SCHEME OF EXAMINATIONS

RULES & REGULATIONS

AND

SYLLABUS

Third & Fourth Semester Examinations

(Effective from the Academic Session 2017-2018)

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

CONTENTS

S. No.	Particulars	Page No.
1.	Scheme of Examinations	3
2.	Objectives of the Course	4
3.	Duration of the Course	4
4.	Eligibility for Admission	
	• Eligibility for Admission in M.Sc. First Semester Industrial Chemistry	4
	• Eligibility for Admission in M.Sc. Third Semester Industrial Chemistry	5
5.	Structure of the Programme	5
6.	Course Number, Course Code or ID and Nomenclature	5
7.	Maximum Marks and Credit Points	5
8.	Attendance	6
9.	Teaching Methodologies	6
10.	Assessment Pattern	6
	• Continuous or Internal or Mid Term Assessment	7
	• Semester or External or End Term Assessment	8
11.	Question Paper Pattern	9
	• Continuous or Internal or Mid Term Assessment	9
	• Semester or External or End Term Assessment	10
12.	Practical Examinations	12
	• Duration of Examination	12
	• Distribution of Maximum Marks	12
13.	Minimum Pass Marks and Rules regarding Determination of Results	12
14.	Classification of Successful Candidates	14
15.	Syllabus	15
	• M.Sc. First Semester Industrial Chemistry	15
	• M.Sc. Second Semester Industrial Chemistry	27
16.	Sample Question Paper	38

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.	Teaching Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
I Year I Semester	Paper-1.1	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:

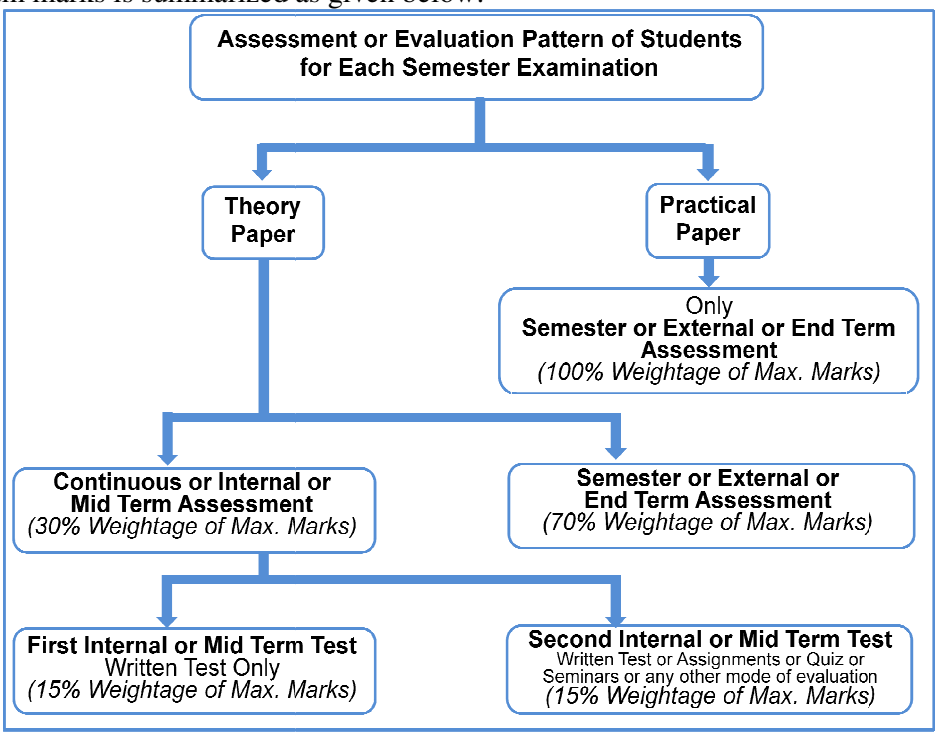
Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester 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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University of Kota
Kota (Rajasthan)-324 005

First Internal Assessment Test 20… - 20….

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

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

Q. No. 1. ……..

or

…….

5 Marks

Q. No. 2. ……..

or

…….

5 Marks

Q. No. 3. ……..

or

…….

5 Marks

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

(a) Attendance:

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

5% weightage of Maximum Marks

Note:

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

(b) Class Test:

10% weightage of Maximum Marks

Format

Department of Pure & Applied Chemistry
University of Kota
Kota (Rajasthan)-324 005

Second Internal Assessment Test 20… - 20….

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

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

Q. No. 1. …….....
4 Marks

Q. No. 2. ……..
or
…….
3 Marks

Q. No. 3. ……..
or
…….
3 Marks

or

(b) Assignment:
(May be divided in parts or questions or may not be. It will be depending on the nature of assignment).
10% weightage of Maximum Marks

or

(b) Quiz:
(May be divided in parts or questions or may not be. It will be depending on the nature of quiz).
10% weightage of Maximum Marks

or

(b) Any other tool may be adopted for internal Assessment
10% weightage of Maximum Marks

(B) Semester or External or End Term Assessment:

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

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

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

- ***Section-A*** *will carry 10 marks with 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 alongwith the papers of higher semester examination) in accordance with the following conditions:

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

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

(iii) A candidate, who has been declared as failed/absent in one or more theory paper(s) at any odd semester examination shall be permitted to join the courses of study for the next higher semester *i.e.* permitted to join the course of second semester after first semester 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
Third Semester Examinations

Paper-3.1: IND-CHEM-631: Separation Techniques 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 of Separation: 15-18 L

Nature of separation process, classification of separation methods.

Chromatography:

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

Paper Chromatography:

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

Supercritical Fluid Chromatography (SFC):

Principle, instrumentation, qualitative and quantitative analysis.

Unit-II: Thin Layer Chromatography (TLC): 15-18 L

Principle, advantage over paper chromatography, types, preparation of thin layer, choice of sorbent and solvent, development, detection and applications.

High Performance Thin Layer Chromatography (HPTLC):

Principle, advantage over TLC, instrumentation, choice of sorbent and solvent, development, detection and applications.

Unit-III: Column Chromatography: 15-18 L

Principle, resolution, stationery phase, column efficiency, factors influencing column efficiency, experimental set up and applications; principle and application of flash chromatography.

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

Unit-IV: High Performance Liquid Chromatography (HPLC): 15-18 L

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

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

Unit-V: Electrophoresis: 15-18 L

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

Capillary Electrophoresis (CE):
Principle, theory, instrumentation, sample preparation and applications, capillary electro-chromatography and miscellar electro-kinetic capillary chromatography.

Books:

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

Paper-3.2: IND-CHEM-632: Spectral Techniques 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: Ultraviolet-Visible (UV-VIS) Spectroscopy: 15-18 L

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

Infrared (IR) Spectroscopy:

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

Unit-II: Nuclear Magnetic Resonance (NMR) Spectroscopy: 15-18 L

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

Unit-III: Carbon-13 NMR Spectroscopy: 15-18 L

Carbon-13 nucleus, operating frequency, carbon-13 chemical shifts and their calculation, spin-spin coupling, proton-coupled, proton-decoupled and off-resonance carbon-13 spectra, applications of ^{13}C NMR spectroscopy.

Electron Spin Resonance (ESR) Spectroscopy:

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value, hyperfine splitting, isotropic and anisotropic hyperfine coupling constants,

spin-orbit coupling, significance of g-tensor, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques and applications.

Unit-IV: Mass Spectrometry: 15-18 L

Basic principles, production of ions by electron impact, chemical ionization and field desorption techniques, separation and detection of ions, mass spectrum: molecular ion peak, base peak, isotopic peak, metastable peak; fragmentation patterns of organic molecules with examples of various classes of compounds, McLafferty rearrangement, factors affecting the fragmentation and governing the reaction pathways, identification of molecular ion peaks, determination of molecular weight and molecular formula of compounds, hydrogen deficiency index, nitrogen rule, negative ion mass spectrometry, introduction to high resolution mass spectrometry (HRMS) and combined or hyphenated techniques likes GC-MS, LC-MS, IC-MS, CE-MS, ICP-MS; applications mass spectrometry.

Unit-V: Structure Elucidation: 15-18 L

An integrated problem solving approach for elucidation of structures of organic compounds based on analytical data including CHNS/O percentage, spectral data (UV, IR, NMR, MS, *etc.*) and hyphenated technique data (GC-MS, LC-MS, ICP-MS, LC-NMR, *etc.*) including reaction sequences to find out the structure.

Books:

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

Paper-3.3: IND-CHEM-633: Chemical Process Industries-II

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: Glass and Ceramic Industries: 15-18 L

Glass: Different types of glasses, physical and chemical properties, raw materials, manufacture of glasses, glass fibers, ceramics and refractories, formation of batch material, melting, shaping or forming, annealing, finishing, method of division of tank and flame space.

Ceramics: Classification and general properties, raw materials, preparation of bodies, formation process, porcelain and china: raw material and manufacturing; earthenwares and stonewares.

Unit-II: Cement and Refractory Industries: 15-18 L

Cement: Types and properties, manufacture of Portland cement, chemical constitution of Portland cement and their characteristics, special cements and their uses, setting and hardening of cement, raw materials, reaction in the kiln, mixing of additives, corrosion of cement stone, manufacturing of lime; gypsum, plaster of Paris, estimation of silica, alumina, calcium oxide and sulphate in Portland cement.

Refractories: Classification, properties, manufacturing, fire clay bricks, high alumina, sillimanite and magnesite refractories, silica bricks, super refractories, graphite refractories, insulating and pure oxide refractories, modern ceramics.

Unit-III: Heavy & Fine Chemicals Industries: 15-18 L

Explanation of the terms heavy (bulk) and fine (speciality) chemicals; industrial production and uses of gases / solids: H_2, N_2, O_2, CO_2, NH_3, Cl_2, NaCl, Na_2SO_4; industrial production and uses of acids / bases: HCl, HNO_3, H_2SO_4, NaOH, KOH and Na_2CO_3; industrial important of boron compounds: Borax and boric acid; industrial oxidizing and reducing agents: $KMnO_4$, $K_2Cr_2O_7$, H_2O_2 and $Na_2S_2O_3$.

Unit-IV: Fertilizer Industries: 15-18 L

Types of fertilizer, commercial nitrogenous fertilizers: Classification, manufacture of ammonium sulphate, urea, ammonia nitrate; classification, manufacturing process and properties of phosphatic fertilizers: single super phosphate, triple super phosphate; manufacturing of phosphoric acid by electric furnace process; commercial potassic fertilizers: classification, manufacturing process and properties of potasium fertilizers-potassium sulphate, mono- and diammonium phosphate; mixed fertilizer; bio-fertilizers: classification, demands and production.

Unit-V: Polymer Industries: 15-18 L

Introduction to polymers, mechanism of polymerization, properties: large deformations, melt viscosity, tensile strength, stress, strain, crazing, shear banding, solubility and electrical; moulding and casting; industrial manufacturing:

polyethylene, polystyrene, polyvinyl chloride, polyesters, urea-formaldehyde, rubbers (synthetic and natural) and their processing, general applications.

Books:

- *Heterogeneous Catalysis and Fine Chemicals edited by M. Guisnet J. Barrault, C. Bouchoule, D. Duprez, C. Montassier, G. Pérot; publisher: Elsevier*
- *Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat Ali, Bassam M. El Ali, and J. G. Speight, McGraw-Hill.*
- *The Fertilizer Encyclopedia by Vasant Gowariker, V. N. Krishnamurthy, Sudha Gowariker, Manik Dhanorkar and Kalyani Paranjape, John Wiley & Sons*
- *The Fertilizer Industry by Murray Park, Woodhead Publishing*
- *Manual of Fertilizer Processing by Nielsson, CRC Press*
- *Dyes & Paints: A Hands-on Guide to Coloring Fabric by Elin Noble*
- *Handbook on Natural Dyes for Industrial Applications by Padma S Vankar, National Institute of Industrial Research*
- *Industrial Cutting of Textile Materials by I. Vilumsone-Nemes, Woodhead Publishing Limited*
- *The Complete Technology Book on Pulp & Paper Industries by NIIR Board of Consultants and Engineers*
- *Environmentally Friendly Production of Pulp and Paper by Pratima Bajpai, John Wiley and Sons*
- *A text book of chemical technology vol.1, 2 and 5: S.D. Shukla and G.N. Pandey.*
- *Ullman's Encyclopedia of industrial chemistry.*
- *Encylopedia of Chemical Technology, Vol 10 and 11.*
- *Industrial Organic Chemistry: K. Weissermel and H.J. Arpe.*
- *Outlines of Chemical Technology: Dryden*
- *Chemical Process Industries: Shrive.*
- *Industrial Chemistry: B.K. Sharma.*
- *Synthetic Organic Chemistry, O.P. Agarwal ,10th edition , Publishing House, Meerut, 1994.*
- *R.N. Shreve: Chemical processes Industrial, McGraw Hill Book Company Inc, New York 1956.*
- *K. Bhogavathi Somdavi: Applied Chemistry, MJP Publications, 2006*

Paper-3.4: IND-CHEM-634: Petrochemical & Lubricant Industries

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.*
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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: Petroleum and Petrochemicals: 15-18 L

Origin of petroleum and petrochemicals, types of petrochemicals, raw materials for aliphatic, aromatic and inorganic petrochemicals; separation and purification, manufacturing process: properties and uses of aromatics, naphthenes, acetone,

acetylene, ethylene, propylene, venyl chloride, butanol, ethyl hexanol, isopropanol, carbon black.

Unit-II: Petroleum Products: 15-18 L

Petroleum resources, petroleum composition, nature of crude oil, different types of crude oil; general processing of crude oil, fractionation and stippling; thermal decomposition process, stabilization and gas recovery; cracking process: thermal and catalytic; blending of gasoline: knocking, Octane number; aviation gasoline, diesel oil, cetane number, kerosene, LPG: composition and uses, synthetic petrol (Fischer-Tropsch method), petrochemicals in India

Unit-III: Petroleum refining and BTX Chemicals: 15-18 L

Catalysis in petroleum refining and petrochemicals process: Introduction, homogeneous and heterogeneous catalysts; catalyst morphology and activity, catalysts for petroleum refining: cracking catalysts, reforming catalysts, hydro treating catalysts; catalysts for petrochemicals industry: catalysts for synthesis gas, hydrogenation catalysts, hydrocarbon oxidation catalysts, polymerization catalysts; recent advances in industrial catalysis, manufacturing of petrochemicals from benzene, toluene and xylenes.

Unit-IV: Petrochemicals from C_1, C_2, C_3, C_4 cuts: 15-18 L

Manufacturing of petrochemicals from C_1, C_2, C_3, C_4 cuts, chemicals from methane, ethane, ethylene, acetylene, propane, propylene, butane and their reaction of synthesis, octane number, cetane number.

Unit -V: Lubricants: 15-18 L

Properties and classification of lubricants, mechanism of lubrication, surface energy, adsorption, laws of friction, viscosity index, cloud and pour points, flash and fire points, aniline point value, iodine and saponification value, neutralization number, lubricating greases, emulsification, selection of lubricants.

Books:

- *Handbook of Petrochemicals Production Processes by Robert A. Meyers, McGraw-Hill Professional*
- *Handbook of Petrochemicals and Processes by G. Margaret Wells, Ashgate*
- *Chemical Process Industries by R. N. Shreve.*
- *Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent.*
- *Industrial Chemicals by Faith, Keyes, Clark.*
- *Petrochemical Process Technology by I. D. Mall, Macmillan*
- *Chemistry of Petrochemical Processes by Sami Matar & Lewis F. Hatch, Gulf Professional Publishing*
- *Chemicals from petroleum by Weddams*

Paper-3.5: IND-CHEM-635: 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**

Analysis of Alloys & Ores:

- Analysis of Nichrome alloy:
  - Cr by colorimetry
  - Ni by gravimetry
- Analysis of Zinc blend ore
  - Zn by complexometry
  - Fe by volumetry
- Analysis of Calcite ore
  - Ca by complexometry
  - Fe by colorimetry
- Analysis of felspar ore
- Analysis of steel and ferrous alloy:
  Carbon, silicon, manganese, phosphorous, sulphur, selenium, copper, nickel, chromium, vanadium, tungsten, molybdenum, cobalt, aluminium, titanium, nitrogen, lead, niobium, iron

Analysis of Ferrous Slags:

- Determination of iron, calcium and magnesium, total oxides

Analysis of clays and feldspars:

- Determination of moisture, silicon dioxide, total oxides, ferric oxide, titanium dioxide, aluminium oxide, calcium oxide, magnesium oxide.

Analysis of Cement and building materials:

- Analysis of cement and building materials: Silicon dioxide, aluminium oxide, ferric oxide, calcium oxide, magnesium oxide, sulphurtrioxide, sulphide- sulphur, loss on ignition, insoluble residue, sodium and potassium oxide.

Analysis of Quartzes:

- Volatile residue, zirconium dioxide, aluminium oxide, calcium and magnesium oxides, sodium and potassium oxide.

Analysis of Glasses:

- Determination of various parameters of glass
- Determination of lead and lead glass.

Analysis of Ceramics:

- Determination of titanium dioxides and aluminium oxide from oxide ceramics.

Analysis of Fuel / Petroleum / Petroleum Products:

- Determination of calorific value of fuel and coal
- Estimation of moisture in given coal sample.

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

Analysis of Polymers:

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

Analysis of Heavy & Fine Chemicals:

- Preparation and characterization of copper sulphate.
- Preparation and characterization of methyl orange and methyl red.
- Estimation of $Na_2CO_3.10H_2O$ in washing soda.
- Determination of thiosulphate content of a commercial hypo solution.
- Estimation of available chlorine in the sample of bleaching powder.

Synthesis:

- Preparation of antiseptic creams
- Preparation of analgesic ointments
- Preparation of talcum powder.
- Preparation of washing and bathing soaps
- Preparation of solid and liquid detergents.
- Preparation of following polymers and characterize by UV, IR, NMR, MS spectral data:
  - Polyethylene
  - Polyvinyl chloride
  - Polyacrylamide
  - Polystyrene
  - Nylon-66
  - Phenol-formaldehyde resin
  - Urea-formaldehyde resin
  - Melamine-formaldehyde resin

Electroanalytical Methods of Analysis:

(i) Oxidation-Reduction Titrations

- Standardization with sodium oxalate of $KMnO_4$ and determination of Ca^{2+} ion.
- Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_3^{-1} and $C_2O_4^{-2}$ ions.
- Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum)
- Standardization of hypo solution with potassium iodate / $K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder, Sb^{3+} and Cu^{2+}.
- Determination of hydrazine with KIO_3 titration.

(ii) Precipitation Titrations

- $AgNO_3$ standardization by Mohr's method by using adsorption indicator.
- Volhard's method for Cl^- determination.
- Determination of ammonium / potassium thiocyanate.
- Estimation of magnesium or cadmium as oxinate by titration with standard bromate solution.
- Estimation of KBr in the given solution by titrating against std. $AgNO_3$ solution using eosine as indicator.

(iii) Complexometric Titrations:

- Determination of Cu^{2+} and Ni^{2+} by using masking reagent by EDTA titration.
- Determination of Ni^{2+} (back titration).
- Determination of Ca^{2+} (by substitution method).
- Estimation of the purity of oxalic acid employing standard Ce(IV) solution.
- Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations on potentiometer by using mercury electrode

(iv) Voltametric Titrations:

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

(v) Electrogravimetric Titartions:

- Electrogravimetric estimation of barium, copper, chromium, lead, nickel present in the solution at ppm level.

(vi) Amperometric Titrations:

- Amperometric determination of Zinc with standard EDTA solution.
- Amperometric titration of lead with standard potassium dichromate solution.
- Amperometric determination of magnesium (or cadmium) by precipitating it as oxinate and titrating against standard $KBrO_3$ solution.
- Estimation of the mercapto group in thioglycollic acid by titrating with standard $AgNO_3$ solution amperometrically.
- Amperometric titration of (i) thiourea v/s silver nitrate (ii) vitamin C v/s ferric nitrate
- Amperometric titration of (a) Pb v/s SO_4^{2-} (b) Pb v/s $K_2Cr_2O_7$ (c) Ni v/s DMG.
- Estimation of sulphadizine in sulpha tablet by amperometric titration method

Spectrophotometry & Colorimetry:

- Study of copper-ethylene diamine complex: Slope-ratio method.
- To determine the amount of each para nitro-phenol and meta nitro-phenol from the given mixture by spectrophotometric titration using standard solution of NaOH (max-280 nm)
- Determination of Fe^{3+} using thiocyanate method.

- Determination of Ni^{2+} in presence of Cu^{2+} using salicyladoxime method.
- Determination of nickel/molybdenum/tungsten/vanadium/uranium by extractive spectrophotometric method.
- Simultaneous spectrophotometric determination of (Cr & Mn) and (Ti & V)
- Determination of an indicator constant and isobestic point of an indicator spectrophotophometrically.
- Estimation of pectin as Ca-pectate colorimetrically
- Determination of available phosphorus in soil Olesen's colorimetric method.
- Determine the indicator constant of methyl red spectrophotometrically
- Determination of Cd^{2+}, Zn^{2+}, Co^{2+} using anthranilic acid method.
- Determination of Bi^{3+} using pyrogallol method.
- Determination of Ni^{2+} by rubeanic acid method.
- Colorimetric and spectrophotometric determination of managanese in steel.
- Estimations of copper, iron, nickel, manganese, chromium and zirconium using Nessler technique and/or spectrophotometry.

Ion Chromatography:

(i) Chemical Applications:

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

(ii) Petroleum Refining:

- Extraction of total petroleum hydrocarbon contaminants (diesel and waste oil) in soils
- Extraction of hydrocarbon contaminants (BTEX, Diesel, and TPH) in soils

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

(iii) Safety and Security Applications:

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

(iv) Cosmetics:

- Rapid Determination of benzalkonium chloride in cosmetics

(v) Polymers:

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

Any other relevant experiments may be added / performed.

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

Syllabus

M.Sc. Industrial Chemistry
Fourth Semester Examinations

Paper-4.1: IND-CHEM-641: Fundamentals of Industrial Management

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: Principles of Management: **15-18 L**

Management, different functions: planning, organising, leading, controlling; organizational structure: types, functions of different departments; motivation: factors, characteristics, methods of improving motivation, incentives, pay, promotion, rewards, job satisfaction, job enrichment; introduction to operations and financial management.

Unit-II: Materials Management: **15-18 L**

Material in industry, inventory control model, ABC analysis, safety stock, reorder, level, economic ordering quantity, stores equipment, stores records, purchasing procedures, purchase records, bin card, cardex, material handling, carbon credit, carbon tax.

Unit-III: Safety Management: **15-18 L**

General occupational safety, flammable material handling and fire fitting equipments, control measures for toxic chemicals, safety with chemical engineering operations, types of hazards, hazardous chemical process, toxic and hazardous chemicals, MSDS of hazardous chemicals, industrial hygiene, safety in laboratories and pilot plants, Safety in transportation and storage of chemicals, safety assessments and protection of various process industries, safety audit, risk assessments and hazard management, Hazop process.

Unit-IV: Disaster Management: **15-18 L**

Accident and emergency disasters, types, analysis, toxicity and effect, hazard and risk, level of disasters, phase of disaster, disaster recovery system rescue and evacuation planning and arrangements, guides for preparation of onsite emergency plan,

transportation of hazardous chemicals, incineration of hazardous chemicals, identification classification and segregation of industrial toxic chemicals.

Unit-V: Environmental Management: 15-18 L

Concept and scope, standards: International and national; environmental policy of the Government of India and the working of the Ministry of Environment and Forests, Central Pollution Control Board, State Pollution Control Boards; eco-mark; environmental accounts and auditing, green funding and taxes, management of pollution due to chemical, mining and manufacturing industries (glass, ceramics, cement, paper, dye, textile, petroleum, coal, plastic, polymer, paint, leather, fertilizer, agrochemical, pharmaceutical, *etc.*).

Books:

- *Industrial Engineering and Management by O.P. Khanna; Dhanpat Rai and Sons, Delhi.*
- *Industrial Organization and Management by Tara Chand; Nem Chand and Brothers; Roorkee.*
- *Marketing Management by Phillip Kotler; Prentice Hall of India, New Delhi*
- *Environmental and Pollution Awareness by BR Sharma; Satya Prakashan, New Delhi.*
- *Industrial Organisation and Engineering Economics by Banga and Sharma; Khanna Publishers, Delhi.*
- *Industrial Management by C.L. Mahajan; Saluja Parkashan, New Delhi.*
- *Management by Jams A Stoner, R Edward Freman and Daniel R. Gilbrat, JR, Sixth Edition, Pearson Education, New Delhi*
- *Industrial Management by VK Sharma, OP Harkut*
- *Environment Protection Law & Policy in India: Deep & Deep publication, New Delhi.*
- *Principles of Management by Philip Kotler, TEE Publication.*
- *Principles of Management by Harold Koontz, H. Weihrich, and A.R. Aryasri, Tata McGraw-Hill, New Delhi*
- *Industrial disaster management and emergency Response, UK Charaborty, Asian Books private Limited ,New Delhi*

Paper-4.2: IND-CHEM-642: IPR, Regulatory Affairs and QA & QC

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: Intellectual Property Rights (IPR): 15-18 L

Concept and fundamentals of IPR, need and economic importance of IPR, detail description of various IP Properties (Patents, Trademarks, Copyrights, Geographical Indications Industrial Designs and Trade secrets), IPR with emphasis on patent regime, factors affecting IP protection, penalties for violation or infringement, trade

related aspects of IPR, concepts behind World Trade Organization (WTO), General Agreement on Tariffs and Trade (GATT), General Agreement on Trade in Services (GATS), Trade-Related Aspects of Intellectual Property Rights (TRIPS), Trade-Related Investment Measures (TRIMs).

Unit-II: Industrial Standards and Control: 15-18 L

Government standards like Agmark, Bureau of Indian Standards (BIS) Hallmark, Indian Standards Index (ISI), Central Drugs Standard Control Organization (CDSCO), Indian Pharmacopoeia (IP), British Pharmacopoeia (BP), US Pharmacopoeia (USP); an introduction to International Organization for Standardization (ISO), British Standard for Occupational Health and Safety management Systems (BS OHSAS), Occupational Safety & Health Administration (OSHA), US Food and Drug Administration (USFDA), ICH Guidelines, Fruit Products Order (FPO), Food and Agriculture Organization (FAO), Food Safety and Standards Authority of India (FSSAI), Scale-Up and Post approval Change (SUPAC).

Unit-III: R&D and Technology Transfer: 15-18 L

Role of R&D, functional structure of R&D, unit research strategies and manufacturing interface, laboratory-industry interface, technology transfer

Pilot Plant Operation and Scale up:

Purpose planning, design and operation, analysis of results, assessment of flexibility of design comprises to cope-up for safety and economic in construction and operation.

Unit-IV: Quality Control: 15-18 L

Concept of quality and quality control, nature of variability's, design of QC laboratory for chemical, instrumental and microbiological laboratories, schedule L1, standardization of reagents, labeling of reagents, control samples, data generation and storage, QC documentation, LIMS sampling techniques, sampling plans, steps to improve quality with reference to ISO and total quality management (TQM), total quality control (TQC), six sigma, preparation of control charts, sampling, inspection, cost reduction & quality improvement.

Unit-V: Quality Assurance: 15-18 L

Concepts of quality assurance (QA), philosophy of GMP and cGMP, preparation of audit, conducting audit, audit analysis, audit report and audit follow up, premises: location, design, plant layout, construction, maintenance of sterilized areas, control of contamination.

Books:

- *Basic principles and acquisition of Intellectual Property Rights by Ramakrishna, CIPRA, NSLIU 2005.*
- *Ownership and Enforcement of Intellectual Property Right by T Ramakrishna, CIPRA, NSLIU-2005.*
- *Intellectual Property Law Handbook by Dr. B. L.Wadhera, Universal Law Publishing Co. Ltd. 2002.*
- *Handbook of Small Scale Industry by P.M. Bhandari.*
- *Intellectual Property Law (Bare Act with short comments)-Universal Law Publishing Co. Ltd. 2007.*
- *The Trade marks Act 1999 (Bare Act with short comments)-Universal Law Publishing Co. Ltd. 2005.*
- *The Patents Act, 1970 (Bare Act with short comments) - as amended by Patents (Amendment) Rules 2006 w.e.f. 5-5-2006. Commercial law publishers (India) Pvt. Ltd. 2006.*
- *Thomas T Gordon and Arthur S Cookfair-Patent Fundamentals for Scientist and Engineers, CRC Press*
- *Prabuddha Ganguli -Intellectual Property Rights, TMH Publishing Co. Ltd.2001*
- *GMP/ISO Quality Audit Manual for Healthcare Manufacturers and Their Suppliers by Steinborn L. Sixth Edition, (Volume 1 with Checklists and Software Package). Taylor & Francis; 2003.*
- *ISO 9000 Quality Systems Handbook -updated for the ISO 9001:2008 standard by Hoyle D. Routledge; 2012.*

Paper-4.3: IND-CHEM-643: Fuel & Energy Technology

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: Fuels: **15-18 L**

Types and properties of solid, liquid and gaseous fuels; agro-residues

Solid Fuels:

Origin, classification and analysis of coal; gasification; oxidation; hydrogenation and liquefaction of coal; solid fuel handling and storage

Liquid Fuels:

Origin and classification and properties of petroleum, liquid fuels from other sources; storage and handling of liquid fuels.

Gaseous Fuels:

Natural gases, methane from coal mines, manufactured gases, producer gas, water gas, refinery gas, LPG; cleaning, purification and handling of gaseous fuels

Unit-II: Fuel Cells and Fuels: **15-18 L**

Fuel Cell:

Basics, difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, performance characteristics of fuel cells, fuel cell types: alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, problems with fuel cells, applications of fuel cells.

Nuclear Fuel:

Basic principles, elements of nuclear power plant, nuclear reactor and fuels, advantage and disadvantages of nuclear power plants.

Hydrogen Fuel:

Its merit as a fuel; production, applications and storage methods

Unit-III: Burners and Furnaces: **15-18 L**

Burners:

Basic features and design of burners for liquid, and gaseous fuels; Ignition: Concept, auto-ignition, ignition temperature; flame stabilization.

Furnaces:

Industrial furnaces, batch & continuous furnaces; heat source; blast furnace; open hearth furnace, Kilns; pot & crucible furnaces; waste heat recovery in furnaces: Recuperators and regenerators; furnace insulation.

Unit-IV: Renewable Energy Sources and Devices: **15-18 L**

Solar Energy:

Principles of conversion of solar radiation into heat, solar collectors, solar energy storage system, solar photovoltaic cell, solar hydrogen energy, solar pumps, heaters, dryers, cookers and refrigerators.

Wind Energy:

Basic principle and conversions, site selection, wind mills, application and safety system, environmental aspects, wind energy conversion system.

Unit-V: Energy from Biomass: **15-18 L**

Type of biogas plants, construction details, applications, thermal gasification of biomass.

Geothermal Energy:

Sources, advantage and disadvantages of geothermal energy over other energy forms, application of geothermal energy

Ocean Wave Energy:

Principles of ocean thermal energy conversion open cycle OTES (Claude cycle), ocean thermal energy system, advantages and limitation of tidal power generation, wave energy conversion devices.

Books:

- *Fuel and Energy by Steven Seidenberg, Gareth Stevens, 1992*
- *Fossil Fuels (Energy: Past, Present, and Future) ed. by Robert Curley, Rosen Education Service, 2011*
- *Fossil Fuels by Julie Richards, Benchmark Books, 2009*
- *Hydrogen Fuel (Energy for the Future and Global Warming) by Andrew Solway, Gareth Stevens Publishing, 2007*
- *Energy Autonomy: The Economic, Social & Technological Case for Renewable Energy by Hermann Scheer, Routledge, 2006.*
- *Alternative Energy: Political, Economic, and Social Feasibility by Christopher A. Simon, Lanham, Maryland: Rowman & Littlefield, 2006.*
- *Fuels, Energy, and the Environment by Ghazi A. Karim, CRC Press, 2012*
- *Nuclear Fuel and Energy Policy by S. Basheer Ahmed, Houghton Mifflin Harcourt, 1979*
- *Advances in Biodiesel Production: Processes and Technologies, Edited by R Luque and J A Melero, Woodhead Publishing, 2012.*
- *Biomass Gasification and Pyrolysis: Practical Design and Theory by By Prabir Basu, Academic Press*
- *Biomass for Renewable Energy, Fuels, and Chemicals by Donald L. Klass, Academic Press, 1998.*
- *Coal Science, By J.A. Pajares and J.M.D. Tascón, Elsevier, 1995*
- *Fundamentals of Petroleum Refining by M Fahim, Taher Al-Sahhaf and Amal Elkilani, Elsevier, 2009.*
- *Handbook of Biofuels Production: Processes and Technologies Edited by R Luque, J Campelo and J Clark, Woodhead Publishing, 2010.*
- *Natural Gas Conversion Edited by A. Holmen, K.-J. Jens and S. Kolboe, Elsevier, 1991*

Paper-4.4: IND-CHEM-644: Pharmaceutical, Agrochemical & Food Industries

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: Pharmaceuticals: **15-18 L**

Structures and synthesis of following:

Anti-infective Drugs: Sulphonamides, ciprofloxacin, fluconazole.

Anti-tubercular Drugs: Isoniazid, ethambutol.

Anti-protozoal Agents: Diodoquine, Carbarsone.

Anti-malarial Drugs: Chloroquine, Primaquine.

Anti-pyretic & Analgesic Drugs: Phenacetin, Paracetamol, Ibuprofen.

Unit-II: Pharmaceuticals: **15-18 L**

Structures and synthesis of following:

Cardiovascular Drugs: Doxazosin, propanolol, captopril, verapamil, aspirin, gemfibrozil, hydrochlorothiazide, nitroglycerin, methyldopa.

Anti-cancer Drugs: Mechlorethamine, irinotecan, daunomycin, paclitaxel, prednisone.

Tranquillizer Drugs: Chloropromazine, diazepam, hydroxyzine, pipradol.

Anesthetics: Procaine, Benzocaine, Pentothal sodium.

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

Structures and synthesis of following:

Insecticides: DDT, BHC, aldrin, endrin, chlorpyrifos, malathion, parathion, endosulfan.

Herbicides: 2,4-D, metolachlor, triclopyr

Fungicides: tea tree oil, citronella oil, jojoba oil, zerum, thirum, kasugancycin

Plant growth regulators: Abscisic acid, auxins, cytokinins, Gibberellins.

Unit-IV: Flavors and Food Additives: **15-18 L**

Flavors: The difference between perfumes and flavors, classification of flavor compounds, chemistry of pepper, ginger, onion, coriander, coffee, tea, cocoa; assessment and blending of flavors.

Food Additives: Sugar substitutes, food colours, antioxidants, acids and bases used in food industries, food chelating agents, emulsifiers, thickening agents, gel builders, stabilizers and anti-caking agents, common food toxicants.

Unit-V: Milk and Dairy Products: **15-18 L**

Milk: Introduction to milk and milk products, types, chemical composition, processing, analysis.

Dairy Products: Manufacture of cream, butter, ghee, khoa, condensed milk, casein, milk powder, infant milk food, malted milk powder, fermented milk products, cheese, ice-cream; quality aspects of dairy products.

Books:

- *Introduction to medicinal chemistry, A Gringuage, Wiley- VCH.*
- *Wilson Gisvold's Text book of organic Medicinal and pharmaceutical Chemistry, Ed. Robert F. Dorge.*

- *An introduction to drug design, S. S. Pandeya and J. R. Dimmock, New age International.*
- *Burger's Medicinal Chemistry and Drug Discovery Volume 1, Ed.M.E. Wolff, John Wiley.*
- *Goodman and Gilman's Pharmacological Basis of Therapeutics, Mc Graw-Hill.*
- *The organic Chemistry of Drug Design and drug action, R.B. Silverman, Academic press.*
- *Strategies for Organic Drug synthesis and Design, D. Lednicer, John Wiley.*
- *The Organic Chemistry of Drug Synthesis, Volume 7, D. Lednicer, John Wiley.*
- *Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up by Peter J. Harrington, John Wiley*
- *Separation Methods in Drug Synthesis and Purification edited by K. Valkó, Elsevier*
- *Encyclopedia of Food Science & Technology & Nutrition. Vol. Macrae R. et al. Academic Press.*
- *Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. By Ranganna, S. Tata-McGraw-Hill.*
- *Principles of Food Science: Part-II Physical Principles of food Preservation edited by Fennema O.R. Marcel Dekker, New York.*
- *Milk and Dairy Product Technology by Edgar Spreer, CRC Press*
- *Modern Technology of Milk Processing & Dairy Products (4th Edition) by NIIR Board*
- *Technology of Dairy Products by Ralph Early, Springer*
- *Handbook of Functional Dairy Products 1st Edition by Colette Shortt, Taylor & Francis*
- *Analytical Methods for Food and Dairy Powders by by Anne Dolivet, Pierre Schuck, Romain Jeantet, John Wiley & Sons*

Paper-4.5: IND-CHEM-645: 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**

Thermal Analysis:
Study of temperature effect on organic and inorganic compounds, calculate of percent decomposition and composition studies of given samples including following compounds as examples:

- Copper sulphate pentahydrate
- Calcium oxalate monohydrate
- Zinc hexafluorosilicate

Atomic Absorption Spectroscopy:

- Determination of metals in given samples by AAS technique.
- Preparation of standard calibration graphs of Pb, Cd, Zn and Fe by AAS.

Fluorimetry & Phosphorimetry:

- Estimation of quinine as quinine sulfate from medicinal tablets
- Determination of amount of vit-B2 in the medicinal tablet fluorometrically.
- Any other experiments related to Spectrofluorimeter / phosphorimeter

Nephelometry & Turbidimetry:

- Determination of chloride by turbidimetry.
- Determination of amount of zinc from given sample solution by nephelometric / turbidimetric titration using standard solution of $K_4(Fe(CN)_6)$ in 0.4M HCl
- Determination of amount of sulphate from the given sample solution by nephelometric / turbidimetric titration using standard solution of $Ba(NO_3)_2$ or $Pb(NO_3)_2$

Analysis of Pharmaceuticals:

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

Clinical Analysis:

- Analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), vitamins (thiamine, ascorbic acid, Vit. A, etc.) and hormones (progesterone, oxytocin, insulin) chemical, instrumental and biological assay wherever applicable.
- Separation and identification of plasma proteins.
- Estimation of Cholesterol in egg yolk or blood serum.
- Estimation of amino acid in protein hydrolysate by Sorenson formal titration method.
- Estimation of blood glucose, protein, chloride, sodium, potassium, urea, uric acid
- Determination of cortisol from blood and urine samples; determination of oestrogens from urine samples.

Analysis of Agrochemicals:

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

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

Analysis of Food & Food Products:

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

- Estimation of sodium benzoate / sodium metabisulphite, boric acid and salicylic acid in food.
- Determination of carbohydrates in coffee.
- Determination of Na/K/Li/Ca in given sample by flame photometry method.
- Chemical analysis of chilli-powder.
- Formulation of rose, jasmine, sandal wood, lavender

Forensic Chemistry:

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

Ion Chromatography:

(i) Medical Science Applications:

- Determination of sulfate counter ion and anionic impurities in aminoglycoside drug substances by IC with Suppressed Conductivity Detection
- Determination of tobramycin and impurities Using HPAE-PAD
- Determination of neomycin B and impurities Using HPAE-PAD
- Determination of streptomycin and impurities Using HPAE-PAD
- Determination of galactosamine containing organic impurities in heparin by HPAE-PAD Using the Dionex CarboPac PA20 Column
- Determination of hemoglobin variants by cation-exchange chromatography
- Determination of transition metals in serum and whole blood by Ion Chromatography
- Analysis of ions in physiological fluids
- Analysis of choline and acetylcholine
- Analysis of fatty acids.
- Determination of oxalate and carbohydrate in urine by Ion Chromatography
- Determination of protein concentrations using AAA-Direct
- Monitoring protein deamidation by cation-exchange Chromatography
- Analysis of mannose-6-phosphate
- Determination of nucleotides by Ion Chromatography with UV absorbance detection
- Determination of residual trifluoroacetate in protein purification buffers and peptide preparations by Reagent-Free Ion Chromatography
- Determination of tryptophan using AAA-Direct
- Identification of a hydroxylysine-containing peptide using AAA-Direct
- High-resolution analysis and purification of oligonucleotides with the DNAPac PA100 Column
- High-resolution cation-exchange alternative to peptide mapping for protein ID and QA/QC

(ii) Food and Beverage Applications:

- Determination of mercury contamination in herbal medicines
- Rapid separation of anthocyanins in Cranberry and Bilberry extracts using a Core-Shell Particle Column
- Determination of trace sodium in cranberry powder
- Determination of sudan dyes I–IV in curry paste
- Determination of mono-, di-, and triphosphates and citrate in Shrimp by Ion Chromatography

- Determination of phytic acid in soybeans and black Sesame seeds
- Determination of nitrate and nitrite Ion Chromatography determination in milk samples
- Separation of organic acids and common inorganic anions in wine
- Determination of hydroxymethylfurfural in honey and biomass
- Fast determination of anthocyanins in pomegranate juice
- Determination of lactose in lactose-free milk products by high-performance anion-exchange Chromatography with Pulsed Amperometric Detection
- Fast HPLC Analysis of dyes in foods and beverages

(iii) Electronics Applications:

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

(iv) Agrochemicals:

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

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.*

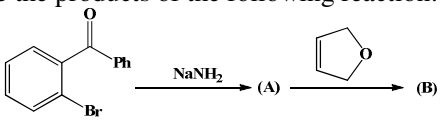
- ***Section-A*** *will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions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

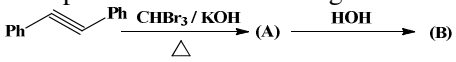
Unit-I

(i) Write the products of the following reaction:



½ + ½ = 1

(ii) Write the products of the following reaction:



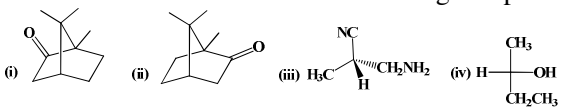
½ + ½ = 1

Unit-II

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

½ + ½ = 1

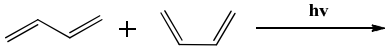
(iv) Write R or S nomenclature for the following compounds:



¼ +¼+¼+¼ = 1

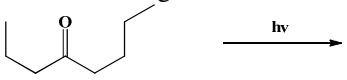
Unit-III

(v) Complete the following reaction:



1

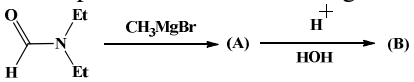
(vi) Complete the following reaction:



1

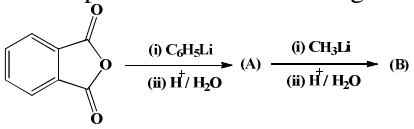
Unit-IV

(vii) Write the products of the following reaction:



½ + ½ = 1

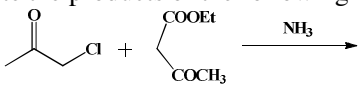
(viii) Write the products of the following reaction:



½ + ½ = 1

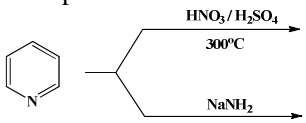
Unit-V

(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

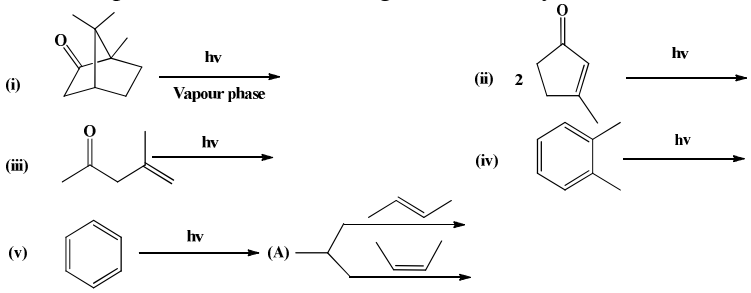
Write note on the following (any two):

(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

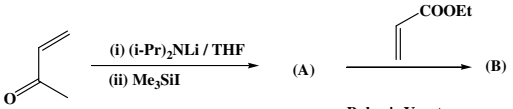
(ii) Phase transfer catalysts

2½ + 2½ = 5

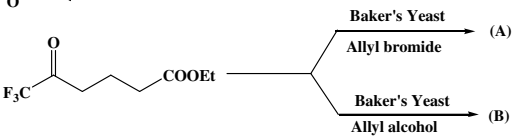
OR

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

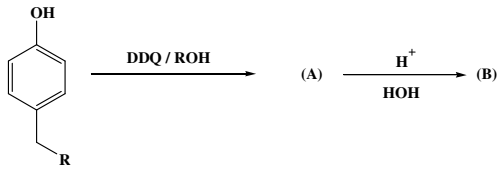
(i)



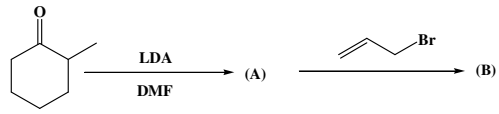
(ii)



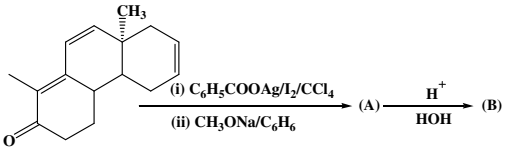
(iii)



(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

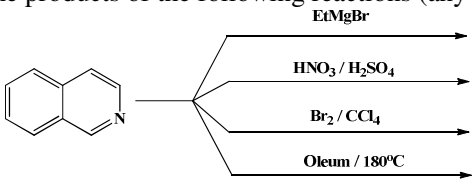
(iv) Skraup synthesis

1¼+1¼+1¼+1¼ = 5

OR

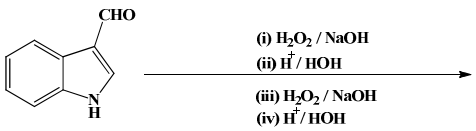
Write the products of the following reactions (any two):

(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 .....