Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
PHONE:EPABX-2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्याससमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

SU/BOS/Science/348 **Date: 24/06/2024.**

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.

Subject: Regarding Minor Change syllabi of M.Sc. Part-I (Sem.I & II) as per NEP-2020 (2.0) degree programme under the Faculty of Science and Technology.

Ref: SU/BOS/Science/556 Date: 25/07/2023 Letter.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the Minor Change in syllabi, nature of question paper and equivalence of M.Sc. Part-I (Sem. I & II) as per NEP-2020 (2.0) degree programme under the Faculty of Science and Technology.

M.Sc.Part-I (Sem. I & II) as per NEP-2020 (2.0)			
1.	Chemistry	3.	Sugar Technology (Entire)
2.	Alcohol Technology (Entire)	4.	

This syllabus, nature of question shall be implemented from the academic year 2024-2025 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in,NEP-2020@suk(Online Syllabus).

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2024 & March/April 2025. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	4	P.G Admission / Eligibility Section
2	The Chairman, Respective Board of Studies	5	Computer Centre/ Eligibility Section
3	B.Sc. Exam/ Appointment Section	6	Affiliation Section (U.G.) (P.G.)

Shivaji University, Kolhapur

Accredited By NAAC with

'A^{++}' Grade

Revised Syllabus as per NEP-2020

For

M. Sc. Part-I

Chemistry

Syllabus to be implemented from

July, 2023 onwards.

Applicable for University Department and Affiliated Colleges PG Centres

Minor Changes in M.Sc. I NEP-2020 Chemistry Sem. I & II Syllabus To be implemented from 2024-25		
M. Sc. I Sem I		
Paper-	**RM-CH106 Research Methodology**	
	Present	**Corrected (to be implemented from 2024-25)**
Unit I	Research Methodology	A) Introduction to Research Methodology B) Scope of Research and Ethics- Additional points are added.
UNIT-II	Literature Searching and Writing Reports	Literature Search and Techniques: The sub points have been modified and techniques are added.
UNIT-III	Quantitative Techniques	Scientific report writing- Old Unit II is modified by adding new points.
UNIT-IV	Computer Applications: Use of Computer Programs	A) Quantitative Techniques B) Computer Applications: Presentation and Communication skills- This unit is modified by combining unit III and Unit IV (Old) with addition of few more points.
M. Sc. I Sem II		
Paper-	**PCH201: Physical Chemistry-II**	
	Present	**Corrected (to be implemented from 2024-25)**
UNIT-III	Electrochemistry	Electrochemistry- Theory of strong electrolytes- Debye-Huckel theory and subpoints are replaced by electrokinetic phenomena.
Paper-	**ACH202: Analytical Chemistry-II**	
UNIT-I	Basics of Analytical Chemistry, Errors, treatments and statistics	Basics of Analytical Chemistry and Indian Knowledge System(IKS) – Introduction to IKS is added.
Practical Examination Days		
	Present	**Corrected (to be implemented from 2024-25)**
	No. of Days = 04	No. of Days = 03

SHIVAJI UNIVERSITY, KOLHAPUR
Revised Syllabus for the Master of Science in Chemistry
(As per NEP - 2020)
Applicable from the Academic Year 2023 –24

1. **Title**: M. Sc. Chemistry, Shivaji University, Kolhapur Revised Syllabus as per NEP - 2020.
2. **Faculty**: Faculty of Science and Technology.
3. **Year of Implementation**: For M. Sc. I (Semester I and Semester II): From July 2023 and for M. Sc. II (Semester III and Semester IV): From June 2024.

4. Program Outcomes (POs):

a) Demonstrate, solve, and have an understanding of major concepts in all disciplines of Chemistry.

b) Solve problems, think methodically, and independently and draw logical conclusions.

c) Employ critical thinking and scientific knowledge to design, carry out, record, and analyze the results of chemical reactions.

d) Create an awareness of the impact of Chemistry on the environment, society, and development among the scientific community.

e) Find out the green route for the chemical reactions for sustainable development.

f) To inculcate scientific temperament in the students and among the scientific community.

g) Use modern techniques, sophisticated equipment, and various Chemistry softwares

5. Program-Specific Outcomes (PSOs):

a) Students will develop critical thinking and the Analytical mind by taking knowledge in advanced-level Chemistry

b) The relevance of the extension of Chemistry in the social context for solving social issues

c) Analytical or experimental skills make the students capable of doing higher-level research work in the emerging fields of Chemistry

d) Students will gain a thorough Knowledge of the subject to work on projects at different research and academic institutions.

e) Students will become familiar with the different branches of Chemistry like Analytical, Organic, Inorganic, Physical, Environmental, Polymer, and Biochemistry. They will also learn to apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

f) Employability Skills shall enable the students to find jobs in core Chemistry and other related fields

g) Entrepreneurial Skills shall empower the students to start their industries/businesses in core Chemistry fields

6. The entire course of M. Sc. (Chemistry) will be of **four Semesters** spread over two years.

7. Pattern of Examination: The Examinations will be conducted **semester wise for theory and Practical.**

8. Fee structure: As per Shivaji University guidelines.

9. Eligibility criteria for Admission: B. Sc. in Chemistry.

10. Medium of Instruction: English

11. Structure of course: Given in Framework Chart

The University department and University affiliated colleges centers offers following specializations at M. Sc. II (Semester III and IV):

i) Physical Chemistry

ii) Inorganic Chemistry

iii) Organic Chemistry

iv) Analytical Chemistry

v) Applied Chemistry (Only at University Department)

vi) Industrial Chemistry (Only at University Department)

12. Scheme of Teaching and Examination:

(Applicable to University Department and University affiliated colleges centers)

a. Each unit in theory course shall comprise 15 lectures, each of 60 minutes' duration and there shall be four lectures per theory course per week.

b. Entire course of M. Sc. Chemistry will be of **2200** marks.

c. Examination of each **theory course** shall be of **100 marks** (80 university examination + 20 internal assessment). University examination of 80 marks (3 hours' duration) will be conducted at the end of each Semester. Internal assessment of 20 marks will be done before the semester examination during each semester.

d. Examination of practical course shall be of 150 marks per semester for first year and 50 Marks for second year.

e. Research Project is compulsory at second year. (10 Credits)

f. On-the Job training is mandatory at second semester (4 Credits)

g. Seminar activity is compulsory for M. Sc. II year students.

h. Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus. Equal weightage should be provided to each unit.

13. Standard of Passing:

There will be separate passing for theory courses and practical courses. Minimum 40% marks will be required for passing separately for theory and practical courses.

14. Nature of Question paper and scheme of marking:

- Theory question paper: Maximum marks -80
- Total No. of question – 7
- All questions are of equal marks. Out of these seven questions five questions are to be attempted. Question No.1 is compulsory and objective/short answer type. Total number of bits is 16 with one mark each. Total marks – 16 (which cover multiple choices, fill in the blanks, definition, true or false). These questions will be answered along with other questions in the same answer book.
- Remaining 6 question are divided into two sections, namely section-I and section – II. Four questions are to be attempted from these two section such that not more than two questions from any of the section. Both sections are to be written in the same answer book.

Shivaji University, Kolhapur
Credit Frameworks for M.Sc. Programs as per NEP to be implemented in 2023-24
M.Sc. Inorganic Chemistry

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective [Chose any one elective]					
I	6.0	I	OCH101 (4 Cr) ICH102 (4 Cr) PRCH104 (4 Cr-Major Experiments- **5 from each Section**) PRCH105 (2 Cr-Minor Experiments-**3 from each Section**)	E-ICH103 (4 Cr) OR E-OCH103 (4 Cr) OR E-PCH103 (4 Cr) OR E-ACH103 (4 Cr) OR	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Inorganic Chemistry (After 3yr B.Sc. Degree)** **Note: Common practicals for M.Sc.-I** **M.Sc.- II will be discipline specific i.e. Inorganic Chemistry oriented**
		II	PCH201 (4 Cr) ACH202 (4 Cr) PRCH204 (4 Cr-Major Experiments- **5 from each Section**) PRCH205 (2 Cr-Minor Experiments-**3 from each Section**)	E-ICH203 (4 Cr) OR E-OCH203 (4 Cr) OR E-PCH203 (4 Cr) OR E-ACH203 (4 Cr)	---	OJT-ICH206 (4 Cr) OR FP-ICH206 (4 Cr) [Any One]	---	22	
Cum. Cr. for PG Diploma			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									
II	6.5	III	ICH301 (4 Cr) ICH302 (4 Cr) ICH303 (4 Cr) PR-ICH305 (2 Cr)	E-ICH304 (4 Cr) OR E-OCH304 (4 Cr) OR E-PCH304 (4 Cr) OR E-ACH304 (4 Cr) OR	---	---	RP-ICH306 (4 Cr)	22	**PG Degree After 3-Yr UG** **Or** **PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e.Inorganic Chemistry oriented**
		IV	ICH401 (4 Cr) ICH402 (4 Cr) ICH403 (4 Cr)	E-ICH404 (4 Cr) OR E-OCH404 (4 Cr) OR E-PCH404 (4 Cr) OR E-ACH404 (4 Cr) OR	---	---	RP-ICH405 (6 Cr)	22	
Cum. Cr. For 1 Year PG Degree			**28**	**8**	**4**	**4**	**10**	**44**	
Cum. Cr. For 2 Year PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. **Research Methodology will be common for all but the codes will be maintained different.**

M.Sc. Organic Chemistry

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	**Elective [Chose any one elective]**					
I	6.0	I	OCH101 (4 Cr) ICH102 (4 Cr) PRCH104 (4 Cr-Major Experiments- **5 from each Section**) PRCH105 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH103 (4 Cr) OR E-OCH103 (4 Cr) OR E-PCH103 (4 Cr) OR E-ACH103 (4 Cr) OR	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Organic Chemistry (After 3yr B.Sc. Degree)** **Note: Common practicals for M.Sc.-I** **M.Sc.- II will be discipline specific i.e. Organic Chemistry oriented**
		II	PCH201 (4 Cr) ACH202 (4 Cr) PRCH204 (4 Cr-Major Experiments- 5 from each Section) PRCH205 (2 Cr-- Minor Experiments-3 from each Section))	E-ICH203 (4 Cr) OR E-OCH203 (4 Cr) OR E-PCH203 (4 Cr) OR E-ACH203 (4 Cr)	---	OJT-OCH206 (4 Cr) OR FP-OCH206 (4 Cr) [Any One]	---	22	
Cum. Cr. for PG Diploma			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									
II	6.5	III	OCH301 (4 Cr) OCH302 (4 Cr) OCH303 (4 Cr) PR-OCH305 (2 Cr)	E-ICH304 (4 Cr) OR E-OCH304 (4 Cr) OR E-PCH304 (4 Cr) OR E-ACH304 (4 Cr) OR	---	---	RP-OCH306 (4 Cr)	22	**PG Degree After 3-Yr UG** **Or** **PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e.Organic Chemistry oriented**
		IV	OCH401 (4 Cr) OCH402 (4 Cr) OCH403 (4 Cr)	E-ICH404 (4 Cr) OR E-OCH404 (4 Cr) OR E-PCH404 (4 Cr) OR E-ACH404 (4 Cr) OR	---	---	RP-OCH405 (6 Cr)	22	
Cum. Cr. For 1 Year PG Degree			**28**	**8**	**4**	**4**	**10**	**44**	
Cum. Cr. For 2 Year PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. **Research Methodology will be common for all but the codes will be maintained different.**

M.Sc. Physical Chemistry

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	**Elective [Chose any one elective]**					
I	6.0	I	OCH101 (4 Cr) ICH102 (4 Cr) PRCH104 (4 Cr-Major Experiments- **5 from each Section**) PRCH105 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH103 (4 Cr) OR E-OCH103 (4 Cr) OR E-PCH103 (4 Cr) OR E-ACH103 (4 Cr) OR	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Physical Chemistry (After 3yr B.Sc. Degree)** **Note: Common practicals for M.Sc.-I** **M.Sc.- II will be discipline specific i.e. Physical Chemistry oriented**
		II	PCH201 (4 Cr) ACH202 (4 Cr) PRCH204 (4 Cr-Major Experiments- **5 from each Section**) PRCH205 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH203 (4 Cr) OR E-OCH203 (4 Cr) OR E-PCH203 (4 Cr) OR E-ACH203 (4 Cr)	---	OJT-PCH206 (4 Cr) OR FP-PCH206 (4 Cr) [Any One]	---	22	
Cum. Cr. for PG Diploma			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									
II	6.5	III	PCH301 (4 Cr) PCH302 (4 Cr) PCH303 (4 Cr) PR-PCH305 (2 Cr)	E-ICH304 (4 Cr) OR E-OCH304 (4 Cr) OR E-PCH304 (4 Cr) OR E-ACH304 (4 Cr) OR	---	---	RP-PCH306 (4 Cr)	22	**PG Degree After 3-Yr UG** **Or** **PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e.Physical Chemistry oriented**
		IV	PCH401 (4 Cr) PCH402 (4 Cr) PCH403 (4 Cr)	E-ICH404 (4 Cr) OR E-OCH404 (4 Cr) OR E-PCH404 (4 Cr) OR E-ACH404 (4 Cr) OR	---	---	RP-PCH405 (6 Cr)	22	
Cum. Cr. For 1 Year PG Degree			**28**	**8**	**4**	**4**	**10**	**44**	
Cum. Cr. For 2 Year PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. **Research Methodology will be common for all but the codes will be maintained different.**

M.Sc. Analytical Chemistry

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	**Elective [Chose any one elective]**					
I	6.0	I	OCH101 (4 Cr) ICH102 (4 Cr) PRCH104 (4 Cr-Major Experiments- **5 from each Section**) PRCH105 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH103 (4 Cr) OR E-OCH103 (4 Cr) OR E-PCH103 (4 Cr) OR E-ACH103 (4 Cr) OR	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Analytical Chemistry (After 3yr B.Sc. Degree)** **Note: Common practicals for M.Sc.-I** **M.Sc.- II will be discipline specific i.e. Analytical Chemistry oriented**
		II	PCH201 (4 Cr) ACH202 (4 Cr) PRCH204 (4 Cr-Major Experiments- **5 from each Section**) PRCH205 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH203 (4 Cr) OR E-OCH203 (4 Cr) OR E-PCH203 (4 Cr) OR E-ACH203 (4 Cr)	---	OJT-ACH206 (4 Cr) OR FP-ACH206 (4 Cr) [Any One]	---	22	
Cum. Cr. for PG Diploma			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									
II	6.5	III	ACH301 (4 Cr) ACH302 (4 Cr) ACH303 (4 Cr) PR-ACH305 (2 Cr)	E-ICH304 (4 Cr) OR E-OCH304 (4 Cr) OR E-PCH304 (4 Cr) OR E-ACH304 (4 Cr) OR	---	---	RP-ACH306 (4 Cr)	22	**PG Degree After 3-Yr UG** **Or** **PG Degree after 4-Yr UG** **Note: All the practicals /Project will be discipline specific i.e. Analytical Chemistry oriented**
		IV	ACH401 (4 Cr) ACH402 (4 Cr) ACH403 (4 Cr)	E-ICH404 (4 Cr) OR E-OCH404 (4 Cr) OR E-PCH404 (4 Cr) OR E-ACH404 (4 Cr) OR	---	---	RP-ACH405 (6 Cr)	22	
Cum. Cr. For 1 Year PG Degree			**28**	**8**	**4**	**4**	**10**	**44**	
Cum. Cr. For 2 Year PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. **Research Methodology will be common for all but the codes will be maintained different.**

M.Sc. Industrial Chemistry

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	**Elective [Chose any one elective]**					
I	6.0	I	OCH101 (4 Cr) ICH102 (4 Cr) PRCH104 (4 Cr-Major Experiments- **5 from each Section**) PRCH105 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH103 (4 Cr) OR E-OCH103 (4 Cr) OR E-PCH103 (4 Cr) OR E-ACH103 (4 Cr) OR	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Industrial Chemistry (After 3yr B.Sc. Degree)** **Note: Common practicals for M.Sc.-I** **M.Sc.- II will be discipline specific i.e. Industrial Chemistry oriented**
		II	PCH201 (4 Cr) ACH202 (4 Cr) PRCH204 (4 Cr-Major Experiments- **5 from each Section**) PRCH205 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH203 (4 Cr) OR E-OCH203 (4 Cr) OR E-PCH203 (4 Cr) OR E-ACH203 (4 Cr)	---	OJT-INDCH206 (4 Cr) OR FP-INDCH206 (4 Cr) [Any One]	---	22	
Cum. Cr. for PG Diploma			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									
II	6.5	III	INDCH301 (4 Cr) INDCH302 (4 Cr) INDCH303 (4 Cr) PR-INDCH305 (2 Cr)	E-ICH304 (4 Cr) OR E-OCH304 (4 Cr) OR E-PCH304 (4 Cr) OR E-ACH304 (4 Cr) OR	---	---	RP-INDCH306 (4 Cr)	22	**PG Degree After 3-Yr UG** **Or** **PG Degree after 4-Yr UG** **Note: All the practicals /Project will be discipline specific i.e. Industrial Chemistry oriented**
		IV	INDCH401 (4 Cr) INDCH402 (4 Cr) INDCH403 (4 Cr)	E-ICH404 (4 Cr) OR E-OCH404 (4 Cr) OR E-PCH404 (4 Cr) OR E-ACH404 (4 Cr) OR	---	---	RP-INDCH405 (6 Cr)	22	
Cum. Cr. For 1 Year PG Degree			**28**	**8**	**4**	**4**	**10**	**44**	
Cum. Cr. For 2 Year PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. **Research Methodology will be common for all but the codes will be maintained different.**

M.Sc. Applied Chemistry

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective [Chose any one elective]					
I	6.0	I	OCH101 (4 Cr) ICH102 (4 Cr) PRCH104 (4 Cr-Major Experiments- **5 from each Section**) PRCH105 (2 Cr- Minor Experiments-**3 from each Section**)	E-ICH103 (4 Cr) OR E-OCH103 (4 Cr) OR E-PCH103 (4 Cr) OR E-ACH103 (4 Cr) OR	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Applied Chemistry (After 3yr B.Sc. Degree)** **Note: Common practicals for M.Sc.-I** **M.Sc.- II will be discipline specific i.e. Applied Chemistry oriented**
		II	PCH201 (4 Cr) ACH202 (4 Cr) PRCH204 (4 Cr-Major Experiments- (**5 from each Section**) PRCH205 (2 Cr- Minor Experiments-(**3 from each Section**)	E-ICH203 (4 Cr) OR E-OCH203 (4 Cr) OR E-PCH203 (4 Cr) OR E-ACH203 (4 Cr)	---	OJT-APCH206 (4 Cr) OR FP-APCH206 (4 Cr) [Any One]	---	22	
Cum. Cr. for PG Diploma			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									
II	6.5	III	APCH301 (4 Cr) APCH302 (4 Cr) APCH303 (4 Cr) PR-APCH305 (2 Cr)	E-ICH304 (4 Cr) OR E-OCH304 (4 Cr) OR E-PCH304 (4 Cr) OR E-ACH304 (4 Cr) OR	---	---	RP-APCH306 (4 Cr)	22	**PG Degree After 3-Yr UG** **Or** **PG Degree after 4-Yr UG** **Note: All the practicals /Project will be discipline specific i.e. Applied Chemistry oriented**
		IV	APCH401 (4 Cr) APCH402 (4 Cr) APCH403 (4 Cr)	E-ICH404 (4 Cr) OR E-OCH404 (4 Cr) OR E-PCH404 (4 Cr) OR E-ACH404 (4 Cr) OR	---	---	RP-APCH405 (6 Cr)	22	
Cum. Cr. For 1 Year PG Degree			**28**	**8**	**4**	**4**	**10**	**44**	
Cum. Cr. For 2 Year PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. **Research Methodology will be common for all but the codes will be maintained different.**

M. Sc. Part – I (Semester – I)

OCH101: Organic Chemistry-I [Credit 4, 60 L Hours]	
UNIT-I **A) Reaction Mechanism: Structure and Reactivity [8L]** Types of reactions, strength of acids and bases. Generation, structure, stability, and reactivity of carbenes, arynes, nitrenes, and effect of structure on reactivity, resonance, and steric effects. Thermodynamic and Kinetic requirements, Introduction to Kinetic and Thermodynamic control reaction. **B) Aliphatic Nucleophilic substitutions [7L]** SN_2, SN_1 and SNi reactions with respect to mechanism and stereochemistry. Nucleophilic substitutions at allylic, aliphatic trigonal, benzylic, and vinylic carbons. Reactivity, the effect of substrate structure, the effect of attacking nucleophiles, leaving groups, and reaction medium. SN reactions at bridgehead carbon, competition between SN_1 and SN_2, Ambident nucleophiles, Neighboring Group Participation.	**15 L**
UNIT-II **A) Introduction to aromaticity in Benzenoid and non–Benzenoid compounds [7 L]** Three, four, and five-membered systems. tropone, tropolone, and tropylium salts. **B) I- Aromatic Electrophilic Substitutions [6 L]** Introduction, the arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts, and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio, ipso attack, and orientation in their ring systems. Diazo-coupling, Vilsmeier-Hack reaction, Von Richter rearrangement. **II-Nucleophilic aromatic substitution reactions SN_1, SN_2 [2 L]**	**15 L**
UNIT-III **A) Elimination Reactions [5 L]** The E_1, E_2 and E_{1cB} mechanisms. Orientation in elimination reactions. Hoffmann versus Saytzeff elimination, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions. Pyrolytic elimination reactions. **B) Study of the following reactions [10 L]** Mechanism of condensation reaction involving enolates, Benzoin, Stobbe, Robinson annulation, Simon-Smith, Vlhmann, Mc-Murry, Prins, Wurtz-Fittig reaction, Hunsdiecker	**15 L**

reaction, Pummerer, Corey-Chaykovsky reaction, Nef reaction, Passerini reaction, Baylis-Hilman reaction, Mitsunobu Reaction.	
UNIT-IV **Stereochemistry** Concept of chirality, prochiral relationship, homotopic, enantiotopic, and diasteriotopic groups, and faces. Racemic modifications and their resolution. R and S nomenclature. Conformational analysis: Cyclohexane derivatives, stability, and reactivity, Conformational analysis of disubstituted cyclohexanes. Introduction of optical activity in the absence of chiral carbon.	**15 L**
RECOMMENDED BOOKS: 1. A Guidebook to Mechanism in Organic Chemistry (Orient-Longmans)- PeterSykes 2. Organic Reaction Mechanism (Benjamin) R. Breslow 3. Mechanism and Structure in Organic Chemistry (Holt Reinh.)E. S. Gould. 4. Organic Chemistry (McGraw-Hill) Hendrikson, Cram and Hammond. 5. Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio. 6. Reactive Intermediates in Organic Chemistry (John Wiley) N. S. Issacs. 7. Stereochemistry of Carbon Compounds. (McGraw-Hill) E.L.Eliel 8. Organic Stereochemistry (McGraw-Hill) by Hallas. 9. Organic Reaction Mechanism (McGraw-Hill) R. K. Bansal. 10. Organic Chemistry- R. T. Morrison and R. N. Boyd,(Prentice Hall.) 11. Modern Organic Reactions (Benjamin) H. O. House. 12. Principle of Organic Synthesis- R.O.C. Norman and J. M. Coxon. (ELBS) 13. Reaction Mechanism in Organic Chemistry- S. M. Mukharji and S. P. Singh. 14. Stereochemistry of Organic Compounds by D. Nasipuri. 15. Advanced Organic Chemistry (McGraw-Hill) J. March. 16. Introduction to Stereochemistry (Benjamin) K. Mislow. 17. Stereochemistry by P. S. Kalsi (New Age International)	
ICH102: Inorganic Chemistry-I [Credit 4, 60 L Hours]	
UNIT-I **Chemistry of Transition Elements** General characteristics and properties of transition elements, Coordination chemistry of	**15 L**

transition metal ions, Stereochemistry of coordination compounds, Crystal field theory (CFT) for tetrahedral, octahedral, square pyramidal, square planar, and trigonal bipyramidal fields, Crystal field stabilization energy (CFSE), Factors affecting the crystal field splitting parameters, Strong and weak field complexes, Spectrochemical series, Jahn-Teller Distortion, Applications of CFT for defining kinetic properties of complexes and site selections of cations, anions in spinels. Molecular orbital theory (MOT) for octahedral complexes involving sigma- and pi-bonding, and for tetrahedral complexes.	
UNIT-II **Organometallic Chemistry** Definition and criteria of organometallic compounds, Classification of organometallic compounds based on hapticity and polarity of M-C bond, Nomenclature and general characteristics, 18 electron rule-applications and exceptions, Synthesis, bonding, properties and reactivity of representative organometallic compounds (-CO, -NO, -alkene, -alkyne), Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination, Organometallics in homogeneous catalysis: Hydrogenation of olefins, hydroformylation reaction, Monsanto Acetic Acid, and polymerization of olefins.	**15 L**
UNIT-III **Transition Metal Carbonyls and Related Compounds** Introduction, Preparation, structure, physical and chemical properties of metal carbonyls, Anionic and cationic carbonyl complexes, Lewis base derivatives of carbonyls, Carbonylhydrides, Carbonyl halides, Miscellaneous derivatives of metal carbonyls, Nitrosyl complexes of transition metals, complexes of molecular nitrogen, Cyanide complexes of transition metals.	**15 L**
UNIT-IV **Molecular Symmetry and Group Theory** Introduction to Symmetry, Symmetry operations, Symmetry elements, Point group and its classification (Cn-type, Dn-type, Special-type), Schoenflies symbol for point groups, Group and its Properties, Group multiplication table, Matrix representation of symmetry elements, Reducible and Irreducible representations, Properties of Irreducible representation, Great orthogonal theorem (without proof) and its importance, Construction of character table for water molecule, Mulliken symbolism rules for irreducible representations,	**15 L**
RECOMMENDED BOOKS:	

1. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
2. A. F. Wells, Structural Inorganic Chemistry– 5th edition(1984)
3. J. H. Huheey, Inorganic Chemistry-Principles, structure and reactivity, Harper and Row Publisher, Inc. New York(1972)
4. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
5. A. R. West, Plenum, Solid State Chemistry, and its applications
6. H. J. Emeleus and A. G. Sharpe, Modern Inorganic Chemistry
7. A. R. West, Basic Solid State Chemistry, 2nd edition
8. M. C. Dayand J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
9. A. H. Hanney, Solid State Chemistry, A. H. Publications
10. O. A. Phiops, Metals, and Metabolism
11. Cullen Dolphin and James, Biological aspects of Inorganic Chemistry
12. Williams, An Introduction to Bioinorganic Chemistry
13. M. N. Hughes, Inorganic Chemistry of Biological Processes
14. Ochi, Bioinorganic Chemistry
15. F.A. Cotton, R.G. Wilkinson. Advanced Inorganic Chemistry
16. Willam L. Jooly, Modern Inorganic Chemistry
17. Manas Chanda, Atomic Structure and Chemical Bonding
18. N. N. Greenwood and A. Earnshaw, Chemistry of elements, Pergamon
19. S. J. Lippard, J. M. Berg, Principles of bioinorganic Chemistry, University Science Books
20. G. L. Eichhron, Inorganic Biochemistry, Vol I and II, Elesevier
21. Progress Inorganic Chemistry,Vol18 and38,J.J.Loppard,Wiley
22. Inorganic Chemistry, P. Atkins, T. Overtone, J. Rourke, M. Weller, F. Armstrong, 5th Eds., Oxoford University Press.
23. Inorganic Chemistry, H. E. House, Elsevier Publishers.

E-OCH103 Elective Paper: Organic Chemistry-II [Credit 4, 60 L Hours]

UNIT-I **Study of the following rearrangements** Curtius, Lossen, Witting, Neber, Orton, Hofmann-Martius, Demjanov, Dakin, Rupe, Gabriel–Colman, Carroll, Payne, Favorskii, Sommelet-Hauser, Stevens.	**15 L**
UNIT-II	**15 L**

Study of Coupling Reactions Heck, Suzuki, Stille, Nigeshi, Sonogashira, Buchwald-Hartwig, Cadiot-Chodkiewicz, A^3, Kumada, Ulman, Chanlam, Hiyama coupling, Tsuji-Trost reaction.	
UNIT-III **Oxidation** Applications of oxidizing agents: Woodward-Prevost hydroxylation, Chloranil, and hydrogen peroxide. Swern oxidation. PCC (Corey's reagent), PDC (Cornforth reagent), Baeyer-Villiger oxidation. Dakin oxidation, Ceric Ammonium Nitrate (CAN), Sodium Hypochlorite, The Babler Oxidation, Corey Kim Oxidation, Wacker Oxidation, $NaIO_4$ and HIO_4, Etard oxidation.	**15 L**
UNIT-IV **Reductions** Study of following reductions- Catalytic hydrogenation using homogeneous and heterogeneous catalysts. Study of the following reducing reagents and reactions: Metal complex hydrides, Wolff-Kishner, Birch, Sodium in alcohol, Fe in HCl, Adam's catalyst, Lindlar catalyst, TBTH, Corey-Bakshi-Shibata reduction (CBS reagent), Zinc borohydride, Luche reduction ($CeCl_3$, $NaBH_4$, MeOH).	**15 L**
RECOMMENDED BOOKS: 1. Modern Synthetic Reactions-(Benjamin) H. O. House. 2. Reagents in Organic Synthesis-(John Wiley) Fieser and Fieser 3. Principles of Organic Synthesis-(Methuen) R. O. C. Norman 4. Hydroboration- S. C. Brown. 5. Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West. 6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar 7. Oxidation by-(Marcel Dekker) Augustin 8. Advanced Organic Chemistry 2nd Ed. R R. Carey and R. J. Sundburg 9. Organic Synthesis-(Prentice Hall)R. E. Ireland. 10. Homogeneous Hydrogenation-(J. K.) B. R. James. 11. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis. 12. Organic Reactions- R. Adams. 13. Some Modern Methods of Organic Synthesis-(Cambridge) W. Carruthares. 14. Organic Chemistry- Jonathan Clayden	
E-ICH103 Elective Paper: Inorganic Chemistry -II [Credit 4, 60 L Hours]	

Unit I **Non-aqueous solvents** Classification of solvents, Characteristics of solvents, Types of reactions in solvents, Physical and chemical properties of the non-aqueous solvents such as liquid ammonia, sulfur dioxide, dinitrogen tetroxide, anhydrous sulphuric acid, and molten salts.	**15 L**
Unit II **Nuclear and Radiochemistry** Nuclear stability and nuclear binding energy, Radioactivity, and radioactive decay, Classification of nuclear reactions, Nuclear reaction cross section, Nuclear fission, Nuclear fusion, Artificial or Induced Radioactivity, Designing, and constructions of Nuclear Reactors, Nuclear Reactors in India, Applications of radioactivity in agriculture, medical field, and industry.	**15 L**
Unit III **Bioinorganic Chemistry** Role of metal ions in biological processes, structure and properties of metalloproteins, porphyrines, metalloenzymes, oxygen transport, electron transfer reactions, cytochromes, ferredoxins and iron sulfur proteins, ion transport across membranes, Nitrogen fixation-nitrogenase, metal complexes in medicines	**15 L**
Unit IV **Solid State Chemistry** Crystal structure, Crystal types, Crystal defects, Electronic structure of solids, Band theory, Theory of Metals, Semiconductors and Insulators, Superconductivity, optical and magnetic properties, Solid state reactions, AB[Nickelarsenide(NiAs)], AB_2[fluorite(CaF_2) and anifluorite], layer structure [cadmium chloride and iodide ($CdCl_2$ & CdI_2)]	**15 L**
RECOMMONDED BOOKS: 1. J. E. Huheey, Inorganic Chemistry- Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972) 2. J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London 3. M.C. Dayand J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP 4. Jones, Elementary coordination Chemistry 5. Martell, Coordination Chemistry 6. T. S. Swainand D. S.T. Black, Organometallic Chemistry 7. John Wulff, structure and properties of materials, vol–4, electronic properties, Wiley	

Eastern
8. L. V. Azoroff, J. J .Brophy, Electronic processesing materials, McCraw Hill
9. F.A. Cotton, R. G. Wilkinson. Advanced Inorganic Chemistry
10. Willam L. Jooly, Modern Inorganic Chemistry
11.Manas Chanda, Atomic Structure and Chemical bonding
12.P. L.Pauson, Organometallic Chemistry
13.H. S. Sisler, Chemistry in non–aqueous solvents, Reinhold Publishing Corporation, USA,4th edition (1965)
14.H. J. Arnikar, Essentials of Nuclear Chemistry
15.Friedlander, Kennedy and Miller, Nuclear and Radiochemistry.
16.Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A. K. Das and M. Das, CBS Publishers.
17.Inorganic Chemistry, P. Atkins, T. Overtone, J. Rourke, M. Weller, F. Armstrong, 5th Eds., Oxoford University Press.
18.Inorganic Chemistry, H. E. House, Elsevier Publishers.

E-PCH103 Elective Paper: Physical Chemistry-I [Credit 4, 60 L Hours]

UNIT-I **15 L**

PHOTOCHEMISTRY

Absorption of light, laws of photochemistry, electronic structure of molecules, molecular orbital,electronicallyexcitedsingletstates,designationbasedonmultiplicity rule, construction of Jablonski diagram, electronic transition, Frank Condon principle, selection rules, intensity of absorption bands, nature of electronic spectra and primary process, photo- dissociation, pre-dissociation, Photo physical phenomena: photo-physical pathways of excited molecular system(radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, collisional quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and applications in chemical analysis. Photochemical reactions, photo-oxidation, photoreduction, photo- dimerization, photoisomerization and photosensitized reactions. Photochemistry of environment: Greenhouse effect. Numerical Problems

UNIT-II **15 L**

ELECTROCHEMISTRY

Ion-ion interaction: Debye-Huckel Theory, limited and extended law. Ion transport in solution: Fick's laws of diffusion, Einstein relation between diffusion coefficient and ionic mobilities, The Nernst-Einstein equation, relation between absolute and conventional mobilities. Abnormal ionic conductance of hydroxyl and hydrogen ions. batteries –Acid and alkaline storage batteries, Li ion battery	
UNIT III **BIOPHYSICAL CHEMISTRY** Introduction to biophysical chemistry: Amino acids, peptide, proteins, enzymes, nucleic acids: Introduction to primary, secondary, tertiary and quaternary structures, acid base properties. Intermolecular forces: H-bonding, Van der Waals forces, Lenard-Jones potential, columbic interactions, 1-4 interactions, hydrophobic hydration and interaction. Protein folding/defolding phenomena, use of spectroscopic and thermodynamic tools for protein-ligand binding equilibrium study, hydrodynamic and equilibrium thermodynamic methods for determination of molar mass of biological macromolecules.	**15 L**
UNIT-IV **MACROMOLECULES** Macromolecules: Mechanism of polymerization, molecular weight of a polymer (Number and mass average) viscosity average molecular weight, numerical problems. Degree of polymerization and molecular weight, practical significance of polymer molecular weight, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultra centrifugation) Chemistry of polymerization: Ceiling temperature, Free radical polymerization (Initiation, propagation and termination), kinetics of free radical polymerization, step growth polymerization (Polycondensation), molecular weight distribution, kinetics of step polymerization, cationic and anionic polymerization. Electronically conducting polymers, thermodynamics of polymer solutions: Flory-Huggins Theory. Glass transition temperature and molecular weight, factors influencing Glass transition temperature, determination of glass transition temperature, Numerical Problems	**15L**
RECOMMENDED BOOKS: 1. Biophysical Chemistry – J. P. Allen, Wiley-Blackwell, 2008. 2. Biophysical Chemistry – A. Cooper, RSC, 2004. 3. Thermodynamics of Biochemical Reactions– R.A. Alberty, Wiley-Interscience, 2003.	

4. Textbook of Biophysical Chemistry – U.N. Dash, McMillan India, 2006.
5. Physical Chemistry of macromolecules- D. D. Deshpande, Vishal Publications.
6. Polymer Chemistry- F. W. Billmeyer Jr, John-Wiley&Sons, 1971.
7. An Introduction to Electrochemistry by S. Glasstone
8. Modern Electrochemistry Vol. I &II by J. O. M. Bockris and A.K.N. Reddy.
9. Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959
10. Electrochemistry- S. Glasstone, D. VanNostrand,1965
11. Photochemistry– J.G. Calverts and J.N. Pitts, John-Wiley&Sons
12. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
13. Introduction to Photochemistry-Wells
14. Photochemistry of solutions-C.A. Parker, Elsevier

E-ACH103 Elective Paper: Analytical Chemistry-I [Credit 4, 60 L Hours]

UNIT-I **15 L**

Thermal Analysis Techniques

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

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

b) Differential thermal analysis (DTA) and differential scanning calorimetry (DSC), instrumentation, methodology, application and research implications. Thermometric titrations method and applications

Problems: Simple problems based on TG, DTG, DTA and DSC.

UNIT-II **15 L**

Atomic Spectroscopy

a) Atomic Absorption Spectroscopy Introduction, Principal, difference between AAS and FES, Advantages of AAS over FES, advantages and disadvantages of AAS, Instrumentation, Single and double beam AAS, detection limit and sensitivity, Interferences, applications. Graphite furnace atomic absorption spectroscopy, general description, advantages and

disadvantages. Flame photometry, Cold Vapour Mercury, Hydride Generation, Spark emission, challenges and limitations. b) Inductively Coupled Plasma Spectroscopy Introduction, Nebulisation Torch, Plasma, Instrumentation, Interferences, and Applications. Problems: Simple problems based on FES, AAS, GFAAS, ICP-AES, ICP-OES etc.	
UNIT-III **UV-Visible Spectroscopy** Ultraviolet and visible spectrophotometry (UV-Vis) Introduction, Beer Lambert's law, the magnitude of Molar absorptivities, instrumentation, Effect of solvents, Woodward-Fieser's rule, calculation of absorption maxima of dienes, dienones and polyenes, applications, Structural problems based on UV-Vis.	**15 L**
UNIT-IV **Infrared Spectroscopy** Infrared Spectroscopy (IR) Introduction, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups. Factors affecting frequencies, applications. Fourier Transform Infrared Spectroscopy: Instrumentation and applications. Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) Spectroscopy: Instrumentation and applications. Universal Total reflectance-Fourier Transform Infrared (UTR-FTIR) Spectroscopy: Instrumentation and applications. **Problems:** Simple structural problems based on IR.	**15 L**
RECOMMENDED BOOKS 1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle. 2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler 3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming 4. Absorption spectroscopy of organic molecules- V.M. Parikh 5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi 6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel 7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago 8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.) 9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd. 10. Instrumental methods of chemical analysis, H. Kaur, PragatiPrakashan. 11. Fundametals of molecular spectroscopy-C.N. Banwell and E. M.McCash.	

PRCH104 Practical Paper-I [Credit 4, 120 Hours]	
Chemistry Major Practical Course	
A) Organic Chemistry Experiments **Organic Preparations (Any Five)**: (One-stage preparations involving various types of reactions and confirmation of product by TLC) 1. Coumarin Synthesis- 7-OH-4-methyl coumarin from Resorcinol and EAA. 2. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile. 3. Preparation of Hydantoin. 4. Synthesis of triazoles- Reaction of aldehyde and thiosemicarbazide. 5. Preparation of benzimidazole from OPD 6. Preparation of Orange II 7. Synthesis of dihydropyrimidone by Biginelli reaction 8. Synthesis of Dibenzylidene acetone 9. Preparation of Benzanilide from Benzophenone Oxime 10. Benzoic acid and benzyl alcohol from benzaldehyde (Cannizarro reaction). 11. Preparation of m-dinitrobenzene from nitrobenzene. (Any suitable preparation may be added) **B) Inorganic Section** 1) Ore Analysis i) Determination of Silica and Manganese in Pyrolusite ore. ii) Determination of iron from Haematite ore. 2) Alloy Analysis i) Determination of tin & lead from Solder alloy. ii) Determination of copper and nickel from monel metal alloy. 3) Determination of concentration of phosphates in water samples colorimetrically. Any other advanced experiments related to Inorganic Chemistry **C) Physical Section** 1) Chemical Kinetics: Kinetics of reaction between bromate and iodide. 2) Adsorption: Study of adsorption of acetic acid on charcoal. 3) Viscosity: Determination of molecular weight of polymers. 4) Refractometry:	

i) Determination of molecular radius of molecule of organic compound.

ii) Determination of concentration of sugar in unknown sample.

5) Polarimetry: Kinetics of inversion of cane sugar in presence of strong acid.

(New experiments may also be added)

D) Analytical Section

1. To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample Spectrophotometrically.
2. To determine the iron potentiometrically by titrating with potassium dichromate.
3. To determine the solubility of Calcium oxalate in presence of different concentration of KCl.
4. To determine the solubility of Calcium oxalate in presence of different concentration of HCl.
5. Analysis of pharmaceutical tablets for ibuprofen content.
6. To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically/spectrophotometrically.
7. To estimate the amount of D-glucose in a given solution colorimetrically.
8. To determine the acid value of given oil.

PRCH105 Practical Paper-II [Credit 2, 60 Hours]

Chemistry Minor Practical Course

A) Organic Section

Organic Estimations:(Any Three)

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

Any suitable Expt. may be added.

B) Inorganic Section

Preparations and purity (Any four)

1. Potassimtrioxalatochromate(III)trihydrate

2. cis-potassiumdioxalatodiaquachromate(III)
3. Potassionhexathiocyanatochromate(III)
4. Bis(dimethylglyoximato)nickel(II)
5. Carbonatotetramminocobalt(III)nitrate
6. Hexamminocobaltic(III)chloride

C) Physical Section

1. Potentiometry:
   i) Determination of solubility and solubility product of silver halides.
   ii) Determination of binary mixture of weak and strong acid.
2. Conductometry:
   i) Determination of mixture of acids and relative strength of weak acids.
   ii) Determination of solubility of lead sulphate.
   iii) Determination of CMC and ΔG of sodium dodecyl sulphate.
3. pH-metry: Determination of dissociation constant of dibasic acid.

D) Analytical Section

1. Determination of standard deviation from the results obtained by redox titration of iron solution against standard potassium dichromate solution.
2. Determination of sodium from the fertilizer sample using cation exchange chromatography.
3. Determination of calcium from given drug sample.
4. Determination of hardness, alkalinity and salinity of water sample.
5. Separation and estimation of Cd^{2+} and Zn^{2+} by ion exchange chromatography for given Cd^{2+} and Zn^{2+} mixture. (Any other experiments may be added)
6. Application of excel spreadsheet for determination of Mean, median, standard deviation and graph plot.

RECOMMENDED BOOKS:

1. A Text Book of Practical Organic Chemistry- A. I. Vogel.
2. Practical Organic Chemistry- Mann and Saunders.
3. A Handbook of Quantitative and Qualitative Analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.

5. Practical Med. Chem..-Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy
6. A text book of Quantitative Inorganic Analysis– A. I. Vogel
7. Experimental Inorganic Chemistry -W. G. Palmer
8. The analysis of minerals and ores of the rarer elements–W.R. Schoeller and A. R. Powell, Charles, Griffin and Company Limited.
9. Experimental Inorganic / Physical Chemistry–M. A. Malti, Horwood Series in Chemical Science, Horwood Publishing Chinchster.
10. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
11. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
12. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
13. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.)

RM-CH106 Research Methodology [Credit 4, 60 L Hours]

UNIT-I **15 L**

A) Introduction to Research Methodology

Objective of research, motivation in research, Introduction to research methodology, design and implementation of research methods, types of research, Fundamental research, applied research, experimental research, and interdisciplinary research, the research process, formulating, reviewing the literature.

B) Scope of Research and Ethics:

Scientific methods of research, criteria of good research, and characteristics of a good research, Research problem: Identification, Selection, developing research title, Criteria for prioritizing topics for research, Prioritizing Topics for Research, Formulation of research objectives.

Types and importance of research ethics, Institutional ethics committee, Plagiarism, Patenting and intellectual property rights. Publication ethics: definition, introduction, and importance.

UNIT-II Literature Search and Techniques **15 L**

Literature review, Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, and Formula Index.

Literature Search technique: SCOPUS, Google Scholar, PUBMED, Web of Science, science direct, Indian Citation Index, Research Gate, and scifinder, Scirus, ChemIndustry, Wiki-Databases, ChemSpider. Overview of the journal article: Selection of journals, Data bases and research metrics Databases: i) indexing databases ii) Citation databases: Web of Science, Scopus, UGC-Care List etc. Research Metrics: a) Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score b) Metrics: h-index, g index, i10 index. Citation Index, Impact Factor	
UNIT-III Scientific report writing Publication Process: Types of technical documents- Full length research paper, Short/Brief communications, Letters to editor, Book chapter, Review, Conference report, Patents, dissertation. Components of a research publication/proposal: Title/Topic statement, Abstract/key words, Aims and objectives, Hypothesis building, Rationale of the paper, Work plan, Materials and methodology, Results and discussion, mechanism, Key issues, and arguments, Acknowledgement, Conflict of interest statement, bibliography, Technical Resumes & Cover Letters. Softwares in Chemistry: Data Plotting, Structure Drawing, Grammar Checkers and Sentence Correction Tools. Use of bibliography tools (Endnote/Zotero/Mendeley).	**15 L**
Unit IV **A) Quantitative Techniques** Classification of quantitative methods, General steps required for quantitative analysis, reliability of the data, classification of errors, accuracy, precision, statistical treatment of random errors, the standard deviation of complete results, error proportion in arithmetic calculations, Uncertainty and its use in representing significant digits of results, confidence limits, Estimation of detection limit. **B) Computer Applications: Presentation and Communication skills** The students will learn how to operate a PC and how to run standard programs, software and packages. Execution of linear regression, X-Y plot, numerical integration, and differential as well as differential equation solution programming, Chemo metrics – Computer-based laboratory, instrumental data interpretation, statistical data interpretation Conference presentation, preparation of effective slides and presentation. Tables, Figures and Pictures using Excel, PowerPoint slide preparation, Preparation of Posters, Electronic submission of manuscripts, oral and poster, Communication skills.	**15 L**

References: 1) Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, and F. J. Hooler. 2) Quality in the Analytical Chemistry Laboratory by R. D. Treble and D. G. Holcombe. 3) Molecular dynamics simulations elementary methods by J. M. Haile. 4) The art of molecular dynamics simulations by D. C. Rapaport. 5) Introduction to computational chemistry by F. Jensen. 6) Molecular modeling principles and applications by A. R. Leach. 7) Computer Education by Prof. Lalini Varanasi, Prof. V. Sudhakar, and Dr. T. Mrunalini, Neelkamal Publications PVT. LTD. 8) Basic Computing Principles by B. West, BPB Publications, New Delhi 1992 9) Essentials of computational chemistry by C. J. Cramer. 10) Practical Research Methods, Catherine Dawson, UBS Publishers Distribution, New Delhi 2002. 11) Research Methodology – Methods and Techniques, C. R. Kothari, Wiley Easter Ltd, New Delhi 1985. 12) Research Methodology – A Step by step Guide for Beginners 2nd edn. Kumar Ranjit, Pearson Education, Singapore, 2005. 13) Introduction to Research and Research Methodology M. S. Sridhar. 14) The Information Specialist's Guide to Searching & Researching on the Internet & the World Wide Web by Ernest Ackermann, Karen Hartman, Fitzroy Dearborn Publishers, London. 15) Learning to Use the World Wide Web, Ernest Ackermann, BPB Publications	

M. Sc. Part – I (Semester – II)

PCH201: Physical Chemistry-II [Credit 4, 60 L Hours]	
UNIT-I **QUANTUM CHEMISTRY** Introduction: Wave particle duality of material and DeBroglie's hypothesis, uncertainty principle, Schrodinger equation, wave function, conditions for acceptable wave functions and its interpretation, properties of wavefunctions, Operators and related theorems, algebra of operators, commutator, linear operators, Normalization and orthogonality, Eigenfunctions and Eigenvalues, postulate of quantum mechanics. Solutions of wave equation for a free particle and particle in a box problem, Transition dipole moment integral and selection rules,	**15 L**

particle in a box application to electronic spectra of conjugated linear organic molecules. Linear and angular momentum operators, eigen function and eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin angular momenta, symmetric and antisymmetric wavefunctions, Pauli Exclusion Principle, spectroscopic term symbols. Numerical problems	
UNIT-II **STATISTICAL THERMODYNAMICS** Probability and distribution, Stirling's Approximation, Weights and configurations, the most probable configuration, Ensembles, ensemble average and time average of property. Statistical equilibrium, thermodynamic probability, Maxwell-Boltzmann (MB) distribution law. Partition function and its significance. Rotational, translational, vibrational and electronic partition functions. Relationship between partition function and thermodynamic properties, thermodynamic probability and entropy: Boltzmann – Planck equation and third law of thermodynamics, Application to monoatomic gases – Sackur-Tetrode equation, applications to diatomic molecules, Statistical expression for equilibrium constant, Limitations of Maxwell-Boltzmann statistics, Numerical Problems.	**15 L**
Unit-III **ELECTROCHEMISTRY** Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex Electrokinetic phenomena: Electrical double lever, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.	**15 L**
UNIT-IV **CHEMICAL KINETICS** Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO_2 and F_2, decomposition of ozone, and nitrogen pentoxide. Ionic	**15L**

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

RECOMMONDED BOOKS:

1. IntroductoryQuantumChemistry-A. K. Chandra.TataMcGraw-Hill.1988.
2. Physical Chemistry: A molecular Approach Donald A. McQuarrie and John D. Simon, Viva Books, New Delhi, 1998.
3. Quantum Chemistry–Donald A. McQuarrie, Viva Books, NewDelhi,2003.
4. Quantum Chemistry-W. Kauzmann, Academic press.
5. Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists-S. Glasstone, D. Van Nostrand Company, Inc.,1944.
6. Quantum Chemistry-R.K. Prasad, New Age International, NewDelhi.
7. Physical Chemistry–R.S. Berry, S.A. Rice, J. Ross, 2ndEd., Oxford University Press, NewYork, 2000.
8. Physical Chemistry–P.W.Atkins, Oxford Universitypress, 8thedition, 2006.
9. Text book of Physical Chemistry– S.Glasstone.
10. Principles of Physical Chemistry– Marron and Pruton.
11. Physical Chemistry–G.M.Barrow, Tata-McGraw Hill, Vth edition,2003.
12. Thermodynamics for Chemists –S. Glasstone, D. Van Nostrand, 1965.
13. Elements of statistical thermodynamics- L. K. Nash, 2nd Ed. Addison Wesley 1974.
14. Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists - S. Glasstone, D. Van Nostrand Company, Inc.,1944.
15. An Introduction to Statistical Thermodynamics–T.L. Hill, Addison-Wesley. 1960
16. Statistical Mechanics–DonaldA.McQuarrie,2000.
17. An Introduction to Electrochemistry by S. Glasstone
18. Modern Electrochemistry Vol.I & II by J.O.M. Bockris and A.K.N. Reddy.
19. Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959
20. Chemical Kinetics-K. J. Laidler, Pearson Education,2004
21. Kinetics and Mechanism-A. A. Frostand R. G. Pearson.
22. Electrochemistry- S. Glasstone, D. VanNostrand,1965

23. Advanced Physical Chemistry-Gurdeep Raj, Goel Publishing House 24. Basic chemical Kinetics-G.L. Agarwal, Tata-McGraw Hill 25. Physical Chemistry– G.M. Barrow, Tata-McGraw Hill, Vth edition,2003.	
ACH202: Analytical Chemistry-II [Credit 4, 60 L Hours]	
UNIT-I **Basics of Analytical Chemistry and Indian Knowledge System (IKS)** **Basics of Analysis:** Chemical analysis, instrumental methods, Analytical methods, Techniques of analysis, classification of analytical techniques, Classification of instrumental methods, factors affecting choice of analytical methods, interferences. **Statistical analysis:** Types and sources of error, determinate and indeterminate errors, accuracy and precision Absolute and relative errors, Minimization of errors, Significantfigures, Mean, median and standard deviation, Least square method. **MS Office in Chemistry applications:** Excel Spreadsheet, Introduction to excel and its applications for computation and graph plotting, calculations using formulas for summation, mean, standard deviation. MS-Word for Chemical Documentation, MS PowerPoint for Virtual Chemical Animations. Numerical Problems. **Indian Knowledge System (IKS) and Chemistry:** Introduction, concept, Historical background, stone age, iron age, bronze age, metallurgy, alloys and Indian perspectives	**15 L**
UNIT-II **Fundamentals of Quantitative Analysis** **Volumetric Analysis:** Introduction, general terms in volumetric analysis, indicators, indicator theory, choice of indicators. Acid-base titrations, titration curves with example, Buffer solutions, acid-base equilibrium in- polyprotic acids, amino acids, carbonates, bicarbonates, mixture of two acids. Complexometric titrations-stability of complexes, metal-ion buffer, titrations involving unidentate and multidentate ligands. Precipitation titrations and solubility equilibria, indicators, factors affecting solubility, applications of precipitation titrations. Oxidation-reduction equilibria and applications, Nernst equation, titration curves, redox indicators, applications with respect to $KMnO_4$, $K_2Cr_2O_7$, Iodine, and Potassium bromate. **Gravimetric Analysis:** Introduction, general terms used in gravimetry, steps in gravimetric analysis, conditions for precipitation, purity of the precipitate – Co-precipitation and Post-precipitation, precipitation from homogenous solution, organic precipitants. Advantages and disadvantages of gravimetric analysis. Determination of iron gravimetrically form iron ore,	**15 L**

determination of lead gravimetrically from Galena ore, determination of Pb gravimetrically from type metal alloy. Problems.	
UNIT-III **Chromatographic methods of separation** General principle, classification of chromatographic methods, migration rates of solutes, chromatographic behavior of solutes, band broadening, terms in chromatography, plate theory, column efficiency and resolution. Introduction to paper, TLC and column chromatography. **Gas Chromatography:** Basic Principle, Instrumentation, detectors, Applications, Advantages and disadvantages. **HPLC:** Basic Principle, Instrumentation, detectors, applications, advantage and disadvantages. **Ion exchange chromatography:** Introduction and basic principles, instrumentation, types of exchangers, synthesis of ion exchangers, mechanism of ion exchange, exchange theories, methodology, applications. Problems.	**15 L**
UNIT-IV **Electro Analytical Techniques** **a) Voltammetry:** Voltammetric methods of analysis, voltametric techniques, current in voltammetry, shape of voltammograms **Polarography:** Introduction, Instrumentation, Ilkovic equation and its verification. Polarographic measurements, Dropping mercury electrode, Determination of half wave potential, qualitative and quantitative applications. **Amperometry:** Basic principles, instrumentation, Amperometric titration curves, Amperometric indicators, procedure for Amperometric titrations, Evaluation of amperometry in research and analytical applications **b) Electrogravimetry:** Introduction, Types of electrogravimetric techniques, Diffusion Migration, Convection, instrumentations, applications.	**15 L**
RECOMMENDED BOOKS: 1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle. 2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler 3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming 4. Absorption spectroscopy of organic molecules- V.M. Parikh 5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi	

6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel 7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago 8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.) 9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd. 10. Instrumental methods of chemical analysis, H. Kaur, PragatiPrakashan. 11. Fundametals of molecular spectroscopy-C.N. Banwell and E. M.McCash.	

E-OCH203 Elective Paper: Organic Chemistry-III [Credit 4, 60 L Hours]	
UNIT-I **Organic Photochemistry** Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclization reactions, rearrangements of 1,4 and 1,5-dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α, β-unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions, dimerization and oxetane formation, photochemistry of aromatic compounds, photo fries reactions of anilides, photo fries rearrangements. Singlet molecular oxygen reactions.	**15 L**
UNIT-II **A) Hydroboration [5L]** Various hydro borating agents their mechanism and synthetic applications of 9-borabicyclo-[3.3.1]nonane (9-BBN), thexylborane, and diisoamylborane. (Sia_2BH), BH_3•SMe_2. (BMS). **B) Enamines [4L]** The formation, reactivity and synthetic applications of enamines **C) Protection of Functional Groups [6L]** Principle of protection of alcohol, amine, carbonyl and carboxyl groups	**15 L**
UNIT-III: **A) Study of Organometallic Compounds [07L]** Organo-lithium, Use of lithium dialkylcuprate, their addition to carbonyl and unsaturated carbonyl compounds, Allylic organometallics of boron, silicon and tin **B) Methodologies in Organic Synthesis [08L]**	**15 L**

Ideas of synthones and retrones, Functional group transformations and inter-conversions of simple functionalities.	
UNIT-IV **Reagents in Organic Synthesis** Tebbe reagent, Baker's yeast, Lawessons reagent, Diazomethane. Dimethyl dioxirane. Korn-Blum oxidation, Moffatt Oxidation Doring Parikh, Goldmann, Ag_2CO_3 on celite. TPAP, IBX, Dess-Martin oxidation	**15 L**
RECOMMENDED BOOKS: 1. Modern Synthetic Reactions-(Benjamin) H. O. House. 2. Reagents in Organic Synthesis-(John Wiley) Fieser and Fieser 3. Principles of Organic Synthesis-(Methuen) R. O. C. Norman 4. Hydroboration- S. C. Brown. 5. Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West. 6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar 7. Oxidation by-(Marcel Dekker) Augustin 8. Advanced Organic Chemistry 2nd Ed. R R. Carey and R. J. Sundburg 9. Organic Synthesis-(Prentice Hall)R. E. Ireland. 10. Homogeneous Hydrogenation-(J. K.) B. R. James. 11. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis. 12. Organic Reactions - R. Adams. 13. Some Modern Methods of Organic Synthesis-(Cambridge) W. Carruthares. 14. Organic Chemistry- Jonathan Clayden	
E-ICH203 Elective Paper: Inorganic Chemistry-III [Credit 4, 60 L Hours]	
UNIT-I **Chemistry of Non-transition Elements and their compounds** Periodic properties of the non–transition elements, Polymorphism in carbon, phosphorous and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur–nitrogen compounds, peroxo compounds of boron, carbon, sulphur, Structure and bonding in oxy acids of nitrogen, phosphorous, sulphur and halogens, interhalogens, psudohalides	**15 L**
UNIT-II	**15 L**

Stereochemistry and bonding in Main group compounds Hybridization and structure of molecules, VSEPR Theory (Postulates and Applications), t y p e of pi-bonding (pπ-pπ and pπ-dπ) and its consequences, Bent rule, Walsh Diagram, Some simple reactions of covalently bonded molecules (Atomic inversion, Berry Pseudo rotation, Nucleophilic displacement, Free radical reaction).	
UNIT-III **Chemistry of f-block elements (Lanthanides and Actinides)** Occurrence, properties of the f-block elements, colour, oxidation state, Spectral and magnetic properties of lanthanides and actinides, lanthanide contraction, Use of lanthanide compounds as shift reagents, compounds of lanthanides, Photoluminescence properties of lanthanide compounds, Modern methods of separation of lanthanides and actinides, Applications of lanthanide and actinide compounds in Industries.	**15 L**
UNIT-IV **Stability of Metal complexes** Thermodynamic vs. kinetic stability, Stability constant, Stepwise and overall stability constants with their relation, Trends in stepwise stability constant, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect, Ternary complexes and factors affecting their stabilities, Stability of metal complexes of crown ethers, Determination of stability constants by spectrophotometric methods (Job's and Mole/slope ratio for composition), Bjerrum' spHmetric method.	**15 L**
RECOMMONDED BOOKS: 1. A. F. Wells, Structural Inorganic Chemistry– 5thedition (1984) 2. J. H. Huheey, Inorganic Chemistry Principles, structure and reactivity, Harper and Row Publisher, Inc. NewYork (1972) 3. J. D .Lee, Concise inorganic Chemistry, Elbs with Chapmanand Hall, London 4. M.C. Dayand J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP 5. Jones, Elementary coordination Chemistry 6. Martell, Coordination Chemistry 7. T. S. Swainand D. S.T. Black, organometallic Chemistry 8. John Wulff, structure and properties of materials, vol 4, electronic properties, WileyEastern 9. L. V. Azoroff, J. J. Brophy, Electronic processes in materials, McCraw Hill 10.F.A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry	

11. Willam L. Jooly ,Modern Inorganic Chemistry
12. Manas Chanda, Atomic Structure and Chemical bonding
13. P. L. Pauson, Organometallic Chemistry
14. H. S. Sisler,Chemistry in non–aqueous solvents, Reinhold Publishing Corporation, USA, 4th edition (1965)
15. H. J. Arnikar, Essentials of Nuclear Chemistry
16. Friedlander, Kennedy and Miller, Nuclear and Radiochemistry.
17. Fundamental Concepts of Inorganic Chemistry (Vol I to VII),A. K. Dasand M. Das, CBS Publishers.
18. Inorganic Chemistry, P. Atkins, T. Overtone, J.Rourke, M. Weller, F. Armstrong, 5th Eds.,Oxoford University Press.
19. Inorganic Chemistry, H. E. House, Elsevier Publishers.

E-PCH203 Elective Paper: Physical Chemistry-III [Credit 4, 60 L Hours]

UNIT-I **15L**

THERMODYNAMICS

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

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

UNIT-II **15L**

SURFACE PHENOMENA

Adsorption, adsorption isotherms, surface area determination, Gibbs adsorption equation and its verification, Surface tension, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization.

Thermodynamics of micellisation, factors affecting critical micelle concentration (cmc), experimental methods of cmc determination. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces. Significance of surface phenomena in advanced technologies like nanotechnology, drug formulation etc.

UNIT-III **KINETIC THEORY OF GASSES** 1. Postulates of kinetic theory of gases, P-V-T relations for an ideal gas, non-ideal behavior of gases, equation of state, compressibility factor, virial equation, van der Waal's equation, excluded volume and molecular diameter, relations of van der Waal's constants with virial coefficients and Boyle temperature. 2. Molecular statistics, distribution of molecular states, deviations of Boltzmann law for molecular distribution, translational partition function, Maxwell Boltzmann law for distribution of molecular velocities, physical significance of the distribution law, deviation of expressions for average, root mean square and most probable velocities, experimental verification of the distribution law. 3. Molecular collision in gases, mean free path, collision diameter and collision number in a gas and in a mixture of gases, kinetic theory of viscosity and diffusion. Numerical Problems	**15 L**
Unit IV **COLLOIDS** Colloids: Colloidal solution, classification of colloids, Lyophobic and Lyophilic Colloids, Properties of colloids, Sol: Preparation, Theories of origin of charge on sol particles, Determination of charge on a colloidal particle, Stability of sols, Association colloids, Spontaneous ageing of colloids, Factors affecting the spontaneous ageing, theories of spontaneous ageing, coagulation, kinetics of coagulation. Emulsion: Types of emulsion, preparation, properties, Characteristics, Identification test between two types of emulsions, microemulsion, reverse microemulsion, emulsifiers, demulsification. Gels: classification, methods for the preparation of gels, properties of gels, Applications of colloid science.	**15 L**
RECOMMENDED BOOKS: 1. Physical Chemistry–P. W. Atkins, Oxford Universitypress,8thedition,2006. 2. Text book of Physical Chemistry– S. Glasstone. 3. Principles of Physical Chemistry– Marron and Pruton. 4. Physical Chemistry–G. M .Barrow,Tata-McGrawHill,Vthedition,2003. 5. Advanced Physical Chemistry-Gurdeep Raj, Goel Publishing House	

6. Physical chemistry of surfaces –A. W. Adamson, 4thEd. JohnWiley,1982 7. Introduction to Colloid and Surface Chemistry-D. J. Shaw, Butter worth Heinemann,1992. 8. Surface Activity: Principles, Phenomena and Applications (Polymers, Interfaces and Biomaterials)–K.Tsujii,1stEd.Academic Press,1998. 9. Thermodynamics for Chemists- S. Glassstone, 1965 10. Thermodynamics: A core course- R. C. Shrivastava, S. K. Saha and A. K. Jain 2004	
E-ACH203 Elective Paper: Analytical Chemistry-III [Credit 4, 60 L Hours]	
UNIT-I **Structural Spectroscopic techniques** Nuclear Magnetic Resonance (NMR) Magnetic and non-magnetic nuclei, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, chemical shift, anisotropic effect, spin spin coupling, coupling constant, applications to simple structural problems.	**15 L**
UNIT-II **Mass spectrometry (MS)** Basic principle, working of mass spectrometer, ionization, types of ionization and classification of MS based on ionization, analyzers (magnetic sector, quadrupole, ion-trap, time of flight, formation of different types of ions, Mclafferty rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications. **Problems: Simple structural problems based on IR, UV, NMR and MS**	**15 L**
UNIT III **Microwave Spectroscopy** Rotation of Molecules, Rigid and Non-rigid Rotors; Quantum Aspects of Molecular Rotational Energy and Selection Rules of Transitions; Diatomic and Polyatomic Molecules, Techniques and Instrumentation; Applications of Microwave Spectroscopy. Numerical problems	**15 L**
UNIT IV **Raman Spectroscopy** Introduction, Pure rotational Raman Spectra, Vibrational Raman Spectra, Polarization of light from Raman and Infra-red spectroscopy, Techniques and Instrumentation, Near Infra-red FT-Raman Spectroscopy. Hyphenated Raman techniques. Numerical problems	**15 L**
RECOMMENDED BOOKS:	

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

PR-CH204 Practical Paper-III [Credit 4, 120 Hours]

Chemistry Major Practical Course

A) Organic Section

Qualitative Analysis: **Separation of Binary Mixture by Micro analytical Technique**

Separation of binary mixture using physical and chemical methods. Identification of individual compounds and checking its purity by TLC. Preparation of the derivative of one of the compounds. The following types are expected: (i) Solid-Solid (ii) Non-volatile liquid- Non-volatile liquid (iii) Water-soluble/insoluble solid-Non-volatile liquid with compounds from the same or different chemical classes in all three categories.

The candidate is expected to carry out separation of at least **03** mixtures.

B) Inorganic Section

1) Ore Analysis

i) Determination of calcium and magnesium from Dolomite ore.

ii) Determination of copper and iron from Chalcopyrite ore.

2) Alloy Analysis

i) Determination of copper and zinc from brass alloy.

ii) Determination of iron & chromium from steel alloy.

3) Separation of Fe^{2+} Cu^{2+} Ni^{2+} by anion exchange.

C) Physical Section

1) Refractometry**:**

i) Determination of atomic refractions of H, C and Cl atoms.

ii) Determination of composition of mixture of liquids.

2) Cryoscopy: Determination of apparent weight and degree of dissociation a strong electrolyte

3) Chemical kinetics**:** Kinetics of iodination of acetone in presence of strong acid

4) Phase Equilibrium: To construct phase diagrams for ternary system.

5) Viscosity**:** Determination of radius of sucrose molecules.

(New experiments may also be added)

D) Analytical Section

1. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent.
2. To determine the solubility of PbI_2 in presence of different concentration of KNO_3
3. To determine the solubility of PbI_2 in presence of different concentration of KCl
4. Potentiometric estimation of bleaching powder.
5. Determination of capacity of cation exchanger
6. Determination of capacity of anion exchanger
7. Determination of turbidity of water sample using nephalometer
8. To determine the iron content from soap sample

PR-CH205 Practical Paper-IV [Credits 02, 60 hours]

Chemistry Minor Practical Course

A) Organic Section

Organic Estimations (Any Three):

1. Determination of percentage of Keto-enol form.
2. Estimation of Ibuprofen.
3. Estimation of Aspirin.
4. Estimation of the Acid value of an oil.
5. Estimation of Caffeine.

Any other suitable experiments may be added.

B) Inorganic Section

Preparations and purity (Any four)

1) Tris (acetylacetonato)cobalt(III)trihydrate
2) Penta-aquachloro chromium(III)chloride
3) Hexathioureaplumbus(II)nitrate
4) Bis (acetylacetonato) copper(II)
5) Diaquabis(ethylediammine) copper(II)iodide
6) Copper ferrite

C] Physical Section

1) Potentiometry:
   i. Determination of formal redox potential of system (Fe^{2+}, Fe^{3+})
   ii. Determination of binary mixture of halides.
   iii. Determination of dissociation constant of acetic acid.
2) Conductometry:
   i. Titration of ternary acid mixture of acids.
   ii. Verification of Onsagar Equation for1:1 type of strong electrolyte.
   iii. Determination of ΔG, ΔH, ΔS of silver benzoate by solubility product method.

D] Analytical Section

1. Determination of sulphate by nephalometry/tubidimetry
2. Determination of isoniazid from pharmaceutical tablet
3. Determination of caffeine from tea powder
4. Determination of iron from iron tablet samples
5. Estimation of fatty acid from soap sample

RECOMMENDED BOOKS:

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago

8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.) 9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd. 10. Fundametals of molecular spectroscopy-C.N. Banwell and E. M. McCash. 11. A textbook of Quantitative Inorganic Analysis– A. I. Vogel 12. Experimental Inorganic Chemistry-W. G. Palmer 13. The analysis of minerals and ores of the rarer elements– W. R. Schoeller 14. A. R. Powell, Charles, Griffin and Company Limited 15. A text book of Quantitative Inorganic Analysis– A. I. Vogel 16. Practical Organic Chemistry- Mann and Saunders. 17. A Handbook of Quantitative and Qualitative Analysis- H. T. Clarke. 18. Organic Synthesis Collective Volumes by Blat.	

M.Sc. I Syllabus (NEP-2020)

To be implemented from July 2023 onwards Semester I & II

Nature of Question paper

Total Marks 80

Instructions: 1) Attempt in all five questions.
2) Question No. 1 is compulsory.
3) Attempt any two questions from Section-I and any two questions from Section-II.
4) All questions carry equal marks. Figures to right indicate marks.

Q.1 Solve the Following (Compulsory1 Mark each) 16 Marks

a)
.
.To
.
p)

Section I

Q.2. Two sub questions (8 marks each) or Three sub question (6+6+4 marks) = 16 Marks

Q.3. Two sub questions (8 marks each) or Three sub question (6+6+4 marks) = 16 Marks

Q. 4 Two sub questions (8 marks each) or Three sub question (6+6+4 marks) = 16 Marks

Section II

Q.5. Two sub questions (8 marks each) or Three sub question (6+6+4 marks) = 16 Marks

Q.6. Two sub questions (8 marks each) or Three sub question (6+6+4 marks) = 16 Marks

Q.7. Writes notes on **any four** of the following (Out of Six) 16 Marks

a)
.
.To
.
e)

M.Sc. I Syllabus (NEP-2020)
To be implemented from July 2023 onwards
Nature of Practical Examination

Semester I

Practical Paper I and II (100+50) = 150 marks

Semester II

Practical Paper III and IV(100+50)= 150 marks

Number of Examination Days = 03