L. Soni & H.M. Chawla*
- *A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal*
- *Organic Synthesis: Jagadamba Singh and L.D.S. Yadav*
- *Principles of Organic Synthesis-Norman & Coxon*
- *Heterocyclic Chemistry at a Glance 2e by Joule & Mills Blackwell*
- *Heterocyclic Chemistry by RK Bansal*
- *Heterocyclic Chemistry Volume I and II by RR Gupta*
- *Fundamentals of Biochemistry 5e Voet & Voet*
- *Lehninger Principles of Biochemistry 4e Nelson & Cox*
- *Harper's Illustrated Biochemistry. XXVIII edition. Murray, Granner, Mayes and Rodwell. Lange Medical Books/ McGraw-Hill.*
- *Elementary Organic Spectroscopy, 5th Edition, Y R Sharma, S. Chand & Company.*
- *Organic Spectroscopy and Applications, Jag Mohan, Narosa Publishers*
- *Organic Spectroscopy, Kemp, W. Palgrave*

Physical Chemistry:

- *Atkins' Physical Chemistry, Oxford University Press*
- *Principles of Physical Chemistry: Prutton and Marron*
- *Elements of Physical Chemistry: Lewis Glasstone*
- *Principles of Physical Chemistry: B. R. Puri and L. R. Sharma*
- *A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand*
- *A Text Book of Physical Chemistry by K. L. Kapoor*
- *Modern Electrochemistry 2A-Fundamentals of Electrodics-Bockris, Reddy & Gamboa*
- *Introductory Quantum Chemistry, Chandra, A. K., Tata McGraw-Hill.*
- *Fundamentals of Quantum Chemistry, 2nd Ed. House, J. E., Elsevier*
- *Quantum Chemistry, Lowe, J. P. & Peterson, K. Academic Press.*
- *Fundamentals of Molecular Spectroscopy, 4th Ed. Banwell & McCash. Tata McGraw-Hill: New Delhi.*
- *Atomic & Molecular Spectroscopy, Kakkar, R. Cambridge University Press*
- *Fundamentals of Photochemistry, Rohatagi Mukherjee. Wiley Eastern Ltd.*

Analytical Chemistry:

- *Principles of Instrumental Analysis, Skoog, Holler and Nieman, Thomson Asia Pvt. Ltd. Singapore.*
- *Analytical Chemistry Vol-I Qualitative Analysis-Treadwell & Hall*
- *Analytical Chemistry Vol-II Quantitative Analysis-Treadwell & Hall*
- *Chemical Analysis-Modern Instrumentation Methods and Techniques, 2e-Francis Rouessac*
- *Handbook of Instrumental Techniques for Analytical Chemistry-Frank Settle*

Suggested Books for Practical Papers:

Inorganic Chemistry

- *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*
- *Vogel's Textbook of Quantitative Analysis, Bassett, Denney, Jeffery and Mendham*
- *Qualitative Analysis by Welcher and Hahn.*
- *Practical Chemistry: Giri Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.*

Organic Chemistry:

- *Vogel's Textbook of Practical Organic Chemistry, Tatchell, John Wiley.*
- *Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health*
- *Practical Organic Chemistry, 5th Ed., Furniss, Hannaford, Smith, Tatchell. Pearson.*
- *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia & Aggarwal, University Press.*
- *Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, & Dhingra, S., University Press.*
- *Laboratory Hand Book of Chromatographic & Allied Methods, Mikes, & Chalmes, Elles Harwood Ltd. London*

Physical Chemistry

- *Practical Physical Chemistry, James and Prichard, Longman.*
- *Findley's Practical Physical Chemistry, Levitt, Longman.*
- *Experimental Physical Chemistry, Das and Behera, Tata McGraw Hill.*
- *Experimental Physical Chemistry, Athawale & Mathur, New Age International: New Delhi.*
- *Senior Practical Physical Chemistry, Khosla, Garg, and Gulati. R. Chand & Co.: New Delhi*
- *Experiments in Physical Chemistry 8th Ed.; Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York*
- *Experimental Physical Chemistry 3rdEd.; Halpern, A.M. & McBane, G. C. W.H. Freeman & Co.: New York.*
- *Experimental Physical Chemistry, J. N. Gurtu, R. Kapoor.*

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

Syllabus

B.Sc. (Pass Course) Biology and Mathematics Groups

Fourth Semester Examination

Paper-4.3: CHE.....T
Chemistry-IV

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 3 Hours

Total Maximum Marks : 100 Marks
Continuous Assessment : 30 Marks
Semester Assessment : 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I Chemistry of *p*-Block Elements:

Atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, allotropy; inert-pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Structure, bonding and properties, acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following:

- Hydrides: hydrides of Group 13 (boranes and borohydrides), Group 14 (carbides and silicates), Group 15 (N and P), Group 16 (O and S) and Group 17.
- Oxides and oxoacids of nitrogen, sulphur, phosphorus and chlorine
- Per-oxoacids of sulphur
- Halogens, interhalogens, pseudo-halogens and poly-halides

Unit-II Coordination Compounds:

Double salts and coordination compounds, Werner's theory and its experimental verification, effective atomic number, valence bond theory (inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu), electroneutrality principle and back bonding. Crystal field theory, measurement of 10Dq (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10Dq (Δ_o, Δ_t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry, Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

Nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

Unit-III Nitroalkanes and Nitroarenes:

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline media. Picric acid. Halonitroarenes: reactivity.

Alkyl and Aryl Amines:

Structure and physical properties, stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds and nitriles). Reductive amination of aldehydic and ketonic compounds. Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

Unit-IV Alcohols:

Monohydric alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols. hydrogen bonding, acidic nature, reactions of alcohols. Dihydric alcohols: preparation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement. Trihydric alcohols: preparation and properties, chemical reactions of glycerol.

Phenols:

Structure and bonding, preparation and properties, acidic character, comparative acidic strengths of alcohols and phenols, factors effecting to acidity, resonance stabilization of phenoxide ion, reactions of phenols: electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen rearrangement, Gattermann synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tieman reaction.

Ethers and Epoxides:

Preparation and properties, chemical reactions: cleavage and autoxidation. Zeisel's method. Synthesis of epoxides. Acid and base catalyzed ring opening of epoxides, orientation of epoxide ring opening. Reactions of Grignard and organolithium reagents with epoxides.

Unit-V Chemical Equilibrium:

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Ionic Equilibrium:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis: calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts: applications of solubility product principle. Qualitative treatment of acid: base

titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants**.**

Paper-4.4: CHE.....P
Chemistry Practical-IV

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 6 Hours
Maximum Marks : 50 Marks
Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: Inorganic Chemistry	10
2.	Exercise No. 2: Organic Chemistry	10
3.	Exercise No. 3: Physical Chemistry	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Inorganic Chemistry:

Gravimetric Analysis:

- Estimation of copper as CuSCN.
- Estimation of nickel (II) using dimethylglyoxime (DMG).
- Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
- Estimation of aluminium by precipitating with oxime and weighing as $Al(oxime)_3$.

Inorganic Preparations:

- Sodium/Potassium trioxalatoferrate (III) complex $Na_3[Fe(C_2O_4)_3]$.
- Nickel dimethylglyoximate complex $[Ni(DMG)_2]$.
- Hexaammine nickel complex $[Ni(NH_3)_6]Cl_2$
- Tetraammine copper complex $[Cu(NH_3)_4]SO_4$.
- Hexaammine chromium complex $[Cr(NH_3)_6]Cl_3$
- *cis*-and *trans*-bisoxalatodiaquachromate (III) complex
- Tetraamminecarbonatocobalt (III) complex

Organic Chemistry:

Organic Synthesis:

- Acetylation: Salicylic acid, amines (aniline, *o*-, *m*-, *p*-toluidines and anisidines), phenols and glucose.
- Benzoylation: any one of the amines (aniline, *o*-, *m*-, *p*-toluidines and anisidines) and any one of the phenols (phenol, resorcinol, p-cresol, β-naphthol).
- Aliphatic Electrophilic Substitution: Preparation of Iodoform from ethanol and acetone.
- Aromatic Electrophilic Substitution:
    - Nitration:
      Preparation of *m*-dinitrobenzene,
      Preparation of *p*-nitroacetanilide
    - Halogenation:
      Preparation of *p*-bromoacetanilide
      Preparation of 2,4,6-tribromophenol.

The solid samples of the compounds synthesized must be collected and may be used for recrystallization, melting point and TLC.

Column Chromatography:
Packing of columns and separation of following organic mixtures:

- Leaf pigments from spinach leaves.
- Fluorescein and methylene blue.
- Racemic mixture of mandelic acid.

Physical Chemistry:

Ionic Equilibrium:

- Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
- Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- Preparation of buffer solutions of different pH
  - Sodium acetate-acetic acid
  - Ammonium chloride-ammonium hydroxide
- pH metric titration of strong acid vs. strong base and weak acid vs. strong base.
- Determination of dissociation constant of a weak acid.
- Determination of solubility product of PbI_2 by titrimetric method.

Molecular Weight Determination:

- Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
- Determination of the apparent degree of dissociation of an electrolyte (e.g. NaCl) in aqueous solution at different concentrations by ebullioscopy.

Suggested Books for Theory Papers:

Inorganic Chemistry:

- *Basic Inorganic Chemistry: F. A. Cotton and G. Wilkinson, Wiley Eastern*
- *Chemistry of the Elements, N.N. Greenwood and A. Earnshaw*
- *Shriver & Atkins' Inorganic Chemistry*
- *Concise Inorganic Chemistry: J. D. Lee, ELBS*
- *Theoretical Inorganic Chemistry, ACS Publications. M.C. Day and J. Selbin*
- *Advanced Inorganic Chemistry, Vol I & II. Satya Prakash, G.D. Tuli, S.K. Basu and R.D. Madan*
- *Principles of Inorganic Chemistry: B. R. Puri and L. R. Sharma*
- *Fundamentals of Inorganic Chemistry, Vol. I, Das, CBS Publications, 2nd Ed.*
- *Bioinorganic Chemistry-Bertini*
- *Biological Inorganic Chemistry-An Introduction-Robert R. Crichton*
- *The Organometallic Chemistry of Transition Metals, 4e-Robert H Crabtree*
- *Organometallic Chemistry, Mehrotra and Singh. New Age International Publishers, 2ndEdn.*
- *Basic Organometallic Chemistry, 2ndEdn., Gupta B. D. and Elias A. J., University Press.*

Organic Chemistry:

- *Organic Chemistry, Claydon, Nick Greeves and Stuart Warren, Oxford University Press*
- *Organic Chemistry, Graham Solomons, John Wiley & Sons, Inc.*
- *Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.*
- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry (Volume 1), I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry (Volume 2): Stereochemistry and the Chemistry of Natural Products, I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*

- *Organic Chemistry, Vol. I, II & III. Jag Mohan, R. Chand & Company*
- *Organic Chemistry, (Vol. I, II & III. S. M. Mukherji, S. P. Singh and R. P. Kapoor*
- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, Tata McGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*
- *Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.*
- *A Textbook of Organic Chemistry: P S Kalsi, New Age International*
- *A Text Book of Organic Chemistry: B. S. Bahl and Arun Bahl*
- *A Text Book of Organic Chemistry: P. L. Soni & H.M. Chawla*
- *A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal*
- *Organic Synthesis: Jagadamba Singh and L.D.S. Yadav*
- *Principles of Organic Synthesis-Norman & Coxon*
- *Heterocyclic Chemistry at a Glance 2e by Joule & Mills Blackwell*
- *Heterocyclic Chemistry by RK Bansal*
- *Heterocyclic Chemistry Volume I and II by RR Gupta*
- *Fundamentals of Biochemistry 5e Voet & Voet*
- *Lehninger Principles of Biochemistry 4e Nelson & Cox*
- *Harper's Illustrated Biochemistry. XXVIII edition. Murray, Granner, Mayes and Rodwell. Lange Medical Books/ McGraw-Hill.*
- *Elementary Organic Spectroscopy, 5th Edition, Y R Sharma, S. Chand & Company.*
- *Organic Spectroscopy and Applications, Jag Mohan, Narosa Publishers*
- *Organic Spectroscopy, Kemp, W. Palgrave*

Physical Chemistry:

- *Atkins' Physical Chemistry, Oxford University Press*
- *Principles of Physical Chemistry: Prutton and Marron*
- *Elements of Physical Chemistry: Lewis Glasstone*
- *Principles of Physical Chemistry: B. R. Puri and L. R. Sharma*
- *A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand*
- *A Text Book of Physical Chemistry by K. L. Kapoor*
- *Modern Electrochemistry 2A-Fundamentals of Electrodics-Bockris, Reddy & Gamboa*
- *Introductory Quantum Chemistry, Chandra, A. K., Tata McGraw-Hill.*
- *Fundamentals of Quantum Chemistry, 2nd Ed. House, J. E., Elsevier*
- *Quantum Chemistry, Lowe, J. P. & Peterson, K. Academic Press.*
- *Fundamentals of Molecular Spectroscopy, 4th Ed. Banwell & McCash. Tata McGraw-Hill: New Delhi.*
- *Atomic & Molecular Spectroscopy, Kakkar, R. Cambridge University Press*
- *Fundamentals of Photochemistry, Rohatagi Mukherjee. Wiley Eastern Ltd.*

Analytical Chemistry:

- *Principles of Instrumental Analysis, Skoog, Holler and Nieman, Thomson Asia Pvt. Ltd. Singapore.*
- *Analytical Chemistry Vol-I Qualitative Analysis-Treadwell & Hall*
- *Analytical Chemistry Vol-II Quantitative Analysis-Treadwell & Hall*
- *Chemical Analysis-Modern Instrumentation Methods and Techniques, 2e-Francis Rouessac*
- *Handbook of Instrumental Techniques for Analytical Chemistry-Frank Settle*

Suggested Books for Practical Papers:

Inorganic Chemistry

- *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*
- *Vogel's Textbook of Quantitative Analysis, Bassett, Denney, Jeffery and Mendham*
- *Qualitative Analysis by Welcher and Hahn.*
- *Practical Chemistry: Giri Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.*

Organic Chemistry:

- *Vogel's Textbook of Practical Organic Chemistry, Tatchell, John Wiley.*
- *Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health*
- *Practical Organic Chemistry, 5th Ed., Furniss, Hannaford, Smith, Tatchell. Pearson.*
- *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia & Aggarwal, University Press.*

- *Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, & Dhingra, S., University Press.*
- *Laboratory Hand Book of Chromatographic & Allied Methods, Mikes, & Chalmes, Elles Harwood Ltd. London*

Physical Chemistry

- *Practical Physical Chemistry, James and Prichard, Longman.*
- *Findley's Practical Physical Chemistry, Levitt, Longman.*
- *Experimental Physical Chemistry, Das and Behera, Tata McGraw Hill.*
- *Experimental Physical Chemistry, Athawale & Mathur, New Age International: New Delhi.*
- *Senior Practical Physical Chemistry, Khosla, Garg, and Gulati. R. Chand & Co.: New Delhi*
- *Experiments in Physical Chemistry 8th Ed.; Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York*
- *Experimental Physical Chemistry 3rdEd.; Halpern, A.M. & McBane, G. C. W.H. Freeman & Co.: New York.*
- *Experimental Physical Chemistry, J. N. Gurtu, R. Kapoor.*

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