SCHEME OF EXAMINATIONS

RULES & REGULATIONS

AND

SYLLABUS

Third & Fourth Semester Examinations
Organic Chemistry Specialization

(Effective from the Academic Session 2016-2017)

Master of Science (M. Sc.)
Chemistry

Faculty of Science

This syllabus is only for courses running at University Department of Chemistry

UNIVERSITY OF KOTA

MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005

INDIA

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University of Kota, Kota

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

Year / Semester	Number of Paper	Code / ID of Paper	Nomenclature of Paper	Duration of Exam.	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
								Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Teaching Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
I Year I Semester	Paper-1.1	CHEM-511	Inorganic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.3	CHEM-513	Physical Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists or Biology for Chemists	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12 Hrs	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
I Year II Semester	Paper-2.1	CHEM-521	Inorganic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.3	CHEM-523	Physical Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12 Hrs	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
II Year III Semester	Paper-3.1	CHEM-631	Chromatography	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.3	CHEM-633	*Elective-I : Group I / II / III / IV*	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	*Elective-II : Group I / II / III / IV*	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	*Practical*	12 Hrs	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
II Year IV Semester	Paper-4.1	CHEM-641	Environmental Chemistry	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Organic Syntheses	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.3	CHEM-643	*Elective-I : Group I / II / III / IV*	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	*Elective-II : Group I / II / III / IV*	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	*Practical*	12 Hrs	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
			Total (I + II + III + IV Semester)	**108**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**1000**

Groups of Specializations in M. Sc. Chemistry

Year / Sem.	Electives	Code	Group-I: Inorganic Chemistry	Group-II: Organic Chemistry	Group-III: Physical Chemistry	Group-IV: Analytical Chemistry
II Year	Elective-I	CHEM-633	Bio-inorganic Chemistry	Organic Synthesis	Electrochemistry	Advanced Analytical Techniques
III Semester	Elective-II	CHEM-634	Photo-inorganic Chemistry	Heterocyclic Chemistry	Chemical Dynamics	Analysis of Commercial Products
II Year	Elective-I	CHEM-643	Organo-transition Metal Chemistry	Chemistry of Natural Products	Nuclear Chemistry	Instrumental Methods of Analysis
IV Semester	Elective-II	CHEM-644	Inorganic Materials	Medicinal Chemistry	Statistical Mechanics	Analysis of Consumers Products

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

Year / Semester	Number, Code/ID and Nomenclature of Paper			Duration of Exam.	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code / ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Teaching Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
I Year I Semester	Paper-1.1	CHEM-511	Inorganic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.2	CHEM-512	Organic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.3	CHEM-513	Physical Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.4	CHEM-514	Mathematics for Chemists / Biology for Chemists	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-1.5	CHEM-515	Practical	12 Hrs	-	18	9	--	--	100	50	100	50
	Total (I Semester)			**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
I Year II Semester	Paper-2.1	CHEM-521	Inorganic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.2	CHEM-522	Organic Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.3	CHEM-523	Physical Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.4	CHEM-524	Computer Applications in Chemistry	3 Hrs	4	-	4	30	12	70	28	100	40
	Paper-2.5	CHEM-525	Practical	12 Hrs	-	18	9	--	--	100	50	100	50
	Total (II Semester)			**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
II Year III Semester	Paper-3.1	CHEM-631	Chromatography	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.2	CHEM-632	Spectroscopy	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.3	CHEM-633	Organic Synthesis	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.4	CHEM-634	Heterocyclic Chemistry	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-3.5	CHEM-635	Practical	12 Hrs	-	18	9	--	--	100	50	100	50
	Total (III Semester)			**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
II Year IV Semester	Paper-4.1	CHEM-641	Environmental Chemistry	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.2	CHEM-642	Recent Methods of Organic Syntheses	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.3	CHEM-643	Chemistry of Natural Products	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.4	CHEM-644	Medicinal Chemistry	3 Hrs	3	-	4	30	12	70	28	100	40
	Paper-4.5	CHEM-645	Practical	12 Hrs	-	18	9	--	--	100	50	100	50
	Total (IV Semester)			**27 Hrs**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**210**
Total (I + II + III + IV Semester)				**108**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**840**

Rules & Regulations

Objectives of the Course:

Chemistry is an important part of the current revolutions in Science. No educated person today can understand the modern world without a basic knowledge of chemistry. The existence of a large number of pharmaceutical, agrochemical and chemical factories, coals, mines and related industries necessitates chemistry education. Hence our goal in introducing the M. Sc programme in Chemistry to educate the students in the fascinating fields of chemistry in an effective manner.

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

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

Duration of the Course:

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

Eligibility for Admission in M. Sc. First Semester:

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

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

Eligibility for Admission in M. Sc. Third Semester:

A candidate may be promoted in the next academic session (odd semester *i.e.* III semester) if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session with 50% of the aggregate marks. The candidate who does not

fulfill the above condition will remain as an ex-student and will re-appear in the due papers along with next odd/even semester examinations.

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

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

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

Structure of the Programme:

The Master of Science in Chemistry programme will consist of core and advanced courses of theory as well as practical which are compulsory for students.

Course Number, Course Code/ID and Nomenclature:

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

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

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

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

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

Maximum Marks:

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

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the

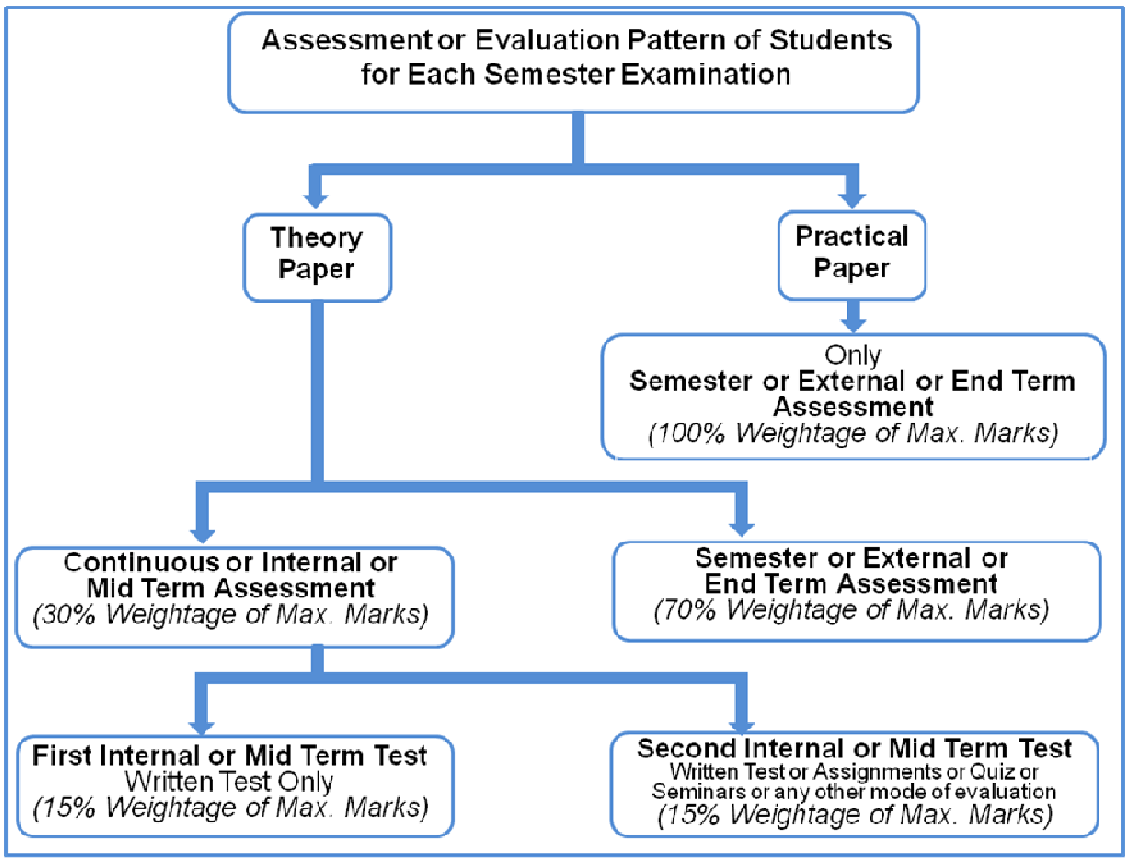
course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted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

Teaching Methodologies:

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

Assessment Pattern:

The assessment of the student shall be divided into two parts in which first part is continuous assessment or internal assessment (30% weightage of the maximum marks) and second part is semester assessment or external assessment (70% weightage of the maximum marks). Assessment pattern and distribution of maximum marks is summarized as given below:



(i) Continuous Assessment or Internal or Mid Term Assessment:

(a) The continuous or internal or mid-term assessment (30% weightage of the maximum marks) for each theory paper shall be taken by the faculty members in the Department during each semester. There will be two internal assessment tests (*i.e.* First Internal Assessment Test or First Mid Term Test and Second Internal Assessment Test or Second Mid Term Test) each of 15% weightage for each theory paper. Each internal assessment test shall be of one hour duration for theory paper and shall be taken according to academic calendar which will be notified by the Department / University.

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

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

(d) Regular attendance of the student shall be considered in the internal assessment. If the attendance / regularity factor is similar for all the students, then it may be merged with the weightage of second internal assessment test (class test / home assignment / quiz, seminar, *etc.*).

(e) Paper wise consolidated marks for each theory paper and dissertation / seminar (*i.e.* total marks obtained during various modes of internal assessment) obtained by the students (out of the 30% weightage of the maximum marks of the paper) shall be forwarded by the Head of the Department (in two copies) to the Controller of Examination 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 Head of the Department concerned 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 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 to avoid any fraction.

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

(i) The Head of the Department concerned 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 should represent the matter to the Head of the Department.

(ii) Semester Assessment or External or End Term Assessment:

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

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

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

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

Question Paper Pattern:

(A) Continuous or Internal or Mid Term Assessment:

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

(i) First Continuous or Internal or Mid Term Assessment:

Format

Department of Pure & Applied Chemistry
University of Kota
Kota (Rajasthan)-324 005
First Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 15**
Semester	**:**	**No. of Students**	**:**
Subject	**:**	**Duration of Exam**	**:**
Paper	**:**	**Name of Teacher**	**:**

Note: All questions are compulsory and marks are given at the end of the each question. Two or three sub-divisions may be given in the question.

Q. No. 1. ……..

or

…….

5 Marks

Q. No. 2. ……..

or

…….

5 Marks

Q. No. 3. ……..

or

…….

5 Marks

(ii) Second Continuous or Internal or Mid Term Assessment:

(a) Attendance:

Marks shall be given by the faculty member in each paper according to its weightage.

5% weightage of Maximum Marks

Note:

If the attendance / regularity factor is similar for all the students, then it may be merged with the weightage of second internal assessment test (class test / home assignment / quiz, seminar, etc.).

(b) Class Test:

10% weightage of Maximum Marks

Format

Department of Pure & Applied Chemistry
University of Kota
Kota (Rajasthan)-324 005
Second Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 10**
Semester	**:**	**No. of Students**	**:**
Subject	**:**	**Duration of Exam**	**:**
Paper	**:**	**Name of Teacher**	**:**

Note: All questions are compulsory and marks are given at the end of the each question. Two or three sub-divisions may be given in the question.

Q. No. 1. …….....

4 Marks

Q. No. 2. ……..

or

…….

3 Marks

Q. No. 3. ……..

or

…….

3 Marks

or

(b) Assignment:

(May be divided in parts or questions or may not be. It will be depending on the nature of assignment).

10% weightage of Maximum Marks

or

(b) Quiz:

(May be divided in parts or questions or may not be. It will be depending on the nature of quiz).

10% weightage of Maximum Marks

or

(b) Any other tool may be adopted for internal Assessment

10% weightage of Maximum Marks

(B) Semester or External or End Term Assessment:

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

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

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

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

SECTION-A

Q. 1.

Unit-I

(i) …… **1 Mark**

(ii) …… **1 Mark**

Unit-II

(iii) …… **1 Mark**

(iv) …… **1 Mark**

Unit-III

(v) …… **1 Mark**
(vi) …… **1 Mark**

Unit-IV

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

Unit-V

(ix) …… **1 Mark**
(x) …… **1 Mark**

SECTION-B

Unit-I

Q. 2. ……..…… **5 Marks**

or

……...…… **5 Marks**

Unit-II

Q. 3. ……...…… **5 Marks**

or

……..…..…… **5 Marks**

Unit-III

Q. 4. ……..…… **5 Marks**

or

……..…..…… **5 Marks**

Unit-IV

Q. 5. . ……..…..…… **5 Marks**

or

……..…….. **5 Marks**

Unit-V

Q. 6. ……...…… **5 Marks**

or

……..…….… **5 Marks**

SECTION-C

Unit-I

Q. 7. ……..…… **15 Marks**

Unit-II

Q. 8. ……..…..…… **10 Marks**

Unit-III

Q. 9. ……..……..… **10 Marks**

Unit-IV

Q. 10. ……..…… **10 Marks**

Unit-V

Q. 11. ……..…....….. **10 Marks**

Practical Examinations:

Continuous or Internal or Mid Term Assessment: ***Not applicable in practical***

External or Semester or End Term Assessment:

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

Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Regularity, Participation in Departmental activities, Laboratory skills, Cleaning of Work place, *etc.*	10
8.	Viva-voce Examination	10
9.	Practical Record	05
	Total Marks	**100**

Minimum Pass Marks and Rules regarding Determination of Results:

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

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

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

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

semester examinations taken together for promotion to the third semester examination.

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

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

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

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

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

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

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

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

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

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

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

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

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

Classification of Successful Candidates:

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

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

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

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

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

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Syllabus

M. Sc. Chemistry
Third Semester Examination

Paper-3.1: CHEM-631: Chromatography

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

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

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

Unit-I: Nature of separation process, classification of separation methods.

Chromatography:
General introduction, principles and types of chromatography, physical sate of mobile phase, mechanism of separation and techniques involved.

Paper Chromatography:
Principle, types, choice of paper and solvent, location of spot, development, visualization, measurement of R_f values, applications.

Supercritical Fluid Chromatography (SFC):
Principle, instrumentation, qualitative and quantitative analysis.

Unit-II: Thin Layer Chromatography (TLC):
Principle, advantage over paper chromatography, types, preparation of thin layer, choice of sorbent and solvent, development, detection and applications.

High Performance Thin Layer Chromatography (HPTLC):
Principle, advantage over TLC, instrumentation, choice of sorbent and solvent, development, detection and applications.

Unit-III: Column Chromatography:
Principle, resolution, stationery phase, column efficiency, factors influencing column efficiency, experimental set up and applications; principle and application of flash chromatography.

Gas Chromatography (GC):
Principle, instrumentation, column efficiency, solid supports, liquid phase, column temperature, detectors, chromatographic identification, multi-dimensional GC, fast GC, applications.

Unit-IV: High Performance Liquid Chromatography (HPLC):

Principle, instrumentation, identification of peaks, effect of temperature and packing material, types of HPLC: partition, adsorption, ion-exchange, size-exclusion or gel; derivatization in HPLC: post and pre-columns, applications.

Ion-Exchange or Ion Chromatography (IC):

Principle, types, regeneration, ion-exchange resins and their capacity, retention, selectivity, factors affecting separation, bonded phase chromatography (BPC), high performance ion chromatography (HPIC), applications.

Unit-V: Electrophoresis:

Theory and classification, factors affecting mobility, macromolecular size and charge interactions with supporting electrolyte, pH and concentration discontinuities, factors affecting, electrophoresis phenomena: electrolysis, electro-osmosis, temperature and supporting media; instrumentation, methodology, preparation of gel-staining and de-staining, preparative zone electrophoresis, continuous electrophoresis, applications.

Capillary Electrophoresis (CE):

Principle, theory, instrumentation, sample preparation and applications, capillary electro-chromatography and miscellar electro-kinetic capillary chromatography.

Books:

- *Chromatography: Basic Principles, Sample Preparations and Related Methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk, John Wiley and Sons*
- *Introduction to Modern Liquid Chromatography by Lloyd R. Snyder, Joseph J. Kirkland and John W. Dolan, Wiley*
- *Practical HPLC Method Development by Lloyd R. Snyder, Wiley-Interscience*
- *Principles & Practices of Chromatography by R. P. W. Scott, Library for Science*
- *Fundamentals of Analytical Chemistry, VIII Edn., D. A. Skoog, D. M. West, F.J. Holler and S.R. Crouch, Thomson Brooks/Cole Publishers.*
- *Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler and T.A. Nieman, 5th Edition, Harcourt Brace & Company, Florida.*
- *Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, Meerut.*
- *Instrumental Methods of Chemical Analysis, Chatwal and Anand, Himalaya Publishing House, Meerut.*
- *Basic Gas Chromatography 2nd Edition by Harold M. McNair, James M. Miller, John Wiley and Sons.*
- *Comprehensive two dimensional gas chromatography, Volume 55 (Comprehensive Analytical Chemistry) by Lourdes Ramos, Elsevier*
- *Forensic Applications of Gas Chromatography 1st Edition by Michelle Groves Carlin, John Richard Dean, Taylor & Francis*
- *Analytical Gas Chromatography 2nd Edition by Phillip Stremple, Elsevier*
- *Electrophoresis by Duncan J. Shaw. Academic Press*
- *Gel Electrophoresis-Advanced Techniques Edited by Sameh Magdeldin. InTech.*
- *Capillary Electrophoresis Guidebook: Principles, Operation, and Applications by Kevin D. Altria. Springer Science & Business Media*

Paper-3.2: CHEM-632: Spectroscopy

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

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

- ***Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*

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

Unit-I: Ultraviolet-Visible (UV-VIS) Spectroscopy:

Electromagnetic radiation and spectroscopy, principles of absorption spectroscopy, nature of electronic excitations, chromophores, auxochromes, origin of UV bands, absorption and intensity shifts, types of absorption bands, factors affecting the position of UV bands, calculation of λ_{max} of simple organic compounds, visible spectra, qualitative and quantitative applications.

Infrared Spectroscopy:

IR regions, molecular vibrations, force constant and bond strengths, calculation of vibrational frequencies, Fermi resonance, combination bands, overtones, hot bands, factors affecting the band positions and intensities, sample handling, anharmonicity, group frequencies, applications.

Unit-II: One Dimensional Nuclear Magnetic Resonance Spectroscopy:

Nuclear angular momentum, nuclear spin, magnetization & nuclear precession, types of NMR spectrometer, free induction decay, basic theory, population densities of nuclear spin states, equivalence & non-equivalence protons, shielding and deshielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, spin-spin interactions: theory and types; factors influencing coupling constant "J", typical ^{1}H NMR absorption signals of various type of compounds, spin systems & classification of spectra (AX, ABX, AMX, ABC, A_2B_2, *etc.*), simplification of spectra: shift reagents and spin decoupling; proton exchange, nuclear overhauser effect, basic idea about NMR studies of nuclei other than ^{1}H: ^{11}B, ^{15}N, ^{19}F & ^{31}P.

Unit-III: Two Dimensional Nuclear Magnetic Resonance Spectroscopy:

Fundamental concepts of 2D NMR: pulse sequences, spins & magnetization vectors; 2D Fourier transform, processing and plotting of 2D spectra, general procedure for running 2D spectra, polarization transfer: INEPT, DEPT; chemical shift correlation: COSY (homonuclear & heteronuclear), NOESY, ROESY.

^{13}C NMR Spectroscopy:

Carbon-13 nucleus, chemical shifts and their calculation, spin-spin coupling, cross-polarization, NOE, APT, INEPT, DEPT, use of NMR in medical diagnostics, applications of NMR spectroscopy

Unit-IV: Mass Spectrometry:

Basic principles, production of ions by electron impact, chemical ionization and field desorption techniques, separation and detection of ions, fragmentation of organic molecules, McLafferty rearrangement, factors affecting identification of molecular ion peaks, base peaks and isotopic peaks; determination of molecular weight and molecular formula of compounds, hydrogen deficiency index, nitrogen rule, high resolution mass spectrometry (HRMS), introduction to combined or hyphenated techniques likes GC-MS, LC-MS, IC-MS, ICP-MS, CE-MS, *etc*.

Unit-V: Structure Elucidation:

An integrated problem solving approach for elucidation of structures of organic compounds based on analytical data including CHNS/O percentage, spectral data (UV, IR, NMR, 2D-NMR, MS, *etc.*) and hyphenated technique data

(GC-MS, LC-MS, ICP-MS, LC-NMR, etc.) including reaction sequences to find out the structure.

Books:

- *Encyclopedia of Spectroscopy and Spectrometry, Three-Volume Set: Encyclopedia of Spectroscopy and Spectrometry, Second Edition: 3 volume set*
- *NMR Spectroscopy: Basic Principles, Concepts, and Applications in Chemistry, Harald Günther, Wiley; 2 edition, 1995.*
- *Carbon-13 NMR spectroscopy, Hans-Otto Kalinowski, Stefan Berger, Siegmar Braun, Wiley, 1988.*
- *Introduction to Spectroscopy, Donald L. Pavia, Cengage Learning, 2009*
- *Pulse methods in 1D and 2D liquid-phase NMR Wallace S. Brey, Academic Press, 1988.*
- *Organic Structure Determination Using 2-D NMR Spectroscopy: A Problem-Based Approach, Jeffrey H. Simpson, Academic Press, 2008.*
- *High-Resolution NMR Techniques in Organic Chemistry, Timothy D. W. Claridge, Elsevier, 1999*
- *Identification of Organic Compounds, R. M. Silverstien, G. C. Hassler and T. C. Morill, John Wiley.*
- *Organic Spectroscopy, Jag Mohan, Narosa Publication.*
- *Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International.*
- *NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R. V. Parish, Ellis Harwood.*
- *Physical Methods in Chemistry, R. S. Drago, Saunders College.*
- *Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.*
- *Introduction to Magnetic Resonance, A. Carrington and A. D. Maclachalan, Harper & Row.*
- *LC/MS: A Practical User's Guide by Marvin McMaster, Wiley-Interscience*
- *Gas Chromatography and Mass Spectrometry: A Practical Guide, Second Edition by O. David Sparkman, Academic Press.*
- *Instrumental Methods of Chemical Analysis, Gurdeep Raj Chatwal and Shaym Anand, Himalaya Publications.*

Paper-3.3: CHEM-633: Organic Synthesis

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

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

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

Unit-I: Disconnection Approach-I:

Introduction, synthons and synthetic equivalents; functional group inter-conversions, order of events, one group C-X and two group C-X disconnections, chemo-selectivity, reversal of polarity, cyclization reactions, amine synthesis.

Protecting Groups:

Principle of protection of alcohol, amine, carbonyl and carboxyl groups, simple practices / exercises

Unit-II: Disconnection Approach-II:

One group C-C-disconnections involving alcohols and carbonyl compounds, regio-selectivity, alkene synthesis, use of acetylenes, Diels-Alder reaction, 1,3-difunctionalised compounds, α-β-unsaturated carbonyl compounds, control in

carbonyl condensations, 1,5-difunctionalised compounds, Michael addition and Robinson annelation.

Unit-III: Oxidation:

Introduction, different oxidative processes, hydrocarbons: alkenes, saturated C-H groups (activated and inactivated), aromatic rings; alcohols and diols; aldehydes and ketones, ketals, carboxylic acids, amines, hydrazines and sulfides; oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate.

Unit-IV: Reduction:

Introduction, different reductive processes, hydrocarbons: alkenes, alkynes and aromatic rings; carbonyl compounds: aldehydes, ketones; acids and their derivatives; epoxides; nitro, nitroso, azo and oxime groups; hydrogenolysis.

Unit-V Molecular Rearrangements:

General mechanistic considerations, nature of migration, migratory aptitude, memory effects, a detailed study of the rearrangements on carbon, nitrogen and oxygen atoms: Pinacol-pinacolone, Wagner-Meerwein, Tiffeneu-Demjanov, benzil-benzilic acid, Dienone-Phenol, Favorskii, Baeyer-Villiger, Wittig, Fries, Beckmann, Hofman, Neber, Curtius, Lossen, Schmidt, benzidine rearrangement.

Books:

- *Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley & Sons.*
- *Organic Synthesis through Disconnection Approach, P. S. Kalsi*
- *Organic Synthesis, Smith M. B. McGraw Hill*
- *Modern Organic Synthesis, G. S. Zweifel and M. H. Nantz, Freeman and Company, New York.*
- *Modern Synthetic Reactions. H.O. House, W.A. Benjamin.*
- *Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.*
- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry, Clayden, Nick Geeves and Staurt Warren, Oxford University Press Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professiona.*
- *Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March. John Wiley.*
- *Advanced Organic Chemistry Part B.F.A. Carey and R.J. Sundberg Plenum Press.*
- *Rodd's Chemistry of Carbon Compounds. Ed. S. Coffey, Elsevier.*

Paper-3.5: CHEM-635: Heterocyclic Chemistry

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

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

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

Unit-I: Nomenclature of Heterocycles:

Trivial, systematic (Hantzsch-Widman system), fusion and replacement systems of nomenclature.

Aromatic Heterocycles:
Chemical behavior, classification (structural type), aromaticity, criteria of aromaticity: structural, electronic, energetic and magnetic criteria; heteroaromatic ring systems, heteroaromatic reactivity and tautomerism in aromatic heterocycles.

Non-aromatic Heterocycles:
Bond angle strain & its consequences in small ring heterocycles, torsional strain, conformation of flexible heterocycles: five-membered & six-membered heterocycles; stereoelectronic effects in six-membered heterocycles: anomeric and related effects; attractive interactions through space (hydrogen bonding and nucleophilic-electrophilic interactions).

Unit-II: Three- and Four-membered Heterocycles:

Three-membered heterocycles with one heteroatom: Syntheses and reactions of aziridines, azirines, oxiranes, oxirenes, thiiranes, thiirenes.

Three-membered heterocycles with two heteroatom: Syntheses and reactions of diaziridines, diazirines, oxaziridines.

Four-membered heterocycles with one heteroatom: Syntheses and reactions of azetidines, azetidinones, oxetanes, oxetanones, and thietanes.

Unit-III: Five-membered Heterocycles:

Five-membered heterocycles with one heteroatom: structure, stability, basicity, aromaticity, synthesis and reactions (with some medicinal importance) of pyrrole, furan, thiophene.

Five-membered heterocycles with two heteroatoms: synthesis and reactions (with some medicinal importance) of 1,2- and 1,3-diazoles, oxazoles and thiazoles.

Five-membered heterocycles with more than two heteroatoms: synthesis and reactions (with some medicinal importance) of triazoles, tetrazoles.

Benzo-fused five-membered heterocycles with one heteroatom: synthesis and reactions (with some medicinal importance) of indole.

Benzo-fused five-membered heterocycles with two and more heteroatoms: synthesis and reactions (with some medicinal importance) of benzimidazoles.

Unit-IV: Six-membered Heterocycles:

Six-membered heterocycles with one heteroatom: synthesis, reactions and medicinal importane of pyridines and pyrones.

Six-membered heterocycles with two and more heteroatoms: synthesis, reactions and medicinal importance of diazines and triazines.

Benzo-fused six-membered heterocycles with one heteroatom: synthesis and reactions including medicinal applications of quinoline, isoquinoline, coumarins and chromones.

Benzo-fused six-membered heterocycles with two and more heteroatoms: Synthesis and reactions including medicinal applications of quinazoline.

Unit-V: Seven-membered Heterocycles:

Synthesis, reactions and medicinal importance of azepines, oxepines, thiepines, diazepines, thiazepines, oxazepines, benzodiazepines, benzoxazepines and benzothiazepines.

Large-membered Heterocycles:
Synthesis, reactions and medicinal importance of azocines and oxocines.

Books:

- *Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.*
- *The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.*
- *Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Blackhall.*
- *Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.*
- *Contemporary Heterocyclic Chemistry, G,.R. Newkome and W.W. Paudler, Wiley-Inter Science.*
- *An Introduction to the Heterocyclic Compounds, R.M. Acheson, John Wiley.*
- *Comprehensive Heterocyclic Chemistry, A.R. Katrizky and C.W. Rees, eds. Pergamon Press.*

Paper-3.5: CHEM-635: Practical

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

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Regularity, Participation in Departmental activities, Laboratory skills, Cleaning of Work place, *etc.*	10
8.	Viva-voce Examination	10
9.	Practical Record	05
	Total Marks	**100**

Qualitative Analysis:
Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid or two solids and one liquid), using TLC for checking the purity of the separated compounds, chemical analysis, IR, PMR and mass spectral data.

Chromatographic Analysis:
Separation and identification of compounds (*e.g.* amino acids, carbohydrates and other organic compounds) by following chromatographic techniques:

- Paper Chromatography
- Thin Layer Chromatography
- Column Chromatography
- Flash Chromatography
- Gas Chromatography
- Liquid Chromatography
- Electrophoresis

Three-steps / Multi-steps Organic Syntheses:
The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques:

- Aniline → Acetanilide → p-nitroacetanilide → *p*-nitroaniline
- Aniline → Acetanilide → p-bromoacetanilide → *p*-bromoaniline
- Benzene → Benzophenone → Benzpinacol → Benzpinacolone
- Benzene → Benzophenone → Benzophenoneoxim → Benzanilide
- Benezene→ 3-benzoyl propanoic acid → 4-Phenyl butanoic acid → α-Tetralone
- Benzaldehyde → Benzoin →Benzil → Benzilic acid

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

Spectrophotometric (UV/VIS) Estimations:

- Amino acids
- Proteins
- Carbohydrates
- Cholesterol
- Ascorbic acid
- Caffeine
- Aspirin
- Paracetamol
- Ibuprofen
- Promethazine
- Methyldopa
- Penicillin
- Verapamil
- Propanolol
- Fluconazole
- Ciprofloxacin
- Garseofulvin
- Diazepam

Analysis of Fuel / Petroleum / Petroleum Products:

- Determination of calorific value of fuel and coal
- Estimation of moisture in given coal sample.
- Estimation of ash content in given coal sample.
- Estimation of proximate value of given coal sample.
- Determination of the strong acid number or inorganic acidity of oil
- Determination of viscosity and surface tension of oil / liquid.
- Determination of saponification value of oil
- Determination of bromine / hydroxyl / iodine value of oil.
- Determination of aniline point of oil.
- Determination of cloud point and pour point of oil.
- Determination of flash point & fire point of oil.
- Determination of aniline point of liquid fuel
- Determination of carbon residue of liquid fuel
- Determination of octane & cetane number
- Determination of sulphur / lead / other elements in petroleum products / coal
- Determination of alkalinity / salinity / rancidity / water content / diesel index of oil / petroleum sample.
- Determination of organic and inorganic chloride in oil / petroleum sample.
- The ultimate analysis of given sample of soft coke.
- Determine the viscosity of a given sample of oil in centistokes at room temperature and at 40^{o}, 50^{o}, 60^{o} 65^{o}, 70^{o}C. Plot a graph between kinematic viscosity and temperature in degree centigrade.

Analysis of Agrochemicals:

- Analysis of soil sample, soil micronutrients for Ca, Fe and P content
- Analysis of pigments with respect to Zn and Cr.
- Analysis of pesticide residue and toxicological effects.
- Analysis of malathion by colorometry.
- Determination of organic carbon in soil by Walk Ley and Black method.

- Determination of available chlorine in bleaching powder by Bunsen method.
- Determination of total chlorine in pesticide formulation.
- Determination of copper in fungicide.
- Estimation of nitrogen from given fertilizer by Kjeldahl method.
- Estimation of phosphorus from given fertilizer by volumetry / colourimetry.
- Estimation of potassium from given fertilizer by gravimetry / Flame photometry.
- Determination of K_2O content in given sample of potash fertilizer.
- Determination of P_2O_5 content in give n sample of phosphatic fertilizers.
- Determination of moisture content in given sample of urea
- Analysis of insecticides: DDT, BHC, aldrin, endosulfon, malathion, parathion.
- Analysis of herbicides: 2,4-Dichlorophenoxyacetic acid, dalapon, paraquat, Banalin, Butacarb.
- Analysis of fungicides: Boardeaux mixture, copper oxychloride, zineb, benomyl.

Analysis of Polymers:

- Determination of acid, saponification, iodine, hydroxyl and carboxyl values of a plastic material.
- Determination of molecular weight of a polymer.

Ion Chromatography

(i) Chemical Applications

- Determination of anions in toothpaste by Ion Chromatography.
- Determination of anions and cations in high purity water by Ion Chromatography.
- Determination of metals and polyphosphates in given sample by Ion Chromatography.
- Determination of azide in aqueous samples by Ion Chromatography.
- Determination of dissolved hexavalent chromium in drinking water, groundwater and industrial waste.
- Determination of diethanolamine and triethanolamine in surface finishing, wastewater and scrubber solutions water effluents by Ion Chromatography
- Determination of fluoride in acidulated phosphate topical solution.
- Determination of oxalate and other anions in Bayer liquor using Ion Chromatography
- Determination of amino acids, carbohydrates, alcohols, and glycols in fermentation Broths
- Determination of calcium, magnesium, manganese and iodine in Brine
- Determination of trace anions and cations in concentrated bases using auto-neutralization pre-treatment/Ion Chromatography
- Determination of trace anions in organic solvents and concentrated hydrofluoric acid.
- Determination of trace transition metals in reagent grade acids, bases, salts, and organic solvents using chelation Ion Chromatography
- Determination of polyphenols
- Determination of N,N-dimethyl-o-toluidine and N,N-diethyl-o-toluidine in ethylene gas samples.
- Determination of transition metals at ppt levels in High-Purity Water and SC2 (D-clean) Baths

(ii) Petroleum Refining

- Extraction of total petroleum hydrocarbon contaminants (diesel & waste oil) in soils

- Extraction of hydrocarbon contaminants (BTEX, Diesel, and TPH) in soils
- Extraction of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans
- Extraction of PAHs from environmental samples by accelerated solvent extraction (ASE)
- Determination of thiosulfate in refinery and other wastewaters
- Automated solid phase extraction (SPE) of total petroleum hydrocarbons using Dionex AutoTrace® Instrument
- Determination of biofuel sugars by Ion Chromatography
- Determination of cations in biodiesel using a Reagent-Free Ion Chromatography.
- Determination of 32 low molecular mass organic acids in biomass by Ion Chromatography Mass Spectrometry

(iii) Safety and Security Applications

- Extraction of explosives from soils by accelerated solvent extraction (ASE)
- Determination of monovalent cations in explosives

(iv) Cosmetics

- Rapid Determination of benzalkonium chloride in cosmetics

(v) Polymers

- Polysialic acid analysis: Separating polymers with high degrees of polymerization

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

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Syllabus

M. Sc. Chemistry
Fourth Semester Examination

Paper-4.1: CHEM-641: Environmental Chemistry

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

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

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

Unit-I: Air Pollution:

Concept of environment chemistry, composition of atmosphere, major sources of air pollution, chemical reactions, smog formation, acid rain, classification and effect of air pollutants, NOx, SOx, COx particulates and ozone; Greenhouse effect and global warming, ozone depletion, automobile emissions, prevention and control of vehicular pollution, alternative fuels: Biodiesel, ethanol, CNG, ULSD.

Monitoring of Air Pollution:

Principles of environment monitoring, methods for monitoring of air pollutants including NOx, SOx, COx, SPM.

Prevention and Control of Air Pollution:

Control of pollution by fuel selection and utilization, process or equipment modification, devices, site selection, stacks, planting trees and growing vegetation, general methods of air pollution control

Unit-II: Water Pollution:

Types of water pollution, sources of water pollution, water pollutants, their classification and effects, water pollution laws and standards.

Analysis of Water:

Chemical and physical examination of water, preservation and pre-concentration, hydrogen ion concentration, acidity, alkalinity, hardness, pH, free CO_2, Cl_2, metals, ions, dissolved chlorine and oxygen, BOD, COD, chlorine dosage, *E. coli* index.

Unit-III: Soil Pollution:

Composition and types of soil, mineral and organic matter in soil, soil pollution by industrial wastes, urban wastes, radioactive pollution and agriculture practices.

Soil Analysis:
Analysis of nitrates, nitrites, ammonical nitrogen, total nitrogen, phosphates, organic carbon, potassium, calcium, sodium, magnesium, iron, zinc, etc.

Control of Soil Pollution:
Control of domestic and industrial wastes, soil remediation, environmental friendly technologies for agriculture

Unit-IV: Industrial Pollution:
Environmental pollution from various industries and control of industrial pollution.

Industrial Wastes and their Treatment:
Characteristics and types of industrial wastes, principles of industrial waste treatment, protection of biosphere and surface water from pollution with industrial sewages, sampling and chemical analysis of industrial waste water, waste water treatment, solid waste management, hazardous waste management.

Unit-V: Radioactive Pollution:
Radioactive substances, state of radioactive isotopes in solution, gases and solids; units of radiation, analysis of radionuclides, sources of radioactive pollution, radioactive fallout, nuclear reactors, nuclear installations, radioactive ore processing, nuclear accidents, effects of radioactive pollution on power plants and polymers, control of radioactive pollution.

Books:

- *Environmental Chemistry. B. K. Sharma. 12th Edition, 2011, Goel Publishing House, Meerut.*
- *Environmental Pollution: Principles, Analysis and Control. P. Narayanan. 1st Edition, 2007, CBS Publishers & Distributors, New Delhi.*
- *Environmental Pollution Control Engineering. C. S. Rao. 2nd Edition, 2006, New Age International Publishers, New Delhi.*
- *Pollution Control in Process Industries. S. P. Mahajan. 20th Ed, 2006, TataMcGraw-Hill, New Delhi.*
- *Industrial Pollution. V. P. Kudesia. 5th Edition, 2007, Pragati Prakashan, Meerut.*
- *Water Supply and Sanitary Engineering. G. S. Birdie & J. S. Birdie. 8th Edition, 2008, Dhanpat Rai Publishing Company, New Delhi.*
- *Environmental Toxicology, J.Rose Gordon and Breach (Ed.), Science Publication, New York, 1993.*
- *Environmental Pollution analysis, S.M. Khopkar, Wiley Eastern, New Delhi, 1994.*
- *Environmental Chemistry, Colin Baird, W.H. Freeman Co. New York, 1998.*
- *Introduction to Atmospheric Chemistry, P.V. Hobbs, Cambridge.*

Paper-4.2: CHEM-642: Recent Methods of Organic Syntheses

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

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

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

questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Unit-I: Greener Approaches of Syntheses:

Concept of green chemistry, atom economy and waste minimization different approaches to green synthesis.

Green Reagents: Dimethyl carbonate; polymer supported reagents: chromic acid and per-acids.

Green Catalysts: Homogeneous and heterogeneous catalysts, solid acid base catalysts, metal oxide supported catalysts, oxidation catalysts, basic catalysts, polymer supported catalysts, phase transfer catalysts, bio-catalysts.

Unit-II: Green Solvents for Organic Syntheses:

Introduction, characteristics properties, types and examples of green solvents.

Ionic Liquids: Selection of ionic liquids for Knovenaegel condensation, Claisen-Smith condensation; preparation of ionic liquids: dialkylimidazolium and alkylpyridinium cation based ionic liquids, ionic liquids with fluorine containing anions and chiral ionic liquids; synthetic applications of ionic liquids alkylation, allylation, oxidation and hydrogenation, concept of supported ionic liquids and their applications.

Supercritical Liquids:

The phase diagram of CO_2, supercritical CO_2, its properties and applications in dry cleaning, decaffeination of coffee and synthesis.

Unit-III: Microwave Assisted Organic Synthesis:

Introduction of microwave assisted organic synthesis, microwave activation, equipment, time and energy benefits, limitations; reactions in organic solvents: esterification, Fries rearrangement, Diels-Alder reaction, decarboxylation; solvent free reactions (solid state reactions): deacetylation, deprotection, saponification, alkylation of reactive methylene compounds, synthesis of nitriles from aldehydes, synthesis of β-lactams, pyrroles, quinolines.

Unit-IV: Ultrasound Assisted Organic Synthesis:

Basics of sonochemistry, ultrasound cavitation, sonocemical effect, experimental parameters, transducers, reactors, homogeneous and heterogeneous sonochemistry, oxidation, reduction, substitution reactions, Kornblum-Russell reaction, Hetero-Micahel reaaction, preparation of Grignard's reagent.

Electrochemical Organic Synthesis:

Introduction to basic principle, anodic oxidations, cathodic reductions, elimination reactions, Kolbe reaction, alkylation, acylation, synthesis of sebacic acid and adiponitrile.

Unit-V: Organic Synthesis Using Reactors:

Introduction to batch reactors, types, concepts of lab and pilot scale organic syntheses; vapour phase reactors: types, design, concepts of lab and pilot scale organic syntheses; case studies of syntheses (including raw materials, process flow diagrams, product synthesis, separation, purification and waste composition) at industrial scale of pharmaceuticals, agrochemicals, organic fertilizers and dyes.

Books:

- *Green Chemistry, Theory and Practice, Paul T. Anastas and John C. Warner*
- *Microwaves in Organic Synthesis, Antonio de la Hoz (Ed), André Loupy (Ed), Wiley-VCH*
- *Organic Synthesis in Water, Paul A Grieco Blackie.*

- *Organic Synthesis: Special Techniques, V. K. Ahluwalia and Renu Aggrawal*
- *Green Chemistry: An Introductory Text, The Royal Society of Chemistry*
- *Chemical Reviews 2007, 107, 2167-2820 (Special issue on Green Chemistry)*
- *Fundamentals and Applications of Organic Electrochemistry: Synthesis, Materials, Devices by Toshio Fuchigami, Mahito Atobe, Shinsuke Inagi*

Paper-4.3: CHEM-643: Chemistry of Natural Products

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

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

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

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

Unit-I: Terpenoids and Carotenoids:

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule, stereochemistry and synthesis of the following representative molecules: citral, geraniol, α-terpineol, menthol, farnesol, zingiberene, abietic acid and β-carotene.

Unit-II: Alkaloids:

Definition, nomenclature and physiological action, occurrence, isolation, identification (qualitative idea only), general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants; structure, stereochemistry and synthesis of the following: ephedrine, coniine, nicotine, atropine, papaverine, strychnine, and morphine.

Unit-III: Steroids and Hormones:

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, isolation, identification (qualitative idea only), structure determination and synthesis of cholesterol, bile acids, androsterone, testosterone, oestrone, progesterone, aldosterone.

Unit-IV: Prophyrins and Plant Pigments:

Prophyrins: Structure and synthesis of haemoglobin and chlorophyll.

Plant Pigments: Occurrence, nomenclature, isolation, general methods of structure determination, and synthesis of apigenin, luteolin, quercetin, myrcetin, diadzein, butein, cyanidine chloride, cyanidin-7-arabinoside, hirsutidin.

Unit-V: Prostaglandins and Metabolism Pathways:

Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects, synthesis of PGE_2 and $PGF_{2\alpha}$, synthesis and reactions of

pyrethroids and rotenones (for structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).

Key Metabolism Pathway: Acetate, mevalonate and shikimic acid pathway.

Books:

- *Natural Products : Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope adn J.B. Harbome, Longman, Essex.*
- *Organic Chemistry: Vol. 2, I.L. Finar, ELBS.*
- *Stereoselective Synthesis: A Practical Approach, M. Norgradi, VCH.*
- *Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston. Harwood Academic Publishers.*
- *Introduction to Flavonoids, B.A. Bohm. Harwood Academic Publishers.*
- *New Trends in Natural Product Chemistry, Ata-ur-Rahman &M.L. Choudhary, Harwood Academic Publishers.*

Paper-4.4: CHEM-644: Medicinal Chemistry

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

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

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

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

Unit-I: Drug Design:

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of pro drugs and soft drugs, structure activity relationship (SAR), factors affecting bio-activity, resonance, inductive effect, isosterism, non-isosterism, special considerations, theories of drug activity: occupancy theory, rate theory, induced fit theory; quantitative structure activity relationship: concepts of drug receptors, elementary treatment of drug receptor ionization constants, steric, Shelton and surface activity parameters and redox potentials, Free-Wilson analysis, Hansch analysis, relationships between Free-Wilson and Hansch analysis, LD-50, ED-50 (Mathematical derivations of equations excluded).

Unit-II: Pharmacokinetics & Pharmacodynamics:

Pharmacokinetics: Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics, use of pharmacokinetics in drug development process; pharmacodynamics: elementary treatment of enzyme stimulation, enzyme inhibition, membrane active drugs, drug metabolism, biotransformation, significance of drug metabolism in medicinal chemistry.

Unit-III: Anti-cancer Drugs:

Introduction, cancer chemotherapy, role of alkylating agents, anti-metabolites, carcinolytic antibiotics and mitotic inhibitors in treatment of cancer; synthesis & mechanism of action of alkylating agents: mechlorethamine; anti-metabolites: 6-mercaptopurine; toposimerase inhibitors: irinotecan, anthracyclines: daunomycin; miotic inhibitors: paclitaxel; corticosteroids: prednisone; recent development in cancer chemotherapy, hormone and natural products.

Antibiotics:

Spectrum of antibiotics, cell wall biosynthesis, inhibitors, β-lactam ring, antibiotics inhibiting protein synthesis, synthesis & mechanism of action of penicillins, cephalosporins, chloramphenicol, tetracycline and streptomycin.

Unit-IV: Cardiovascular Drugs:

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output, direct acting arteriolar dilators, types of cardiovascular drugs, synthesis & mechanism of action of alpha-blockers: doxazosin; beta-blockers: propanolol; ACE inhibitors: captopril; calcium channel blockers: verapamil; anti-coagulants, anti-platelets and thrombolytics: aspirin; cholesterol lowering drugs: gemfibrozil; digitalis drugs: digoxin; diuretic drugs: hydro chlorothiazide; nitrates: nitroglycerin; alpha-2 adrenergic receptors: methyldopa.

Local Anti-infective Drugs:

Introduction and general mode of action, synthesis & mechanism of action of sulphonamides, isoniazid, ciprofloxacin, fluconazole, chloroquine.

Unit-V: Psychoactive Drugs:

Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazipines, buspirone, neurochemistry of mental diseases, antipsychotic drugs: the neuroleptics, anti-depressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs, synthesis & mechanism of action of typical anti-psychotic drugs: chloropromazine, fluspirilene, clopenthixol; atypical anti-psychotic drugs: diazepam, oxazepam, alprazolam, quetiapine, trimethadione, barbiturates, glutethimide.

Books:

- *Burger's Medicinal Chemistry and Drug Discovery All Volumes, Wiley.*
- *Wilson Gisvold's Text book of Organic Medicinal and pharmaceutical Chemistry, Ed. Robert F. Dorge.*
- *Foye's Principles of Medicinal Chemistry, David A. Williams, LWW.*
- *Introduction to Medicinal Chemistry, A Gringuage, Wiley- VCH.*
- *An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press*
- *An Introduction to Drug Design, S. S. Pandeya and J. R. Dimmock, New age International.*
- *Goodman and Gilman's Pharmacological Basis of Therapeutics, Mc Graw-Hill.*
- *The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic press.*
- *Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.*
- *Handbook of Stability Testing in Pharmaceutical Development: Regulations, Methodologies, and Best Practices by Kim Huynh-Ba, Springer*

Paper-4.5: CHEM-645: Practical

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

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	Regularity, Participation in Departmental activities, Laboratory skills, Cleaning of Work place, *etc.*	10
8.	Viva-voce Examination	10
9.	Practical Record	05
	Total Marks	**100**

Organic Synthesis:

The exercises should illustrate the use of organic reagents, eco-friendly synthetic techniques and may involve purification of the products by chromatographic techniques and characterization by UV, IR, NMR, MS, LC-MS, GC-MS, XRD, particle size analyzer, *etc.*:

- Fischer Indole synthesis: Preparation of 2-phenylindole from phenylhydrazine
- Skraup synthesis: Preparation of quinoline from aniline.
- Bischler-Napieralski Synthesis: Preparation of isoquinoline from β-phenylethylamine.
- Fries rearrangement: Preparation of acetophenones.
- Vilsmeier-Haack reaction: Preparation of aromatic aldehydes.
- Wittig reaction: Preparation of alkenes.
- Microwave Assisted Organic Synthesis: any one reaction of acylation, alkylation, substitution, addition, condensation.
- Ultrasound Assisted Organic Synthesis: any one reaction of acylation, alkylation, substitution, addition, condensation.
- Synthesis using PTC: N/C alkylation, oxidation, Wittig reaction, synthesis of 3-alkyl coumarins.
- Electrochemical synthesis: Synthesis of sebacic acid and adiponitrile.
- Enzymatic synthesis: Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomaric excess of S(+)-ethyl-3-hydroxybutanoate and determine its optical activity.
- Vapour Phase Synthesis: Oxidation of toluene, esterification of acetic acid using isoamyl alochol.
- Biosynthesis: Synthesis of ethanol from sucrose, synthesis of metronidazole from 2-aminoimidazole.

Drug Synthesis:

Synthesis, separation and characterization of some of the following drugs:

- Anti-septic : Thymol
- Analgesics : Aspirin, Paracetamol and Phenacetin

- Anti-inflammatory : Diclofenac
- Anti-oxidnats : Flavone (2-Phenyl Chromone)
- Anti-infective : Sulphanilamide or fluconazole or isoniazid
- Anti-protozoal : Metronidazole
- Anti-leprotic : Dapsone
- Anti-malarial : Chloroquine
- Anti-psychotic : Clozapine or olanzapine or quetiapine
- Tranquilisers : Diazepam or oxazepam
- Anti-viral : Acyclovir or efavirenz or nevirapine
- Anaesthetics : Benzocaine
- Cardiovascular : Propanolol or atenolol

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

Extraction of Organic Compounds from Natural Sources:

- Isolation of oleic acid from olive oil.
- Isolation of eugenol from clove.
- Isolation of nicotine dipicrate from tobacco.
- Isolation of cinchonine from cinchona bark.
- Isolation of piperine from black pepper.
- Isolation of protein from seeds
- Isolation of carbohydrate (as reducing sugars) from seeds

Students are required to try some typical colour reactions and check purity of compounds by paper chromatography and TLC by reporting Rf values and determine the density and refractive index wherever it is possible.

Drug Analysis:

- Preparation and characterization of active pharmaceutical ingredients with purity assay.
- Complete assay of aspirin / ibuprofen / paracetamol / sulpha drugs
- Limit test for impurities like Pb, As, Fe, moisture, chloride, sulfate, boron, free halogen, selenium, *etc*.
- Determination of moisture in drug sample by Karl-Fischer titration.
- Estimation of mixture of benzoic acid / salicylic acid / iron in pharmaceutical preparation.
- Estimation of ascorbic acid
- Estimation of Benzoic acid in ointment by titrimetry
- Non-aqueous titration method for estimation of isoniazide and sodium benzoate.
- Estimation of sulphadizine in sulpha tablets
- Determination of asprin in drug tablet by pH metry titration with NaOH.
- Determination of viscosity of ointment / syrup / liquid, *etc*.
- Analysis of the aminoglycoside antibiotics kanamycin and amikacin matches USP requirements
- Determination of viscosity of ointment/syrup/oils using Brookfield viscometer.

Clinical Analysis:

- Analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), vitamins (thiamine, ascorbic acid, Vit. A, etc.) and hormones (progesterone, oxytocin, insulin) chemical, instrumental and biological assay wherever applicable.
- Separation and identification of plasma proteins.

- Estimation of Cholesterol in egg yolk or blood serum.
- Estimation of amino acid in protein hydrolysate by Sorenson formal titration method.
- Estimation of blood glucose, protein, chloride, sodium, potassium, urea, uric acid
- Determination of cortisol from blood and urine samples; determination of oestrogens from urine samples.

Analysis of Food & Food Products:

- Analysis of moisture content, ash, fibre, nutrients, anti-nutrients, toxicants, microorganism-spoilage, preservatives.
- Analysis of amino acids, proteins, carbohydrates, lipids and fat.
- Analysis of edible oils, dairy products, pickles etc., fruit and vegetable products
- Analysis of food additives and adulterations.
- Analysis of sugars in food and beverage by HPLC.
- Analysis of sugars and related hydroxyl acids by GC.
- Determination of sucrose in various food products.
- Determination of mono-and disaccharides in sweets and beverages by HPLC with refractometric detection
- Separation of Asparagine-Linked (N-Linked) oligosaccharides
- Estimation of vitamin A in food product by Carr-price method.
- Estimation of vitamin C in fruit juice by iodometry.
- Determination of Vitamin B_2 (Riboflavin) by flurometry.
- Estimation of proteins, sugars, vitamins, amino acids, crude fibre, total minerals, metals, crude fat and water in foods.
- Estimation of ascorbic acid by cerric ammonium sulphate method.
- Estimation of Glucose and fructose in honey by Lane and Eynone method.
- Determination of Hydroxymethylfurfural in Honey and Biomass
- Estimation of lactose in milk by iodometry.
- Quantitative analysis of iron, calcium and phosphorus in milk powder. (Fe-Colorimetrically, Ca-Complexometrically, P-Colorimetrically)
- Casein isolation from milk by isoelectric precipitation (Yield expected).
- Analysis of lipids: saponification value, acid value and iodine value.
- Determination of tannins, chemical residues and aflatoxins,
- Estimation of preservative and antioxidants.
- Determination of strength of acetic acid from the commercial vinegar sample by potentiometric titration and its confirmation by conducltmetric / pH-metric titration using standard solution of NaOH
- Determination of commercial washing soda by potentiometric titration method.
- Estimation of amino acid in protein hydrolysate by Sorenson formal titration method.
- Estimation of pectin as Ca-Pectate colorimetrically
- Determination of Ca in egg shell by flame photometry method.
- Determination of fluoride in tooth paste colorimetrically with alizarins.
- Estimation of sodium benzoate / sodium metabisulphite, boric acid and salicylic acid in food.
- Determination of carbohydrates in coffee.
- Determination of Na/K/Li/Ca in given sample by flame photometry method.
- Chemical analysis of chilli-powder

Forensic Chemistry:

- Determination of lethal dose, LD-50 and LC-50.
- Determination of cyanide, organophosphate and snake venom.
- Estimation of poisonous materials such as lead, mercury and arsenic in biological samples.

Environmental Chemistry

- Determination of pH, DO, BOD, COD, free CO_2, hardness of water sample.
- Determination of pH, total nitrogen & nitrate, total phosphorous & phosphate, total organic carbon, silica & lime and slats in soil.
- Determination of sodium, potassium, sulphur, magnesium and manganese in soil.
- Monitoring and analysis of SO_2 concentration in ambient air samples using high volume sampler.
- Monitoring and analysis of CO concentration in ambient air samples.
- Monitoring and analysis of NOx concentration in ambient air samples using high volume sampler.
- Monitoring and analysis of ozone concentration in ambient air samples using ozone analyzer.
- A comparison of particulate composition of high polluted and low polluted sites with respect to carbon.

Water Analysis:

- Determination of hardness of water sample by EDTA.
- Determination of *p*H, acidity, alkalinity, TDS, metals, ions.
- Determination of fee and dissolved carbon dioxide, chlorine and oxygen
- Determination of BOD, COD, chlorine dosage, *E. coli* index

Ion Chromatography:

(i) Medical Science Applications

- Determination of sulfate counter ion and anionic impurities in aminoglycoside drug substances by IC with Suppressed Conductivity Detection
- Determination of tobramycin and impurities Using HPAE-PAD
- Determination of neomycin B and impurities Using HPAE-PAD
- Determination of streptomycin and impurities Using HPAE-PAD
- Determination of galactosamine containing organic impurities in heparin by HPAE-PAD Using the Dionex CarboPac PA20 Column
- Determination of hemoglobin variants by cation-exchange chromatography
- Determination of transition metals in serum and whole blood by Ion Chromatography
- Analysis of ions in physiological fluids
- Analysis of choline and acetylcholine
- Analysis of fatty acids.
- Determination of oxalate and carbohydrate in urine by Ion Chromatography
- Determination of protein concentrations using AAA-Direct
- Monitoring protein deamidation by cation-exchange Chromatography
- Analysis of mannose-6-phosphate

- Determination of nucleotides by Ion Chromatography with UV absorbance detection
- Determination of residual trifluoroacetate in protein purification buffers and peptide preparations by Reagent-Free Ion Chromatography
- Determination of tryptophan using AAA-Direct
- Identification of a hydroxylysine-containing peptide using AAA-Direct
- High-resolution analysis and purification of oligonucleotides with the DNAPac PA100 Column
- High-resolution cation-exchange alternative to peptide mapping for protein ID and QA/QC

(ii) Food and Beverage Applications

- Determination of mercury contamination in herbal medicines
- Rapid separation of anthocyanins in Cranberry and Bilberry extracts using a Core-Shell Particle Column
- Determination of trace sodium in cranberry powder
- Determination of sudan dyes I–IV in curry paste
- Determination of mono-, di-, and triphosphates and citrate in Shrimp by Ion Chromatography
- Determination of phytic acid in soybeans and black Sesame seeds
- Determination of nitrate and nitrite Ion Chromatography determination in milk samples
- Separation of organic acids and common inorganic anions in wine
- Determination of hydroxymethylfurfural in honey and biomass
- Fast determination of anthocyanins in pomegranate juice
- Determination of lactose in lactose-free milk products by high-performance anion-exchange Chromatography with Pulsed Amperometric Detection
- Fast HPLC Analysis of dyes in foods and beverages

(iii)Electronics Applications

- Determination of trace anion contamination in the extracts of electronic components
- Determination of sodium at the ppt level in the presence of high concentrations of ethanolamine in power plant waters
- Determination of inorganic anions and organic acids in fermentation broths
- Determination of phosphite in electroless nickel plating bath
- Determination of chloride, suppressors, additives and byproducts in acid copper plating baths
- Determination of saccharin in electrolytic nickel sulfate baths
- Determination of an anionic fluorochemical surfactant (FC-95) in a steel bath
- Determination of an anionic fluorochemical surfactant in a semiconductor Etch Bath
- Monitor trace anion contamination in the extracts of electronic components
- Determination of cations and amines in hydrogen peroxide by Ion Chromatography Using a RFIC™ (Reagent-Free) System
- Determination of dissolved silica and common Anions Using Dual Detection

(iv) Agrochemicals

- Determination of perchlorate in high ionic strength fertilizer extracts by Ion Chromatography

Interpretation of some organic compounds using UV, IR, NMR and MS spectra including following compounds:

- Acetone
- Phenylacetone
- Acetaldehyde
- Crotonaldehye
- Cinnamaldehyde
- Furfuraldehyde
- Glycerol
- Ethyl alcohol
- Isopropyl alcohol
- t-Butyl alcohol
- *p*-aminophenol
- *p*-Bromophenol
- *p*-Methoxybenzyl alcohol
- Acetic acid
- Benzoic acid
- Cinnamic acid
- Phthalic acid
- Ethyl bromide
- Propyl chloride
- Benzyl bromide
- n-Propylamine
- Triethylamine
- Nitrobenzene
- Aniline
- Toluene
- Xylenes
- 1,3,5-Trimethylbenzene
- *p*-Dichlorobenzene
- Toluidines
- Anisidines
- Pyridine
- 4-Picoline
- s-Triazine
- 2-Methoxyethyl acetate
- Vinyl acetate
- Diethyl phthalate
- Acetic anhydride
- Phthalic anhydride
- Acetylene
- Styrene
- Cyclohexane
- Urea
- Acetamide
- Benzamide
- Acetonitrile
- Benzonitrile
- Anisole
- Cresols

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

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

Sample Question Paper

Paper-1.2: CHEM-512: Organic Chemistry

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

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

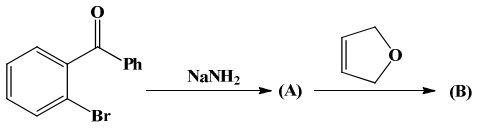
- ***Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B** will carry 25 marks with equally divided into five long answer type questions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

SECTION-A

Q. 1.

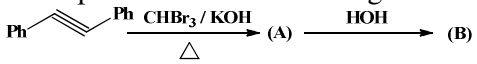
Unit-I

(i) Write the products of the following reaction:



½ + ½ = 1

(ii) Write the products of the following reaction:



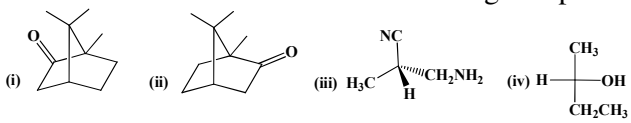
½ + ½ = 1

Unit-II

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

½ + ½ = 1

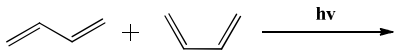
(iv) Write R or S nomenclature for the following compounds:



¼ +¼+¼+¼ = 1

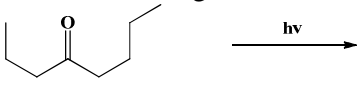
Unit-III

(v) Complete the following reaction:



1

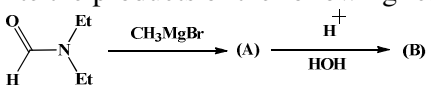
(vi) Complete the following reaction:



1

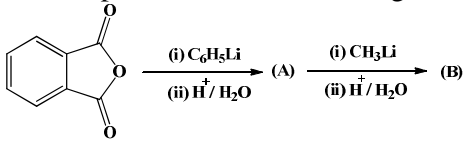
Unit-IV

(vii) Write the products of the following reaction:



½ + ½ = 1

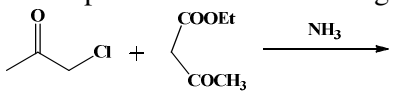
(viii) Write the products of the following reaction:



½ + ½ = 1

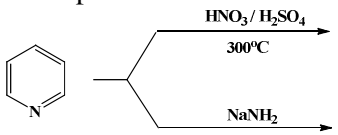
Unit-V

(ix) Write the products of the following reaction:



1

(x) Write the products of the following reaction:



½ + ½ = 1

SECTION-B

Unit-I

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

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

2½ + 2½ = 5

OR

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

(i) Carbocations
(ii) Carbenes

2½ + 2½ = 5

Unit-II

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

2 + 3 = 5

OR

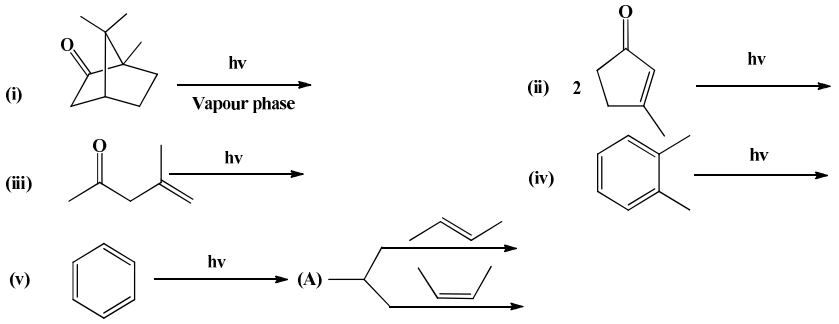
Write note on the following (any two):

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

2½ + 2½ = 5

Unit-III

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



1¼+1¼+1¼+1¼ = 5

OR

Discuss in detail:

(i) Paterno-Büchi reaction

(ii) Photochemistry of 1,5-dienes

2½ + 2½ = 5

Unit-IV

Q. 5. Write note on the following:

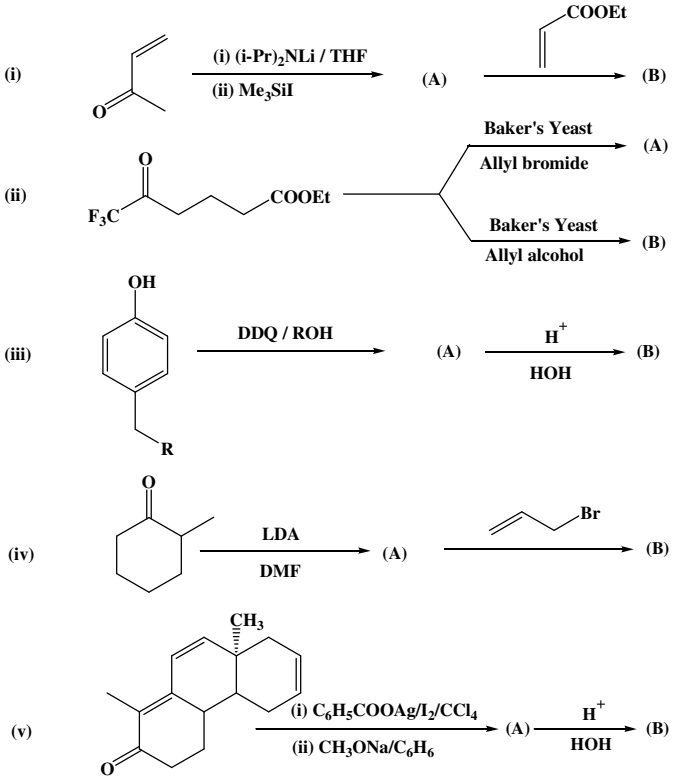
(i) Metal hydrides in organic synthesis

(ii) Phase transfer catalysts

2½ + 2½ = 5

OR

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



1¼+1¼+1¼+1¼ = 5

Unit-V

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

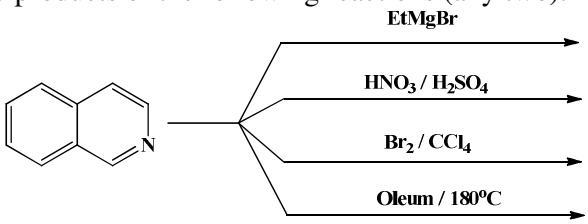
(i) Fischer-indole synthesis
(ii) Doebner-Miller synthesis
(iii) Bischler-Napieralski synthesis
(iv) Skraup synthesis

1¼+1¼+1¼+1¼ = 5

OR

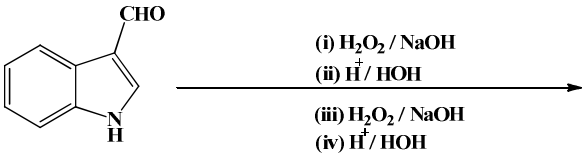
Write the products of the following reactions (any two):

(i)



(ii)

(iii)



2½ + 2½ = 5

SECTION-C

Unit-I

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

2+13 = 15

Unit-II

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

5+5 = 10

Unit-III

Q. 9. Give an account on the following:

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

5+3+2 = 10

Unit-IV

Q. 10. Discuss the synthesis and chemical reactions of the following:
(i) Pyrimidines
(ii) Pyrones

5+5 = 10

Unit-V

Q. 11. Discuss in detail the use of following reagents in organic synthesis (any two):
(i) Grignard's Reagent
(ii) Wilkinson's Catalyst
(iii) Metal Hydrides

5+5 = 10

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