SCHEME OF EXAMINATIONS

RULES & REGULATIONS

AND

SYLLABUS

First & Second Semester Examinations

(Effective from the Academic Session 2016-2017)

This syllabus is for course running under Semester Scheme at the University Department of Chemistry

Master of Science (M.Sc.)
Industrial Chemistry

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

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

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week & Credit Points			Distribution of Assessment Marks				Total Marks	
	Number of Paper	Code or ID of Paper	Nomenclature of Paper					Continuous Assessment (30%)		Semester Assessment (70%)			
					Teaching Th.	Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
I Year I Semester	Paper-1.1	IND-CHEM-511	Inorganic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	IND-CHEM-512	Organic Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.3	IND-CHEM-513	Physical Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	IND-CHEM-514	Mathematics for Chemists or Biology for Chemists	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	IND-CHEM-515	Practical	12	-	18	9	--	--	100	50	100	50
			Total (I Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
I Year II Semester	Paper-2.1	IND-CHEM-521	Fundamentals of Industrial Process Calculations	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	IND-CHEM-522	Environmental Pollution, Monitoring & Control	3	4	-	4	30	12	70	28	100	40
	Paper-2.3	IND-CHEM-523	Chemical Process Industries-I	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	IND-CHEM-524	Computer Applications in Industrial Chemistry	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	IND-CHEM-525	Practical	12	-	18	9	--	--	100	50	100	50
			Total (II Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
II Year III Semester	Paper-3.1	IND-CHEM-631	Separation Techniques in Industrial Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.2	IND-CHEM-632	Spectral Techniques in Industrial Chemistry	3	3	-	4	30	12	70	28	100	40
	Paper-3.3	IND-CHEM-633	Chemical Process Industries-II	3	3	-	4	30	12	70	28	100	40
	Paper-3.4	IND-CHEM-634	Petrochemical & Lubricant Industries	3	3	-	4	30	12	70	28	100	40
	Paper-3.5	IND-CHEM-635	Practical	12	-	18	9	--	--	100	50	100	50
			Total (III Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
II Year IV Semester	Paper-4.1	IND-CHEM-641	Fundamentals of Industrial Management	3	3	-	4	30	12	70	28	100	40
	Paper-4.2	IND-CHEM-642	IPR, Regulatory Affairs and QA & QC	3	3	-	4	30	12	70	28	100	40
	Paper-4.3	IND-CHEM-643	Fuel and Energy Technology	3	3	-	4	30	12	70	28	100	40
	Paper-4.4	IND-CHEM-644	Pharmaceutical, Agrochemical & Food Industries	3	3	-	4	30	12	70	28	100	40
	Paper-4.5	IND-CHEM-645	Practical	12	-	18	9	--	--	100	50	100	50
			Total (IV Semester)	**24**	**34**		**25**	**120**	**48**	**380**	**162**	**500**	**250**
			Grand Total (I + II + III + IV Semester)	**96**	**136**		**100**	**480**	**192**	**1520**	**648**	**2000**	**1000**

Rules & Regulations

Objectives of the Course:

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

M.Sc. Industrial 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. Industrial Chemistry course are:

- To impart knowledge in fundamental aspects of all branches of the Chemistry with basic ideas about Mathematics, Computer, Industrial Management applications in Industrial Chemistry.
- To acquire basic knowledge in the specialized areas like Organic Chemistry, Heterocyclic Chemistry, Medicinal Chemistry, Green Chemistry, Polymer Chemistry, Environmental Chemistry, Dye Chemistry, Pharmaceutical Chemistry, Paper & Pulp Chemistry, Textile Chemistry, *etc*.
- To acquire deep knowledge in the study of Industrial Chemistry including energy & mass balance, flow charts, flow sheets, spectral techniques, separation techniques, analytical techniques involved in this field.
- To acquire deep knowledge of various industries like Heavy & Fine Chemical, Pharmaceutical, Agrochemical, Paper & Pulp, Textile, Plastic & Polymer, Fuel & Energy, Cement & Ceramic, Food Industries, *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 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 Industrial Chemistry to award M.Sc. degree in Industrial Chemistry from this University after completion of a course of study of two academic years divided in the four semester scheme of examination:

- B.Sc. degree under 10+2+3 pattern with Chemistry as a main subject of study, or
- B.Sc. degree with specialization in any branch of Chemistry such as Industrial Chemistry, Polymer Chemistry, Applied Chemistry, Pharmaceutical Chemistry, Medicinal Chemistry, *etc.* or

- Three / Four year B.Sc. (Hons.) degree in Chemistry or any branch of Chemistry such as Industrial Chemistry, Applied Chemistry, Medicinal Chemistry, Pharmaceutical Chemistry, Polymer Chemistry, *etc.* or
- Four year Bachelor of Science and Technology (B.Sc.-Tech.) or Science and Teacher Education (B.Sc.-B.Ed.) or Pharmacy (B.Pharm.) or Technology (B.Tech. Chemical Engineering) degree with Chemistry as a paper.

Eligibility for Admission in M.Sc. Third Semester:

A candidate who has cleared at least 50% of the papers (including practical / project / dissertation / seminar *etc.* as one paper) prescribed for the first and second semester examinations taken together as a regular course of study from this University shall be promoted to the third semester examination as a regular candidate.

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.

Structure of the Programme:

The Master of Science in Industrial Chemistry programme will consist of core and advanced courses of theory as well as practical along with Dissertation / Project Work / Practical training / Field work, which can be done in an organization (Government, Industry, Firm, Public Enterprise, *etc.*) approved by the concerned Department.

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 "IND-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 at postgraduate level.

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

Maximum Marks and Credit Points:

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

laboratory work will be equal to 9 contact hours per week for theory paper and will carry 9 credit points.

Attendance:

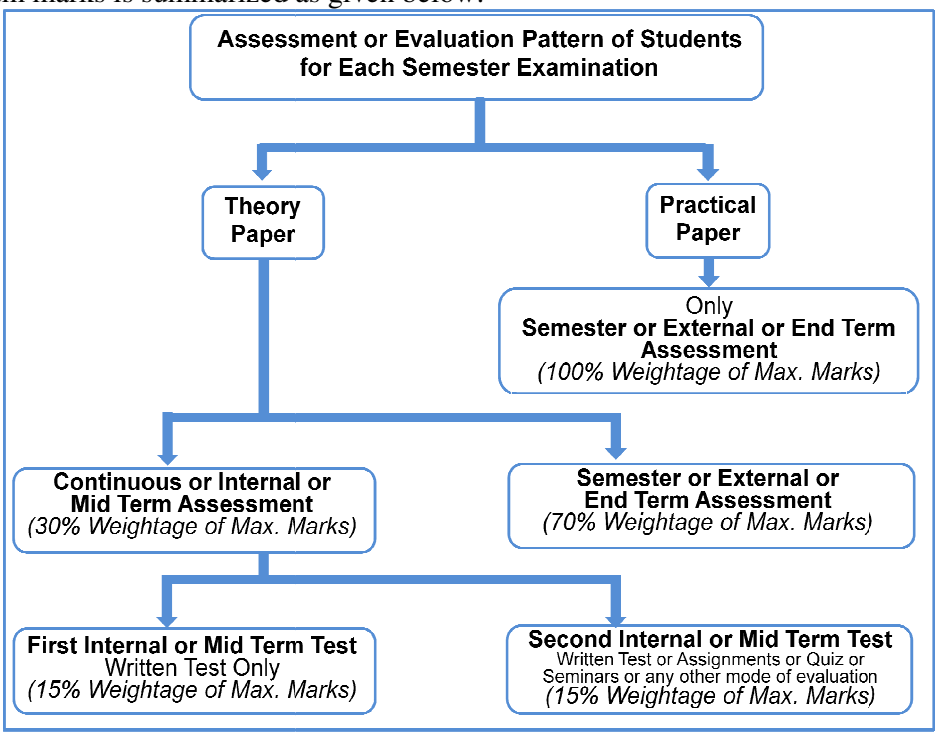
Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester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

Teaching Methodologies:

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

Assessment Pattern:

The assessment of the student shall be divided into two parts in which first part is continuous assessment or internal assessment or mid-term assessment (30% weightage of the maximum marks) and second part is semester assessment or external assessment or end-term 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 of maximum marks of 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 concern Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to Head of the Department who may permit the candidate to appear in the internal assessment after production of satisfactory evidence about the reason of his/her absence in the test(s) and deposition of the defaulter / improvement fee. A record of such candidates shall be kept in the Department.

(d) Regular attendance of the student shall be considered in the internal assessment. Some marks for regularity shall be given to the student(s) who is/are taken classes regularly from the 5% weightage of the maximum marks. The 5% weightage of the maximum marks of regularity shall be taken from the weightage given for second internal assessment (15% weightage of maximum marks). After excluding the 5% weightage of regularity, the second internal assessment shall be of 10% weightage of maximum marks. 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.*) and then second internal assessment test shall be of 15% weightage of maximum marks.

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

(f) The consolidated marks obtained by the students be also made known to them before being communicated by the concerned Head of the Department to the University for final incorporation in the tabulation register. If any discrepancies are discovered or pointed out by the students, the same shall be looked into by the concerned faculty member and corrections made wherever necessary. The decision of the Head of the Department before the communication of marks to

the University shall be final. No corrections shall be made in the internal assessment marks after the declaration of the result by the University.

(g) Consolidated marks of internal assessment obtained out of the 30% weightage of maximum marks of each theory paper which will be communicated to the University shall be in whole number and not in fraction. Marks awarded for the various internal assessments in each paper shall be added up and then round off to the next whole number to avoid any fraction.

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

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

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

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

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

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

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

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

Question Paper Pattern:

(A) 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

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

SECTION-A

Q. 1.

Unit-I

(i) …… **1 Mark**
(ii) …… **1 Mark**

Unit-II

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

Unit-III

(v) …… **1 Mark**
(vi) …… **1 Mark**

Unit-IV

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

Unit-V

(ix) …… **1 Mark**
(x) …… **1 Mark**

SECTION-B

Unit-I

Q. 2. ……..…… **5 Marks**

or

……...…… **5 Marks**

Unit-II

Q. 3. ……...…… **5 Marks**

or

……..…..…… **5 Marks**

Unit-III

Q. 4. ……..…… **5 Marks**

or

……..…… **5 Marks**

Unit-IV

Q. 5. . ……..…..…… **5 Marks**

or

……..…….. **5 Marks**

Unit-V

Q. 6. ……...…… **5 Marks**

or

……..…..… **5 Marks**

SECTION-C

Unit-I

Q. 7. ……..…… **15 Marks**

Unit-II

Q. 8. ……..…..…… **10 Marks**

Unit-III

Q. 9. ……..……..… **10 Marks**

Unit-IV

Q. 10. …… **10 Marks**

Unit-V

Q. 11. …… **10 Marks**

Practical 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 along with the papers of higher semester examination) in accordance with the following conditions:

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

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

(iii) A candidate, who has been declared as failed/absent in one or more theory paper(s) at any odd semester examination shall be permitted to join the courses of study for the next higher semester *i.e.* permitted to join the course of second semester after first semester examination, permitted to join the course of fourth semester after third semester examination, permitted to join the course of sixth semester after fifth semester examination and so on and eligible to re-appear in that paper(s) as due

paper(s) along with next higher semester (next year) examination provided that he/she must have cleared at least 50% of the papers (including practical / project / dissertation / seminar as one paper) collectively prescribed for the first and second semester examinations taken together for promotion to the third semester examination.

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

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

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

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

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

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

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

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

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

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

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

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

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

Classification of Successful Candidates:

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

Description of Marks Obtained	**Division / Result**
• 80% and above 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).

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

Syllabus

M.Sc. Industrial Chemistry
First Semester Examinations

Paper-1.1: IND-CHEM-511: Inorganic Chemistry

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

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

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

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

Unit-I: **Bonding and Structure:** **15-18 L**

Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

MO Approach : Rules for the LCAO method, bonding and anti-bonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of orbitals, MO treatment of homo-nuclear diatomic molecules of 1^{st} and 2^{nd} periods (including idea of s-p mixing) and hetero-nuclear diatomic molecules such as CO, NO and NO^{+}.

Unit-II: **Solid State Chemistry:** **15-18 L**

Structure of Solids: Types of matter, classification of solids, laws of crystallography, crystallographic systems, close packing of atoms; voids in closest packing; radius ratio rule, structure of ionic crystals; ionic crystals with stoichiometry MX, ionic crystals with stoichiometry MX_2, spinel structure.

Crystal Defects and Non-stoichiometry: Classification of defects: subatomic, atomic and lattice defects in solids; thermodynamics of vacancy in metals; thermodynamics of Schottky defects in ionic solids; thermodynamics of Frenkel defects in silver halides; calculation of number of defects and average energy required for defect, non-stoichiometry and its classifications, colour centres.

Unit-III: Nuclear Chemistry: 15-18 L

Nuclear Structure: Stability of nuclei, packing fraction, even-odd nature of nucleons, n/p ratio, nuclear potential, binding energy and exchange forces; properties of isobars, shell model and liquid drop model; decay of radio nuclei, rate of decay; determination of half-life period; modes of decay: alpha, beta, gamma and orbital electron capture; nuclear isomerism; internal conversions; Q value; nuclear cross section; threshold energy and excitation functions.

Nuclear Fission: Conformation of nuclear fission, types of fission reaction, mass distribution of fission product, emission of neutron in fission, fissile and fissionable nuclides, theory of nuclear fission, critical energy for fission, products of nuclear fission.

Unit-IV: Coordination Chemistry: 15-18 L

Principles: Studies of coordination compounds in solution, detection of complex formation in solution, stability constants, stepwise and over-all formation constants, simple methods (potentiometric, pH metric and spectrophotometric methods) of determining the formation constants, factors affecting stability.

Reaction Mechanism: Kinetics and mechanism of reactions in solution, labile and inert complexes, ligand displacement reactions in octahedral and square planar complexes, acid hydrolysis, base hydrolysis and anation reactions, trans effect, inner sphere and outer sphere processes, reactions of coordinated ligands, template effect and its application for the synthesis of macrocyclic ligands.

Unit-V: Organometallic Chemistry: 15-18 L

Introduction and nature of bonding in organometallic compounds of transition metals, σ- and π-bonded organometallic compounds: Introduction, classification and synthesis, general characteristics, chemical reactions, bonding and structure; π-bonded organometallic compounds: (a) η^2-alkene, η^3-allyl (or enyl) and η^5-cyclpentadynyl complexes: Preparative methods, physical properties, chemical properties, bonding of structure, industrial applications of organometallic compounds Zn, Pd and Fe.

Books:

- *Advanced Inorganic Chemistry 5th Edition by F. A. Cotton and G. Wilkinson, Wiley Eastern.*
- *Inorganic Chemistry-Principles of structure and reactivity, 4th edition by J. E. Huheey, E.A. Keiter and R L. Keiter, Pearson-Education.*
- *Mechanism of Inorganic Reactions by F. Basolo and R.G. Pearson Wiley Eastern.*
- *Essentials of Nuclear Chemistry 2nd Edition by H. J. Arniker, Wiley eastern Co.*
- *Elements of Nuclear Chemistry by A. K. Srivatsava and P.C. Jain, S. Chand and Co.*
- *Coordination Chemistry Experimental Methods by K. Burger, Butterworths.*
- *Basic Organometallic Chemistry by J. Haiduc and J.J. Zuckerman, Walter de Gruyter.*
- *Basic Solid State Chemistry by A. R. West, John Wiley & Sons.*
- *Solid-State Chemistry an Introduction, 2nd Ed by Lasley Smart and Elaine Moore, Chapman & Hall*
- *Solid State Chemistry by D. K. Chakraborty, New Age International Pvt. Ltd.*
- *Principles of the Solid State, by H. V. Keer, Wiley Eastern Ltd.*

Paper-1.2: IND-CHEM-512: Organic Chemistry

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

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

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

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

Unit-I: Basic Concepts of Organic Chemistry: 15-18 L

Basic concept of resonance, tautomerism, conjugation, aromaticity, non-aromatic and anti-aromaticity; generation, types, structure and stability of reaction intermediates (carbocations, carbanions, free radicals); types of organic reactions; kinetic and thermodynamic control of chemical reactions; methods of determination of mechanisms of organic reactions (kinetic methods: primary and secondary kinetic isotopic effects; non-kinetic methods: study of intermediates, product analysis, isotope labelling, stereochemical studies and cross over experiments); linear free energy relationship; Hammett equation: significance of reaction and substituent constants; Taft equation.

Unit-II: Stereochemistry: 15-18 L

Fundamentals of organic stereochemistry, introduction of configuration and conformation, determination of configuration of geometrical isomers, d/l, D/L, R/S and E/Z nomenclature, Newman, Sawhorse, flying wedge and Fisher projection formulae and inter-conversions; effect of conformation on reactivity; conformation of ethane, n-butane, cycloalkanes; symmetry, groups and faces; chirality, molecules with more than one chiral center, threo and erythro isomers, enantiotopic and diastereotopic atoms; stereospecific and stereoselective synthesis, asymmetric synthesis, optical activity in the absence of chiral carbon (biphenyls, allenes).

Unit-III: Photochemistry: 15-18 L

Types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy; photochemistry of alkenes: inter & intra-molecular reactions of the olefinic bond, isomerization and cyclisation reactions, photochemistry of 1,3-, 1,4- and 1,5-dienes; photochemistry of carbonyl compounds: cyclic, acyclic and α,β-unsaturated carbonyl compounds, cycloaddition reactions: dimerisations and oxetane formation; photochemistry of aromatic compounds: transformation, isomerisation, additions and rearrangements, photo-Fries rearrangement.

Unit-IV: Reagents in the Organic Synthesis: 15-18 L

Use of following reagents in organic synthesis and functional group transformation: Grignard's reagent, Gilman's reagent, metal hydrides, lithium diisopropylamide (LDA), dicyclohexyl carbodimide (DCC), DDQ, trimethylsilyl iodide, tri-n-butyltin hydride, osmium tetraoxide, selenium oxide, phase transfer catalysts, crown ethers, Merrifield resin, Backer yeast, Wilkinson's catalyst, 1,3-dithiane (reactivity umpolung), Woodward and Prevost hydroxylation, Peterson's synthesis.

Unit-V: Heterocyclic Chemistry: 15-18 L

Nomenclature, classification and importance of heterocycles; five-membered heterocycles: synthesis and reactions of pyrrole, furan and thiophen, order of aromaticity and reactivity in five-membered heterocycles, benzo-fused five-membered heterocycles: synthesis and reactions including medicinal applications of indole; six-membered heterocycles with one heteroatom: synthesis and reactions of pyridines; six-membered heterocycles with two heteroatoms: synthesis and reactions of pyrimidine; benzo-fused six-membered heterocycles with one heteroatom: synthesis and reactions including medicinal applications of quinoline and isoquinoline.

Books:

- *Advanced Organic Chemistry: Reactions, Mechanisms and Structure by J. March, John Wiley & Sons.*
- *Advanced Organic Chemistry, Part A & B, III Edn. by F. A.Carey and Sundberg, Plenum Press.*
- *Principles of Organic Synthesis, II Edn. by R.O.C. Norman, Chapman and Hall.*
- *Organic Chemistry, IV Edn. by S. H.Pine, Hendrickson, D.J.Cram and G.S.Hammond, McGraw-Hill.*
- *Organic Chemistry, Vol. I & II, V Edn. by I. L. Finar, Pearson Education Asia Pvt. Ltd.*
- *Organic Chemistry by P. Mehta and M. Mehta, Prentice Hall India.*
- *A Guide Book to Mechanisms in Organic Chemistry by P. Sykes, Longmans Scientifics and Technical.*
- *Reaction Mechanism in Organic Chemistry, III Edn. by S. M. Mukherji and S. P. Singh,MacMillan*
- *Organic Reactions and Mechanisms, II Edn. by P. S. Kalsi, New Age International Publishers*
- *Organic Reaction Mechanisms by R. K. Bansel, Tata McGraw Hill.*
- *Mechanism and Theory in Organic Chemistry by T.H. Lowry and K.S. Richardson, Harper and Row*
- *Stereochemistry of Carbon Compounds by Ernest L. Eliel, Tata McGraw-Hill Publishing Company*
- *Stereochemistry of Organic Compounds by D. Nasipuri, New Age International Publishers.*
- *Fundamentals of Organic Reaction Mechanisms by J.M.Harris and C.C. Wamser, John Wiley & Sons*

Paper-1.3: IND-CHEM-513: Physical Chemistry

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

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

Unit-I: Chemical Kinetics: 15-18 L

Introduction, collision theory, activated complex theory, Arrhenius equation, salt effect, steady state kinetics, unimolecular, bimolecular and trimolecular reactions, chain reactions, measurement of rate of slow reactions, fast reactions, calculation of conversion and reactor size, heterogeneous reactions, vapour phase catalytic reactions, catalytic rate equations, use of rate equations in reactor design, factor affecting

chemical process, reactor shape and their kinetic behaviuor, back mixing, selection and sizing of homogeneous catalytic reactors.

Unit-II: Thermodynamics: 15-18 L

Classical Thermodynamics: Law of thermodynamics, concept of entropy, Gibbs function, Gibbs-Helmholtz equation, Maxwell relations, thermodynamic equation of state, thermodynamics of systems of variable compositions, partial molar quantities, partial molar volume, chemical potential, Gibbs-Duhem equation, fugasity of real gases and its determination, heat engine, Carnot's cycle, free energy work function.

Statistical Thermodynamics: Definitions of state of a system, Boltzmann distribution law and its derivations, Boltzmann-Planck equation, Fermi-Dirac and Bose-Einstein statistics.

Unit-III: Surface Chemistry: 15-18 L

Adsorption: Definition, thermodynamics of adsorption, Langmuir adsorption isotherm, Langmuir constant and Gibbs energy of adsorption, Langmuir adsorption with lateral interaction, BET adsorption isotherm, adsorption on heterogeneous surface.

Liquid Surface: Microscopic picture of liquid surface, surface tension, equation of Young and Laplace (derivation and application), curve surface, Kelvin equation, capillary condensation, porous solids and nucleation theory.

Surfactants: Micelles and Emulsions: Surfactants, types of micelles, Ostwald ripening, critical micelle concentration, thermodynamics of micellization, structure of surfactants, aggregates, biological membranes, microemulsion, inverse microemulsion formation and stabilization.

Unit-IV: Electrochemistry: 15-18 L

Introduction and over view of electrochemical processes: Electrochemical cell and reactions, Faradic and non-Faradiac processes, basic electrochemical thermodynamics, free energy and cell EMF, half-cell reactions and reduction potentials, formal potentials, reference electrodes, measurements of potential differences, electrochemical potentials, absolute potentials, liquid junction potential.

Ion-ion interactions: Ideal solution, deviation from ideality, activity and activity coefficient, Debye-Huckel theory, limited and extended law.

Electrochemical devices: Batteries and Fuel cells.

Unit-V: Corrosion: 15-18 L

Introduction, economic aspects of corrosion, theories of corrosions, factor affecting corrosions, kinetics of corrosion, thermodynamics of corrosions, uses and abuses of corrosion and corrosion potential: Evans diagrams, measurement of corrosion rate: (i) weight loss method, (ii) electrochemical method, inhibiting corrosion: Cathodic and anodic protection. (i) Inhibition by addition of substrates to the electrolyte environment, (ii) by charging the corroding method from external source, anodic protection, organic inhibitors, green inhibitors, passivation: nature's method for stabilizing surfaces.

Books:

- *Kinetics and Mechanism of Chemical Transformations by J. Rajaram and J. C. Kuriacose, MacMillan.*
- *Atkins Physical Chemistry, Oxford University Press, Oxford*
- *Text Book of Physical Chemistry by D. A. McQuarrie, University Science Books*
- *Chemical Kinetics by K. J. Laidler, Harper and Row.*
- *Physical Chemistry of Surfaces by A. W. Anderson, Wiley-Interscience.*
- *Introduction to Electrochemistry by S. Glasstone, Affiliated East west Press*

Paper-1.4: IND-CHEM-514: Mathematics for Chemists

(For students who have not studied Mathematics in B.Sc.)

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

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

Unit-I: Basic Mathematics: 15-18 L

Matrix algebra, determinants, linear equations, Eigen values and Eigen vectors, basic rules for differentiation, applications of differentiation in chemistry, partial differentiations, maxima and minima, basic rules for integration, application of integral calculus

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

Differential equations, solution of linear differential equations, applications of differential equations; Vectors: definition dot, triple and cross product, Vector Calculus: gradient, divergence and curl; linear programming problems: Formulation, graphical solution, simplex method, solution by simplex method (up to 2 variables).

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

Operations research-concept and applications of OR, transportation problem, assignment problems, basic concepts of inventory control, inventory control models, basic concepts of replacement problems, solutions of replacement problems, basic concepts of theory of reliability.

Unit-IV: Basic Statistics: 15-18 L

Quality control and ABC analysis, curve fitting: methods of least square, permutation & combination, probability theory, representation of data-histogram, Pie chart, measures of central tendency, deviation, dispersion, skewness and kurtosis, random variables, mathematical expectations.

Unit-V: Statistical Inference: 15-18 L

Probability distribution: discrete (binomial and Poisson), probability distribution: continuous (normal) distribution, correlation, regression, sampling concepts, sampling test for mean, testing of hypothesis-test based on t-distribution (t-test), test based on Chi square distribution (Chi square test), basic concepts of estimation.

Books:

- *Mathematical Statistics-Gupta and Kapoor.*
- *Operations Research-Kanti Swaroop.*

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

OR

Paper-1.4: IND-CHEM-514: Biology for Chemists

(For students who have not studied Biology in B.Sc.)

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

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

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

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

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

Unit-II: Carbohydrates: 15-18 L

Monosaccharides: Structure, conformation and functions of important derivatives of monosaccharides; structural polysaccharides: cellulose and chitin, storage polysaccharides: starch and glycogen, structure and biological functions of glucosaminoglycans or mucopolysaccharides, glycoproteins and glycolipids, role of sugars in biological recognition, blood group substances; carbohydrate metabolism: Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

Unit-III: Lipids: 15-18 L

Fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins; liproproteins: composition and function, role in atherosclerosis; properties of lipid aggregates: micelles, bilayers,

liposomes and their possible biological functions; biological membranes, fluid mosaic model of membrane structure, lipid metabolism: β-oxidation of fatty acids.

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

Amino acid metabolism: degradation and biosynthesis of amino acids, sequence determination: chemical/enzymatic/mass spectral, racemization / detection, chemistry of oxytocin and tryptophan releasing hormone (TRH).

Chemical and enzymatic hydrolysis of proteins, amino acid sequencing, secondary structure of proteins, force responsible for holding of secondary structures, α-helix, β-sheets, triple helix structure of collagen, tertiary structure of protein: folding and domain structure, quaternary structure.

Unit-V: Nucleic Acids: 15-18 L

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

Books:

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

Paper-1.5: IND-CHEM-515: Practical

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

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	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**

Laboratory Safety, GLP, SOPs and Basic Concepts:

- General instructions for safe working in chemical laboratories.
- Planning of experiments and recording of results.

- Good laboratories practices.
- Sampling and sample preparation.
- Preparation of standard operating procedures (SOPs).
- Hazards in chemical laboratories.
- Apparatus and reaction procedures: Introduction of working with lab ware.
- Concept of distillation, crystallization, drying, isolation and purification, determination of physical constants.

Solution Preparation and Standardization:

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

Inorganic Chemistry:

Qualitative Analysis:

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

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

Quantitative Analysis:

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

Preparations:

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

- Ferrous ammonium sulphate
- Ferric ammonium sulphate
- Nickel ammonium sulphate
- Bis(acetylacetonato) complexes of Cu, Co, Cr, Mn, and VO
- *trans*-$K[Cr(ox)_2(H_2O)_2]$
- *cis*- $K[Cr(ox)_2(H_2O)_2]$
- $[Cr(NH_3)_6]Cl_3$
- $[Ni(NH_3)_6]Cl_2$
- $Ni(dmg)_2$
- $Na_3[Co(ONO)_6]$
- $[CoCl(NH_3)_5]Cl_3$
- $[Co(H_2O)(NH_3)_5]Cl_3$
- $[Co(ONO)(NH_3)_5]Cl_2$
- $[Co(NO_2)\ (NH_3)_5]Cl_3$

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

Organic Chemistry:

Qualitative Analysis:

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

Quantitative Analysis:

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

Organic Syntheses:

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

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

Physical Chemistry:

Transition Temperature:

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

Thermochemistry:

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

Chemical Kinetics:

- Determination of the effect of (a) change of temperature (b) change of concentration of reactant and catalyst and (c) ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction.
- Determination of the velocity constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as iodine clock reactions.
- Determination of rate constant and formation constant of an intermediate complex in the reaction of Ce(IV) and hypophosphorous acid at ambient temperature.
- Determination of order of reaction with respect to Ag(I) in oxidation of Mn(II) by $S_2O_8^{2-}$ and rate constant for un-catalyzed reaction.
- Determination of the primary salt effect on the kinetics of ionic reaction and testing of the Bronsted relationship (iodide ion is oxidised by persulphate ion).
- Determination of energy and enthalpy of activation in the reaction of KMnO4 and benzyl alcohol in acid medium.
- Determination of energy of activation of and entropy of activation from a single kinetic run
- Kinetics of decomposition of benzene diazonium chloride.
- Kinetics of decomposition of acidified hydrogen peroxide with potassium iodide and determination of activation energy.
- Flowing clock reactions.
- Oscillatory reactions.

Polarography:

- To determine half wave potential of a given ion using half height method, differential method and wave equation method
- Identification and estimation of metal ions such as Cu^{2+}, Cd^{2+}, Pb^{2+}, Zn^{2+}, and Ni^{2+} *etc.* polarographically.
- To study the current-potential characteristics of Cd^{2+} ions using DC polarography, sampled DC, cyclic voltammetry and pulse polarographic techniques.
- Study of a metal ligand complex polarographically (using Lingane's Method).
- Determination of (a) Fe and Mo in steel (b) urea and glucose in biological fluids (c) heavy metals in wine samples and petroleum products polarographically.
- Determination of heavy metals in wood samples

Potentiometry / *p*H metry:

- Determination of temperature dependence of EMF of a cell
- Determination of EMF of Daniel cell.
- Determination of the EMF of various $ZnSO_4$ solutions and hence the concentration of unknown $ZnSO_4$ solution.
- Determination of the valency of mercurous ions potentiometrically.
- Determination of activity and activity constant of electrolytes.
- Determination of thermodynamic parameters for electrochemical reactions (To determine ΔG^o, ΔH^o and ΔS^o for the formation of 1 mole cadmium in 1 wt.% amalgam at 25^{o}C and activity coefficient of solution)
- Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).

- Determination of standard electrode potential (Eo) value of the ferrous-ferric system by titrating ferrous ammonium sulphate against potassium dichromate potentiometrically.
- Determination of standard electrode potential (Eo) value of Ag / AgI electrode and the solubility product of AgI and PbI_2.
- Determine the solubility and solubility product of sparingly soluble salts.
- Estimate the amount of halides present in the given mixture by titrating with $AgNO_3$ solution.
- Micro determination of magnesium present in a given sample with standard Ce(IV) solution potentiometrically through oxinate precipitation.
- Micro determination of vanadium present in V_2O_5 potentiometrically employing cerate method.
- Micro-determination of glucose using potassium ferrocyanide as internal reagent and Ce(IV) solution as standard titrant.
- Determination of the pKa value of chloroacetic acid, trichloroacetic acid, Orthophosphoric acid by potentiometry / pH metry / condctometrically using standard solution of NaOH.
- Determination of hydrolysis constant and degree of hydrolysis of aniline hydrochloride pH metrically

Conductometry:

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

Adsorption:

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

Polarimetry:

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

Surface tension:

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

Viscosity:

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

Any other relevant experiments may be added / performed.

Books:

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

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Syllabus

M.Sc. Industrial Chemistry
Second Semester Examinations

Paper-2.1: IND-CHEM-521: Fundamentals of Industrial Process Calculations

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

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

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

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

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

Unit-I: Material Balance: **15-18 L**

Law of conservation of mass, strategy for analyzing material balance problems, classification of material balance problems, solving material balance problems without chemical reactions, various operations with their block diagrams carried out in industries, material balances involving multiple subsystems, material balances with recycle and bypass operations, material balances of unsteady-state operations, calculation procedures for ideal gas system.

Unit-II: Energy Balance: **15-18 L**

Calculations of enthalpy, general energy balance procedure, sensible heat and heat capacities, relationship between Cp and Cv, energy balances on closed systems, changes using heat capacity equations and enthalpy tables, use of steam tables, heat of reaction, formation and combustion, Hess's law, effect of temperature and pressure on heat reactions, phase change operations, energy balances with chemical reactions, latent heats, energy balance during phase change operations.

Unit-III: Unit Processes: **15-18 L**

Introduction to unit operations, evaporation, distillation, extraction, filtration, crushing, grinding, mixing, crystallization and separation

Unit Operations:

Introduction to unit processes, nitration, sulphonation, halogenations, esterification, polymerization, oxidation and reduction.

Unit-IV: Stoichiometry of Unit Operations: **15-18 L**

Stoichiometry of distillation, gas absorption, crystallization, extraction, leaching and humidification, dew point; relative saturation, molal saturation and absolute saturation (humidity); humid heat and humid volume; psychometric chart for air-water system

Unit-V: Flow of Fluids: **15-18 L**

Nature of fluids, classification of fluids, properties of fluids, hydrostatic pressure, application of fluid statics, manometers, viscosity, average velocity, mass velocity, flow rate, equation of continuity, Bernoulli's equation and its corrections, friction losses, flow of incompressible fluids, flow measurements: venturimeter, orificemeter, pitot tube, rotameter.

Transformation of Fluids:

Methods of transformation of fluids, principles of pipes, fiting and their standards, types and characteristics of valves, pumps

Books:

- *Introduction to Process Calculations: Stoichiometry. K. A. Gavhane. 20th Edn, 2007, Nirali Prakashan*
- *Unit Operations-I: Fluid flow and Mechanical Operations, K. A. Gavhane. 16th Ed, 2008, Nirali Prakashan*
- *Shreve's Chemical Process Industries. G. T. Austin. 5th Edition. McGrow-Hill International Editions.*
- *Unit Processes in Organic Synthesis. P. H. Groggins. 5th Edition, 2007. Tata McGrow-Hill, New Delhi*

Paper-2.2: IND-CHEM-522: Environmental Pollution, Monitoring and Control

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

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

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

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

Unit-I: Air Pollution: **15-18 L**

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, ultra low sulphur diesel (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: 15-18 L

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, general methods of water pollution control.

Unit-III: Soil Pollution: 15-18 L

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: 15-18 L

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: 15-18 L

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-2.3: IND-CHEM-523: Chemical Process Industries-I

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

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

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

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

Unit-I: Cane Sugar and Beverage Industries: 15-18 L

Cane Sugar Industry: Classification of sugar factories based the processes, general idea of carbonation and sulphitation processes and their comparison, manufacturing of white crystalline sugar, byproduct and their use.

Beverage Industry: Manufacturing of distilled spirit, absolute alcohol, beer and wine.

Unit-II: Pulp and Paper Industries: 15-18 L

Pulp Industries: Raw materials, classification, methods of pulping, production of sulphate and sulphite pulp, general principles of some mechanical and chemical pulping kinetics.

Paper Industries: Production of paper, wet process, paper properties testing, process instrumentation; emission: solid and gas waste; applied processes and techniques: sizing, coating, dyeing, addition of chemicals, and calendering; fibre recovery: Broke system

Unit-III: Dyes and Paints Industries: 15-18 L

Dyes Industries: Dye intermediates and their preparations; classification of dyes: structures, synthesis and applications of nitro, azo, phthalenes, xanthenes, rhodamines, thiazine, cyanine, anthraquinone, indigoids, phthalocyanines, wet dyes.

Paints Industries: Introduction, ingredients and classification, new technologies, properties of coatings, solvents, plasticizers, dyes and bioactive additives, paint formulations, testing, evaluation

Unit-IV: Soap, Detergent, Surfactant and Emulsifier Industries: 15-18 L

Introduction and differences between soaps and detergents, theory of detergency, manufacture of soaps and detergents, emulsions and their characteristics, industrial applications: smoke precipitation, Cottrell's method, purification of water, cleaning action of soap, tanning of leather and sewage disposal, and dry cleaning agents.

Unit-V: Cosmetic and Perfume Industries: 15-18 L

Introduction of cosmetics and perfumes, theory of action and mechanism, relation between perfumes and phermones, ingredients of creams, hairsprays, hair dyes,

toothpowder and tooth paste, talcum powder, face powder, lipsticks, nail polish, shampoos sun-tan lotions; synthetic perfumes, synthesis of some important synthetics chemicals used in perfume industry: citral, geraniol, linalool, jasmone, civetone and muskone, vanillin, acetyl longifolene; perfume formulation, some representative formulation of rose, jasmine, sandal wood, lavender.

Books:

- *Ullman's Encyclopedia of industrial chemistry.*
- *The Complete Book on Glass and Ceramics Technology by NIIR Board of Consultants & Engineers, Asia Pacific Business Press Inc.*
- *Raw Materials for Glass and Ceramics: Sources, Processes, and Quality Control by Christopher W. Sinton, John Wiley & Sons*
- *Manufacturing and Design: Understanding the Principles of How Things are Made by Erik Tempelman, Bruno Ninaber van Eyben and Hugh Shercliff, Butterworth-Heinemann Ltd.*
- *Cement industry by D. K. Mittal, Anmol Publications*
- *Cement Data Book, Volume One: International Process Engineering in the Cement Industry by Walter H. Duda, French & European Publications*
- *Cement Industry of India by Kumar Bar Das, APH Publishing*
- *Sugar Processing and By-products of the Sugar Industry by Antonio Valdes Delgado, Carlos de Armas Casanova, Food & Agriculture Org*
- *The World's Cane Sugar Industry Past and Present by H.C. Prinsen Geerligs, Cambridge University Press*
- *The Complete Book on Sugarcane Processing and By-Products of Molasses (with Analysis of Sugar, Syrup and Molasses) by H. Panda, Asia Pacific Business Press Inc.*
- *Soaps and Detergents Vol. 1 by S.C. Bhatia, CBS Publishers & Distributors*
- *Herbal Soaps and Detergents Hand Book by H. Panda, National Institute of Industrial Research*
- *Handbook on Soaps, Detergents & Acid Slurry (3rd Revised Edition) by National Institute of Industrial Research*
- *The Complete Technology Book on Flavours, Fragrances and Perfumes by NPCS Board of Consultants & Engineers*
- *A text book of chemical technology vol.1, 2 and 5: S.D. Shukla and G.N. Pandey.*
- *Industrial Organic Chemistry: K. Weissermel and H.J. Arpe.*
- *Chemical Process Industries: Shreeve.*
- *Industrial Chemistry: B.K. Sharma.*

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

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

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

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

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

Unit-I: General Introduction: 15-18 L

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

PC Software:

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

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

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

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

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

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

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

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

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

Books:

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

Paper-2.5: IND-CHEM-525: Practical

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

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	15
2.	Exercise No. 2 : Major Experiment	15
3.	Exercise No. 3 : Major Experiment	15
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Minor Experiment	10
6.	Exercise No. 6 : Minor Experiment	10
7.	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**

Chromatographic Analysis:

Separation and identification of compounds (*e.g.* amino acids, carbohydrates, ions, inorganic or organic mixtures, *etc.*) by following chromatographic techniques:

- Paper Chromatography
- Thin Layer Chromatography
- Column Chromatography
- Flash Chromatography
- Ion-Chromatography
- Electrophoresis

Inorganic Chemistry:

Flame Photometric Determinations:

- Estimation of sodium / potassium / lithium / calcium / magnesium / barium / strontium in a given sample flame photometrically.

Preparations and Isomeric Identification:

Preparation of selected inorganic compounds and their studies by magnetic susceptibility measurements. Handling of air and moisture sensitive compounds.

- *Cis*-$[Co(en)_2Cl_2]$
- *Trans*-$[Co(en)_2Cl_2]$
- $[Ti(urea)_6]I_3$
- $Na[Cr(NH_3)_2(SCN)_4]$
- $K_3[Fe(C_2O_4)_3]$
- $[Co(NH_3)_6]\ [Co(NO_2)_6]$
- *Cis*-$[Co(trien)(NO_2)_2]Cl.H_2O$
- $Hg[Co(SCN)_4]$
- $[Co(Py)_2Cl_2]$
- $[Cu(NH_3)_4]SO_4.H_2O$
- Prussian Blue / Turnbull's Blue

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

Organic Chemistry

Extraction of Organic Compounds from Natural Sources:

- Isolation of caffeine from tea leaves.
- Isolation of lycopene from tomatoes.
- Isolation of β-carotene from carrots.
- Isolation of limonene from citrus fruits
- Isolation of fatty oil from seeds
- Isolation of casein from milk.
- Isolation of lactose from milk.

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.

Organic Preparations:

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

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

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

- Acetone
- Acetaldehyde
- Cinnamaldehyde
- Ethyl alcohol
- Isopropyl alcohol
- p-aminophenol
- Acetic acid
- Benzoic acid
- Ethyl bromide
- Nitrobenzene
- Ethyl acetate
- Vinyl acetate
- Phthalic anhydride
- Acetamide
- Butanamide
- Styrene

Other examples / spectral data for elucidation of structure may be used.

Physical Chemistry:

Distribution Law:

- Distribution coefficient of iodine between CCl_4 and water
- Distribution coefficient of benzoic acid between toluene and water.
- Determination of the equilibrium constant of the reaction $KI+I_2 \rightarrow [KI_3]$ and hence the concentration of given KI.
- Distribution coefficient of ammonia between chloroform and water.
- Determination of equilibrium constant of copper-ammonia complex by partition method or coordination number of Cu^{2+} in copper-ammonia complex.

Phase Equilibrium:

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

Ionic Equilibrium:

- Determination of pKa of an indicator (*e.g.* methyl red) in (a) aqueous and (b) micellar media.
- Determination of stoichiometry and stability constant of Ferric isothiocyanation complex ion in solution.
- Determination of rate constant of alkaline bleaching of Malachite green and effect of ionic strength on the rate of reaction.
- Determine stability constant of Fe^{2+} complex ion keeping ionic strength constant

Potentiometry / *p*H metry:

- Determination of the EMF of various $ZnSO_4$ solutions and hence the concentration of unknown $ZnSO_4$ solution.
- Determination of temperature dependence of EMF of a cell
- Determination of activity and activity constant of electrolytes.
- Determination of the valency of mercurous ions potentiometrically.
- Determination of the pKa value of chloroacetic acid, trichloroacetic acid, orthophosphoric acid by potentiometry / pH metry / condctometrically using standard solution of NaOH.
- Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).
- Determine the solubility and solubility product of sparingly soluble salts potentiometrically
- Determination of standard electrode potential (Eo) value of Ag / AgI electrode and the solubility product of AgI and PbI2.
- Micro determination of magnesium present in a given sample with standard Ce (IV) solution potentiometrically through oxinate precipitation.
- Micro determination of vanadium present in V_2O_5 potentiometrically employing cerate method.
- Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method.
- Determination of commercial washing soda by potentiometric titration method.
- Estimation of chloride / sulphate / fluoride / nitrate and other ions in water samples by ion selective methods.
- Determine the amount of HCl by using strong base (NaOH) potentiometrically.

- Determination of dissociation constant of Cu-ammonia complex potentiometrically.
- Analysis of mixture of carbonate and bicarbonate (percent in ppm range) using a pH meter or suitable indicators

Spectrophotometry & Colorimetry:

- To verify Lambert-Beer law for $KMnO_4$ solution & to determine the concentration of given $KMnO_4$ solution
- Determine the pH of solution employing methyl red indicator spectrophotometrically.
- Determination of composition of complex by Job's continuous variation method.
- Study of zirconium-alizarin Red-S complex: Mole-ratio method.
- To determine equilibrium constant of reaction $KI+I_2=KI_3$ spectrophotometrically
- To determine the amount of each copper and bismuth or copper and iron (III) from the given mixture at 745 nm by spectrophotometric titration using solution of EDTA.
- Determination of $A1^{3+}$, Ti^{3+}, Fe^{3+} using 8-Hydroxyquinoline.
- Determination of Fe^{2+} using 1,10-phenanthroline method.
- Determination of Cr^{3+} diphenylcarbazide method.
- Determination of Ni^{2+} by DMG method.
- Estimation of purity of a given azo dye by colorometry.
- Determination of fluoride/nitrite/phosphate spectrophotometrically.

Conductometry:

- Conductometric titration of (i) strong acid, monobasic weak acid or polybasic weak acid with strong base (ii) zinc with EDTA, and (iii) KCl v/s $AgNO_3$.
- Conduc. titra. of triple mix. ($HCl+NH_4Cl+KCl$) with (i) NaOH & (ii) $AgNO_3$.
- Determination of thermodynamic ionization constant of a monobasic acid by (i) conductometry and (ii) potentiometry.
- Determination of solubility and solubility product of sparingly soluble salts e.g. $PbSO_4$, $BaSO_4$) conductometrically.
- To study the effect of solvent on the conductance of $AgNO_3$/acetic acid and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye-Hűckel-Onsager theory.
- Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye Hűckel's limiting law.
- Titration of $ZnSO_4$ / $MgSO_4$ against $BaCl_2$ and $Ba(CH_3COO)_2$ and calculation of amount of sulphate present.
- Determination of the critical micelle concentration of sodium lauryl sulphate from measurement of conductivities at different conc. in aqueous solutions
- Determination of transition temperature of given salt (*e.g.* $CaCl_2$) conducto-metrically.

Refractometry:

- Determination of molar refraction of pure liquids
- Determination of concentration of KCl solution/glycerol solution
- Determination of concentration of KI solution

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

Voltametry:

- Determination of trace metal impurities present in a polluted water sample by anodic stripping voltammetric procedure.

Analysis of Soap, Detergent, Shampoo and Cosmetics:

- Assay of soaps and detergents
- Estimation of EDTA in detergent and shampoo.
- Determination of Na/K/Li/Ca in given sample by flame photometry method.
- Determination of washing strength of detergents by surface tension method.
- Determination of CMC of detergents.
- Determination of composition of perfume by GC/MS
- Estimation of fragrance in the perfumes by GC/MS.
- Estimation of Zinc in face powder by gravimetry
- Analysis of suspected allergens in perfumes by GC/MS.
- Estimation of benzoic acid in ointment.

Analysis of Sugar:

- Estimation of sugars in various cough syrup / fruit juices / jams / sauces.
- Analysis of sugars by refractometer and polarimeter
- 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 from Human Polyclonal IgG Using the CarboPac PA200 Column

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.
- Measurement of meterological parameters (relative humidity, wind speed, wind direction and ambient temperature) using weather station.

Analysis of Water:

- 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

Any other relevant experiments may be added / performed.

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

Sample Question Paper

Paper-1.2: IND-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.*

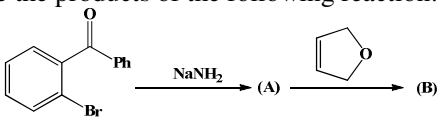
- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (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.

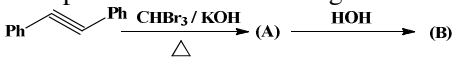
Unit-I

(i) Write the products of the following reaction:



½ + ½ = 1

(ii) Write the products of the following reaction:



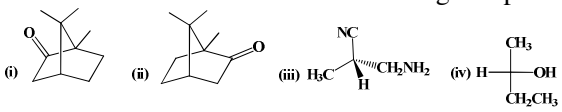
½ + ½ = 1

Unit-II

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

½ + ½ = 1

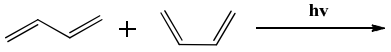
(iv) Write R or S nomenclature for the following compounds:



¼ +¼+¼+¼ = 1

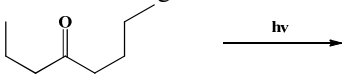
Unit-III

(v) Complete the following reaction:



1

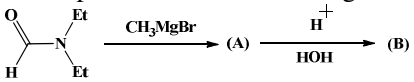
(vi) Complete the following reaction:



1

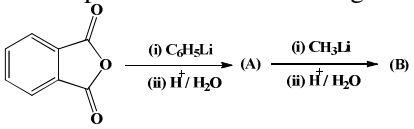
Unit-IV

(vii) Write the products of the following reaction:



½ + ½ = 1

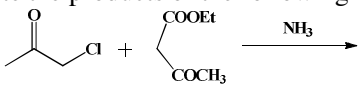
(viii) Write the products of the following reaction:



½ + ½ = 1

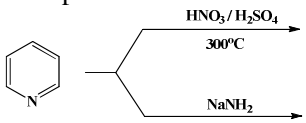
Unit-V

(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

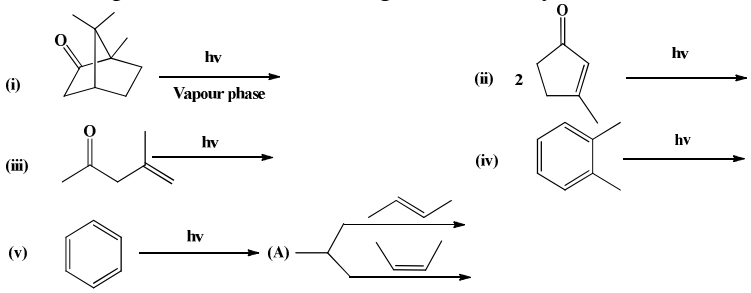
Write note on the following (any two):

(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:

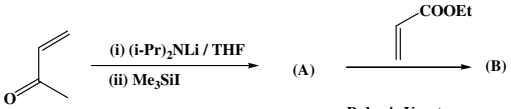
(i) Metal hydrides in organic synthesis

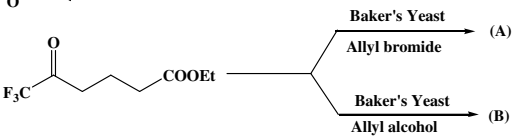
(ii) Phase transfer catalysts

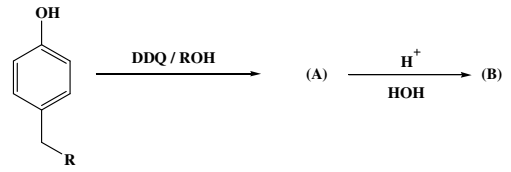
2½ + 2½ = 5

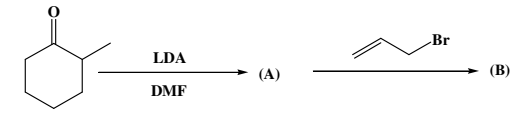
OR

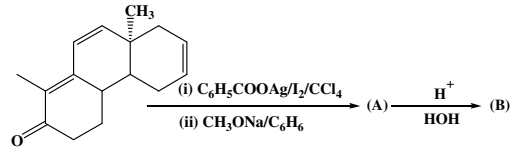
Write the products of the following reactions (any four):

(i) 

(ii) 

(iii) 

(iv) 

(v) 

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

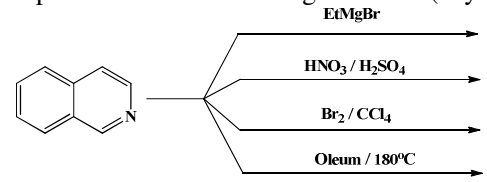
(iii) Bischler-Napieralski synthesis

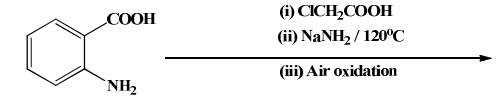
(iv) Skraup synthesis

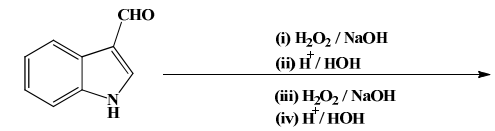
1¼+1¼+1¼+1¼ = 5

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 .....