

**DR.B.R.AMBEDKAR UNIVERSITY**  
**College of Science**  
**Department of Chemistry**  
**M.Sc., (Organic Chemistry) & M.Sc., (Analytical Chemistry)**

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**UNIVERSITY VISION**

Creation of an enabling environment where in universities would act as agents of social change and transformation through innovativeness and outreaching and make it a “People’s University”.

**UNIVERSITY MISSION**

Mitigating the economic and social sufferings of the region by invoking the strengths of faculty through community oriented actions by optimal usage of human resources.

**DEPARTMENT OF CHEMISTRY VISION**

To build foundation for excellence and spur development of the institution as a premier institution, by igniting enthusiasm and passion in the study of Organic and Analytical chemistry.

**DEPARTMENT OF CHEMISTRY MISSION**

- To impart knowledge in fundamental aspects of all branches of chemistry
- To acquire deep knowledge in the study of physical and chemical properties and structure elucidation using various techniques and Applications of organic and inorganic materials
- To acquire basic knowledge in the specialized areas of chemistry
- To train the students in various quantitative and qualitative analysis

**LONG TERM GOALS**

- To establish research laboratory.
- Equip the students in higher education through CSIR- NET exam.
- To organize Refresh and Orientation courses.
- To get the UGC and DST projects.
- Establish computer lab to learn chemistry related softwares.

**SHORT TERM GOALS**

- Encourage the students to join in SWAYAM courses.
- To conduct campus interviews.
- Introduce subject related projects and internships.
- To develop instrumentation lab.
- Acquire some more journals and reference labs.

### **PROGRAMME EDUCATIONAL OBJECTIVES**

- To impart deep knowledge in the study of physical and chemical properties, structure elucidation using various techniques and applications of various organic and inorganic materials
- Aims to target global level research opportunities to pursue Ph.D programme targeted approaches of CSIR–NET and GATE examinations
- To get enormous job opportunities at all level of chemical, pharmaceutical, food products and polymer industries
- To train the students in various quantitative and qualitative analyses of organic and inorganic compounds
- To imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality

### **PROGRAMME OUTCOMES**

After completion of this programme the candidate will be

- Able to face specific competitive exams conducted by service commission
- Gain knowledge in fundamental aspects of all branches of chemistry
- Able to develop laboratory competence in relating chemical structure to spectroscopic phenomena
- Ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation
- Developed various communication skills such as reading, listening, speaking, etc., which we will help in expressing ideas and views clearly and effectively

### **SWOC analysis of Dept of Chemistry**

Strengths:

- 100% Employment.
- Provision for learning lab skills and soft skills.
- Active participation in community engagement programmes.

Weaknesses:

- Specialized equipments are unavailable.
- More effort is needed to get the funded projects from the state/central government to strengthen the department.
- Soft skills and communication skills need to be improved among students.
- No Dept Library.
- No consultancy services.

Opportunities:

Lot of opportunities is available in the following sectors

- Pharmaceutical industries
- Fertilizers companies

- Food industry
- Forensic labs
- Textile manufacturing

**Challenges:**

- Strengthen the societal impact of the Dept of chemistry's, discoveries and innovations and achievements
- To conduct campus placements.
- Enhance the number of candidates to clear NET and GATE exams.
- Improve and increase participation in national and international level conferences and seminars.

**Strategic plans:**

- Pursue funds for summer research fellowships for students.
- Establishment of New Depts.
- To establish research laboratory and dept library.
- To establish Industry institution interaction cell (I I IC).

**Dr. B. R. AMBEDKAR UNIVERSITY, SRIKAKULAM**  
**General Regulations relating to**  
**POST GRADUATE AND PROFESSIONAL COURSES**  
**Syllabus under Credit Based Semester System**  
**(w.e.f 2019-2020)**

1. Candidates seeking admission for the Masters/Professional Degree Courses shall be required to have passed the qualifying examination prescribed for the course of any University recognized by Dr. B.R. Ambedkar University, Srikakulam as equivalent there to
2. The course and scope shall be as defined in the Scheme of Instruction and syllabus prescribed.
3. The course consists of 2/4/6 semesters, @ two semesters/year, unless otherwise specified.
4. The candidates shall be required to take an examination at the end of each semester of the study as detailed in the Scheme of Examination. Each semester theory paper carries a maximum of 100 marks, of which 80 marks shall be for semester-end theory examination of the paper of three hours duration and 20 marks shall be for internal assessment
4. (a) Internal Assessment for 20 Marks: Three mid-term exams, two conventional (descriptive) for 15 marks and the third – ‘on-line’ with multiple choice questions for 5 marks for each theory paper shall be conducted. The average of these first two mid-term and the marks in the online mid exams shall be taken as marks obtained for the paper under internal assessment. If any candidate appears for only one mid-term exam, the average mark, dividing by two shall be awarded. If any candidate fails to appear for all the midterm exams of a paper, only marks obtained in the theory paper shall be taken into consideration for declaring the result. Each mid-term exam shall be conducted only once.
4. (b) Candidates shall be declared to have passed each theory paper if he/she obtains not less than E Grade ie., an aggregate of 40 % of the total marks inclusive of semester-end and internal assessment marks in each paper.
5. A candidate appearing for the whole examination shall be declared to have passed the examination if he/she obtains a Semester Grade Point (SGP) of 5.0 and a CGPA of 5.0 to be declared to have passed the Course.
6. Notwithstanding anything contained in the regulations, in the case of Project Report/Dissertation/ Practical/Field Work/Viva-voce etc., candidates shall obtain not less than D grade, i.e., 50% of marks to be declared to have passed the examination.
7. ATTENDANCE: Candidates shall put in attendance of not less than 75% of attendance, out of the total number of working periods in each semester. Only such candidates shall be allowed to appear for the semester-end examination.
7. (a) A candidate with attendance between 74.99% and 66.66% shall be allowed to appear for the semester-end examination and continue the next semester only on medical and other valid grounds, after paying the required condonation fee.

7. (b) In case of candidates who are continuously absent for 10 days without prior permission on valid grounds, his/her name shall automatically be removed from the rolls.
- 7 (c) If a candidate represents the University at games, sports or other officially organized extra-curricular activities, it will be deemed that he/she has attended the college on the days/periods
- 8 Candidates who put in a minimum of 50% attendance shall also be permitted to continue for the next semester. However, such candidates have to re-study the semester course only after completion of the course period for which they are admitted. The candidate shall have to meet the course fees and other expenditure.
- 9 Candidates who have completed a semester course and have fulfilled the necessary attendance requirement shall be permitted to continue the next semester course irrespective of whether they have appeared or not at the semester-end examination, at their own cost.

Such candidates may be permitted to appear for the particular semester-end examination only in the following academic year; they should reregister/ reapply for the Semester examination.

The above procedure shall be followed for all the semesters

10. Candidates who appear and pass the examination in all the papers of each and every semester at first appearance only are eligible for the award of Medals/Prizes/Rank Certificates
11. BETTERMENT: Candidates declared to have passed the whole examination may reappear for the same examination to improve their SGPA, with the existing regulations without further attendance, paying examination and other fees. Such reappearance shall be permitted only within 3 consecutive years from the date of first passing the final examination. Candidates who wish to appear thereafter should take the whole examination under the regulations then in vogue.
12. The semester-end examination shall be based on the question paper set by an external paper-setter and there shall be double valuation for post-Graduate courses. The concerned Department has to submit a panel of paper-setters and examiners approved by the BOS and the Vice-chancellor nominates the paper-setters and examiners from the panel.
13. In order to be eligible to be appointed as an internal examiner for the semester-end examination, a teacher shall have to put in at least three years of service. Relaxation of service can be exempted by the Vice-Chancellor in specific cases.
14. If the disparity between the marks awarded in the semester-end examination by internal and external examiners is 25% or less, the average marks shall be taken as the mark obtained in the paper. If the disparity happens to be more, the paper shall be referred to another examiner for third valuation. In cases of third valuation, of the marks obtained either in the first or second valuation marks, whichever is nearest to the third valuation marks are added for arriving at the average marks.
15. Candidates can seek revaluation of the scripts of the theory papers by paying the prescribed fee as per the rules and regulations in vogue.

16. The Project Report/Dissertation/ Practical/Field Work/Viva-voce etc shall have double valuation by internal and external examiners.
17. A Committee comprising of the HOD, one internal teacher by nomination on rotation and one external member, shall conduct viva-voce examination. The department has to submit the panel, and the Vice-chancellor nominates viva-voce Committee.
18. Grades and Grade Point Details (with effect from 2009-10 admitted batches)

S.No.	Range of Marks %	Grade	Grade Points	
01	>90 ≤100	O	10	Out Standing
02	>80 ≤90	A+	9	Excellent
03	>70 ≤80	A	8	Very Good
04	>60 ≤70	B+	7	Good
05	>55 ≤60	B	6	Above Average
06	≥50 ≤55	C	5	Average
07	≥40 < 50	D	4	Pass
08	<40	F	0	Fail
09			0	AB (Absent)

### ***Terms used and their***

#### ***explanation:***

**Credit Point:** It is the product of grade point and number of credits for a course.

**Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of Practical work/ field work per week.

**Grade Point:** It is a numerical weight allotted to each letter grade on a 10- point scale.

**Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, D and F.

19. Calculation of SGPA (Semester Grade Point Average) & CGPA (Cumulative Grade Point Average):

For example, if a student gets the grades in one semester A+, A+, A, A, A, B in six subjects having credits 2(S1), 4(S2), 4(S3), 4(S4), 4(S5), 2(S6), respectively. The SGPA is calculated as follows:

$$\text{SGPA} = \frac{\{9(A+) \times 2(S1) + 9(A+) \times 4(S2) + 8(A) \times 4(S3) + 8(A) \times 4(S4) + 8(A) \times 4(S5) + 6(B) \times 2(S6)\}}{162} = \frac{162}{20} = 8.10$$

$$\{2(S1) + 4(S2) + 4(S3) + 4(S4) + 4(S5) + 2(S6)\}$$

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- i. A student securing 'F' grade thereby securing 0.0 grade points has to appear and secure at least 'E' grade at the subsequent examination(s) in that subject.
- ii. If a student gets the grades in another semester B, A+, A, B+, A+, C, A+, in seven subjects having credits 4(S1), 2(S2), 4(S3), 2(S4), 4(S5), 4(S6), 2(S7) respectively,

$$\text{SGPA} = \frac{\{6(B) \times 4(S1) + 9(A+) \times 2(S2) + 8(A) \times 4(S3) + 7(B+) \times 2(S4) + 9(A+) \times 4(S5) + 5(C) \times 4(S6) + 9(A+) \times 2(S7)\}}{\{4(S1) + 2(S2) + 4(S3) + 2(S4) + 4(S5) + 4(S6) + 2(S7)\}} = \frac{162}{22} = 7.36$$

$$\text{CGPA} = \frac{(9 \times 2 + 9 \times 4 + 8 \times 4 + 8 \times 4 + 6 \times 2 + 6 \times 4 + 9 \times 2 + 8 \times 4 + 7 \times 2 + 9 \times 4 + 5 \times 4 + 9 \times 2)}{(20+22)} = \frac{324}{42} = 7.71$$

- a) A candidate has to secure a minimum of 5.0 SGPA for a pass in each semester in case of all PG and Professional Courses. Further, a candidate will be permitted to choose any paper(s) to appear for improvement in case the candidate fails to secure the minimum prescribed SGPA/CGPA to enable the candidate to pass at the end of any semester examination.
- b) There will be no indication of pass/fail in the marks statement against each individual paper.
- c) A candidate will be declared to have passed if a candidate secures 5.0 CGPA for all PG and Professional Courses.
- d) The Classification of successful candidates is based on CGPA as follows:
  - i) Distinction –CGPA 7.0 or more;
  - ii) First Class –CGPA 6.0 or more but less than 7.0
  - iii) Second Class –CGPA 5.0 or more but less than 6.0
  - iv) Pass –CGPA 4.0 or more but less than 5.0
- e) Improving CGPA for betterment of class will be continued as per the rules in vogue.
- f) CGPA will be calculated from II Semester onwards up to the final semester. CGPA multiplied by gives "10" aggregate percentage of marks obtained by a candidate.

**Dr. B. R. AMBEDKAR UNIVERSITY, SRIKAKULAM**

**ANNEXURE – I**

Eligibility

<b>Programmes</b>	<b>Qualifying Examination for Admission</b>
<b>1) M.Sc Organic chemistry</b> <b>2) M.Sc Analytical Chemistry</b>	B.Sc Chemistry/ Applied Chemistry (as main wherever applicable) as one of the subjects.



**ANNEXURE – II**  
**M.Sc., Organic Chemistry and M.Sc., Analytical Chemistry**  
**Scheme of Instruction**

**Program: M.Sc., Organic Chemistry and M.Sc., Analytical Chemistry**  
**Semester: I Scheme of Instruction**

<b>Course Code</b>	<b>Title of the Paper</b>	<b>Compulsory</b>	<b>No. of Periods of instruction per week</b>
SOC/SAC-101	General chemistry-I	Compulsory	4
SOC/SAC-102	Inorganic chemistry-I	Compulsory	4
SOC/SAC-103	Organic chemistry-I	Compulsory	4
SOC/SAC-104	Physical chemistry-I	Compulsory	4
SOC/SAC-105	Lab-I: Inorganic chemistry-I	Compulsory	6
SOC/SAC-106	Lab-II: Organic chemistry-I	Compulsory	6
SOC/SAC-107	Lab-III: Physical chemistry-I	Compulsory	6

**Program: M.Sc., Organic Chemistry and M.Sc., Analytical Chemistry**  
**Semester: II Scheme of Instruction**

<b>Course Code</b>	<b>Title of the Paper</b>	<b>Compulsory</b>	<b>No. of Periods of instruction per week</b>
SOC/SAC-201	General chemistry-II	Compulsory	4
SOC/SAC-202	Inorganic chemistry-II	Compulsory	4
SOC/SAC-203	Organic chemistry-II	Compulsory	4
SOC/SAC-204	Physical chemistry-II	Compulsory	4
SOC/SAC-205	Lab-I: Inorganic chemistry-II	Compulsory	6
SOC/SAC-206	Lab-II: Organic chemistry-II	Compulsory	6
SOC/SAC-207	Lab-III: Physical chemistry-II	Compulsory	6

**Program: M.Sc., Organic Chemistry**  
**Semester: III Scheme of Instruction**

Course Code	Title of the Paper	Compulsory/ Elective	No. of Periods of Instruction per Week
SOC-301	Organic Reaction Mechanism, Pericyclic Reactions and Photochemistry	Compulsory	4
SOC-302	Organic spectroscopy-I	Compulsory	4
<b>SOC-303</b>	<b>Elective Paper-I</b>	<b>Elective-I</b>	
SOC-303A	Organic synthesis	Elective	4
SOC-303B	Catalysis	Elective	
SOC-303C	Organic Biomolecules	Elective	
SOC-303D	Supramolecular Chemistry	Elective	
<b>SOC-304</b>	<b>Elective Paper-II</b>	<b>Elective-II</b>	
SOC-304A	Chemistry of Natural products-I	Elective	4
SOC-304B	Medicinal Chemistry	Elective	
SOC-304C	Enzyme reaction Mechanism and Kintics	Elective	
SOC-304D	Organometallic Chemistry	Elective	
SOC-305	Lab-I: Multi stage organic synthesis and chromatography techniques	Compulsory	6
SOC-306	Lab-II: Estimation of Organic compounds	Compulsory	3

**Program: M.Sc., Analytical Chemistry**

**Semester: III Scheme of Instruction**

<b>Course Code</b>	<b>Title of the Paper</b>	<b>Compulsory/ Elective</b>	<b>No. of Periods of Instruction per Week</b>
SAC-301		Compulsory	4
SAC-302		Compulsory	4
<b>SAC-303</b>	<b>Elective Paper-I</b>	<b>Elective-I</b>	
SAC-303A		Elective	4
SAC-303B		Elective	
SAC-303C		Elective	
SAC-303D		Elective	
<b>SAC-304</b>	<b>Elective Paper-II</b>	<b>Elective-II</b>	
SAC-304A		Elective	4
SAC-304B		Elective	
SAC-304C		Elective	
SAC-304D		Elective	
SAC-305		Compulsory	6
SAC-306		Compulsory	3

**Program: M.Sc., Organic Chemistry**  
**Semester: IV Scheme of Instruction**

<b>Course Code</b>	<b>Title of the Paper</b>	<b>Compulsory/ Elective</b>	<b>No. of Periods of Instruction per Week</b>
SOC-401	Modern Synthetic Methodology in Organic Chemistry	Compulsory	4
SOC-402	Organic Spectroscopy-II	Compulsory	4
<b>SOC-403</b>	<b>Elective Paper-I</b>	<b>Elective-I</b>	4
SOC-403A	Organic Synthesis and Disconnection Approach	Elective	
SOC-403B	Asymmetric Synthesis	Elective	
SOC-403C	Nano Chemistry	Elective	
SOC-403D	Chemistry of Drug Design	Elective	
<b>SOC-404</b>	<b>Elective Paper-II</b>	<b>Elective-II</b>	4
SOC-404A	Chemistry of Natural Products-II	Elective	
SOC-404B	Instrumental Methods of Analysis	Elective	
SOC-404C	Computational Quantum Chemistry	Elective	
SOC-404D	Bioinorganic Chemistry	Elective	
SOC-405	Lab-I: Organic Mixture Analysis	Compulsory	6
SOC406	Lab-II: Comprehensive Viva	Compulsory	3

**Program: M.Sc., Analytical Chemistry****Semester: IV Scheme of Instruction**

<b>Course Code</b>	<b>Title of the Paper</b>	<b>Compulsory/ Elective</b>	<b>No. of Periods of Instruction per Week</b>
SAC-401		Compulsory	4
SAC-402		Compulsory	4
<b>SAC-403</b>	<b>Elective Paper-I</b>	<b>Elective-I</b>	4
SAC-403A		Elective	
SAC-403B		Elective	
SAC-403C		Elective	
SAC-403D		Elective	
<b>SAC-404</b>	<b>Elective Paper-II</b>	<b>Elective-II</b>	4
SAC-404A		Elective	
SAC-404B		Elective	
SAC-404C		Elective	
SAC-404D		Elective	
SAC-405		Compulsory	6
SAC406		Compulsory	3

### Credit Structure: M.Sc., Organic Chemistry

Semester I	Credit	Semester II	Credit	Semester III	Credit	Semester IV	Credit
SOC/SAC-101 General chemistry-I	4	SOC/SAC- 201 General chemistry-II	4	SOC-301 Organic Reaction Mechanism, Pericyclic reactions and Photochemistry	4	SOC-401 Modern Synthetic Methodology in Organic Chemistry	4
SOC/SAC-102 Inorganic chemistry-I	4	SOC/SAC-202 Inorganic chemistry-II	4	SOC-302 Organic Spectroscopy-I	4	SOC-402 Organic Spectroscopy-II	4
SOC/SAC-103 Organic chemistry-I	4	SOC/SAC-203 Organic chemistry-II	4	<b>SOC-303 Elective I</b> SOC-303A: Organic synthesis SOC-303B: SOC-303C: SOC-303D:	4	<b>SOC-403 Elective I</b> SOC-403A Organic synthesis and Disconnection Approach SOC-403B; SOC-403C SOC-403D	4
SOC/SAC-104 Physical Chemistry-I	4	SOC/SAC-204 Physical Chemistry-II	4	<b>SOC-304 Elective II</b> SOC-304A: Chemistry of Natural products-I SOC-304B SOC-304C SOC-304D	4	<b>SOC-404 Elective II</b> SOC-404A: Chemistry of Natural products-II SOC-404B SOC-404C SOC-404D	4
SOC/SAC-105 Inorganic chemistry Laboratory-I	2	SOC/SAC-205 Inorganic chemistry Laboratory-II	2	SOC-305 Lab: I Multi stage Organic synthesis and chromatography techniques	4	SOC-405 Lab: I Organic Mixture Analysis	4
SOC/SAC-106 Organic chemistry Laboratory-I	2	SOC/SAC-206 Organic chemistry Laboratory-II	2	SOC-306 Lab: II Estimations of Organic Compounds	2	SOC-406 Lab:II Comprehensive viva	2
SOC/SAC-107 Physical chemistry Laboratory-I	2	SOC/SAC-207 Physical chemistry Laboratory-II	2	-----	-----	-----	-----
Skill Development Course	2	Skill Development Course	2	Skill Development Course	2	Skill development Course	2
-----	-----	MOOCs Course SWAYAM/NPTEL	2	MOOCs Course SWAYAM/NPTEL	2	MOOCs Course SWAYAM/NPTEL	2
Field Visits/Society engagement program etc.,	2	Field Visits/Society engagement program etc.,	2	Field Visits/Society engagement program etc.,	2	Field Visits/Society engagement program etc.,	2
Summer Intships/ Problem based learning etc.,	1	Summer Intships/ Problem based learning etc.,	1	Summer Intships/ Problem based learning etc.,	1	Summer Intships/ Problem based learning etc.,	1
-----	-----	-----	-----	Open/free elective as add on course	2	Open/free elective as add on course	2
Total	27		29		31		31

### Credit Structure: M.Sc., Analytical Chemistry

Semester I	Credit	Semester II	Credit	Semester III	Credit	Semester IV	Credit
SOC/SAC-101 General chemistry-I	4	SOC/SAC- 201 General chemistry-II	4	SOC-301	4	SOC-401	4
SOC/SAC-102 Inorganic chemistry-I	4	SOC/SAC-202 Inorganic chemistry-II	4	SOC-302	4	SOC-402	4
SOC/SAC-103 Organic chemistry-I	4	SOC/SAC-203 Organic chemistry-II	4	<b>SOC-303 Elective I</b> SOC-303A: SOC-303B: SOC-303C: SOC-303D:	4	<b>SOC-403 Elective I</b> SOC-403A SOC-403B SOC-403C SOC-403D	4
SOC/SAC-104 Physical Chemistry-I	4	SOC/SAC-204 Physical Chemistry-II	4	<b>SOC-304 Elective II</b> SOC-304A: SOC-304B SOC-304C SOC-304D	4	<b>SOC-404 Elective II</b> SOC-404A: SOC-404B SOC-404C SOC-404D	4
SOC/SAC-105 Inorganic chemistry Laboratory-I	2	SOC/SAC-205 Inorganic chemistry Laboratory-II	2	SOC-305	4	SOC-405	4
SOC/SAC-106 Organic chemistry Laboratory-I	2	SOC/SAC-206 Organic chemistry Laboratory-II	2	SOC-306	2	SOC-406	2
SOC/SAC-107 Physical chemistry Laboratory-I	2	SOC/SAC-207 Physical chemistry Laboratory-II	2	-----	-----	-----	-----
Skill Development Course	2	Skill Development Course	2	Skill Development Course	2	Skill development Course	2
-----	-----	MOOCs Course SWAYAM/NPTEL	2	MOOCs Course SWAYAM/NPTEL	2	MOOCs Course SWAYAM/NPTEL	2
Field Visits/Society engagement program etc.,	2	Field Visits/Society engagement program etc.,	2	Field Visits/Society engagement program etc.,	2	Field Visits/Society engagement program etc.,	2
Summer Intenships/ Problem based learning etc.,	1	Summer Intenships/Problem based learning etc.,	1	Summer Intenships/Problem based learning etc.,	1	Summer Intenships/Problem based learning etc.,	1
-----	-----	-----	-----	Open/free elective as add on course	2	Open/free elective as add on course	2
Total	29		29		31		31

**Program: M.Sc., Organic Chemistry and M.Sc., Analytical Chemistry**

**Semester: I Credit Structure**

<b>Course code &amp; Subject</b>	<b>Credits</b>	<b>No of hours per week</b>	<b>Internal assessment</b>	<b>External assessment</b>	<b>Max Marks</b>
SOC/SAC-101 General chemistry-I	4	4	20	80	100
SOC/SAC-102 Inorganic chemistry-I	4	4	20	80	100
SOC/SAC-103 Organic chemistry-I	4	4	20	80	100
SOC/SAC-104 Physical Chemistry-I	4	4	20	80	100
SOC/SAC-105 Inorganic chemistry Laboratory-I	2	4	-----	50	50
SOC/SAC-106 Organic chemistry Laboratory-I	2	4	-----	50	50
SOC/SAC-107 Physical chemistry Laboratory-I	2	4	-----	50	50
Skill Development Course	2				50
Field Visits/Society engagement program etc.,	2				50
Summer Internships/ Problem based learning etc.,	1				25
Total	27				



**Program: M.Sc., Organic Chemistry and M.Sc., Analytical Chemistry****Semester: II Credit Structure**

<b>Course code &amp; Subject</b>	<b>Credits</b>	<b>No of hours per week</b>	<b>Internal assessment</b>	<b>External assessment</b>	<b>Max Marks</b>
SOC/SAC-201 General chemistry II	4	4	20	80	100
SOC/SAC-202 Inorganic chemistry II	4	4	20	80	100
SOC/SAC-203 Organic chemistry II	4	4	20	80	100
SOC/SAC-204 Physical Chemistry II	4	4	20	80	100
SOC/SAC-205 Inorganic chemistry Laboratory II	2	4	-----	50	50
SOC/SAC-206 Organic chemistry Laboratory II	2	4	-----	50	50
SOC/SAC-207 Physical chemistry Laboratory II	2	4	-----	50	50
MOOCs	2				50
Skill Development Course	2				50
MOOCs Course SWAYAM/NPTEL	2				50
Field Visits/Society engagement program etc.,	2				50
Summer Internships/ Problem based learning etc.,	1				25
Total	29				

**Program: M.Sc., Organic Chemistry****Semester: III Credit Structure**

<b>Course code&amp;subject</b>	<b>Credits</b>	<b>No of hours per week</b>	<b>Internal assessment</b>	<b>External assessment</b>	<b>Max Marks</b>
SOC-301 Organic Reaction Mechanisms, Pericyclic Reactions and Photochemistry	4	4	20	80	100
SOC-302 Organic Spectroscopy-I	4	4	20	80	100
<b>SOC-303 Elective I</b> SOC-303A: Organic synthesis SOC-303B: SOC-303C: SOC-303D:	4	4	20	80	100
<b>SOC-304 Elective II</b> SOC-304A: Chemistry of Natural products-I SOC-304B: SOC-304C: SOC-304D:	4	4	20	80	100
SOC-305 Multi Stage Organic Synthesis and Chromatography Techniques	4	6	-----	100	100
SOC-306 Estimations of Organic Compounds	2	3	-----	50	50
MOOCs	2				50
Skill development Course	2				50
Field visits	2				50
Summer internship	1				25
Open/free elective as add on course	2				
Total	31				

**Program: M.Sc., Analytical Chemistry****Semester: III Credit Structure**

<b>Course code&amp;subject</b>	<b>Credits</b>	<b>No of hours per week</b>	<b>Internal assessment</b>	<b>External assessment</b>	<b>Max Marks</b>
SAC-301	4	4	20	80	100
SAC-302	4	4	20	80	100
<b>SAC-303 Elective I</b> SAC-303A: SAC-303B: SAC-303C: SAC-303D:	4	4	20	80	100
<b>SAC-304 Elective II</b> SAC-304A: SAC-304B: SAC-304C: SAC-304D:	4	4	20	80	100
SAC-305	4	6	-----	100	100
SAC-306	2	3	-----	50	50
MOOCs	2				50
Skill development Course	2				50
Field visits	2				50
Summer internship	1				25
Open/free elective as add on course	2				
<b>Total</b>	<b>31</b>				

**Program: M.Sc., Organic Chemistry****Semester: IV Credit Structure**

Course code&subject	Credits	No of hours per week	Internal assessment	External assessment	Max Marks
SOC-401 Modern Synthetic Methodology in Organic Chemistry	4	4	20	80	100
SOC-402 Organic Spectroscopy	4	4	20	80	100
<b>SOC-403 Elective I</b> SOC-403A: Organic synthesis and Disconnection Approach SOC-403B SOC-403C SOC-403D	4	4	20	20	100
<b>SOC-404 Elective II</b> SOC-404A: Chemistry of Natural products-II SOC-404B SOC-404C SOC-404D	2	4	20	80	100
SOC-405 Organic Mixture Analysis	4	6	-----	100	100
SOC-406 Comprehensive viva	2	3	-----	50	50
MOOCs	2				50
Skill development Course	2				50
Field visits	2				50
Summer internship	1				25
Open/free elective as add on course	2				
Total	31				

**Program: M.Sc., Analytical Chemistry****Semester: IV Credit Structure**

<b>Course code&amp;subject</b>	<b>Credits</b>	<b>No of hours per week</b>	<b>Internal assessment</b>	<b>External assessment</b>	<b>Max Marks</b>
SAC-401	4	4	20	80	100
SAC-402	4	4	20	80	100
<b>SAC-403 Elective I</b> SAC-403A: SAC-403B SAC-403C SAC-403D	4	4	20	20	100
<b>SAC-404 Elective II</b> SAC-404A: SAC-404B SAC-404C SAC-404D	2	4	20	80	100
SAC-405	4	6	-----	100	100
SAC-406	2	3	-----	50	50
MOOCs	2				50
Skill development Course	2				50
Field visits	2				50
Summer internship	1				25
Open/free elective as add on course	2				
Total	31				

**SYLLABUS**

**Course: General Chemistry- I****Code: SOC/SAC-101**

## UNIT 1

Wave equation – interpretation of wave function – properties of wave function – normalization and orthogonalisation, Operators – Postulates of quantum mechanics - Wave mechanics of simple systems with constant potential energy, particle in one dimensional box – factors influencing colour-transition-dipole integral.

## UNIT 2

Symmetry arguments in deriving the selection rules – the concept of tunneling. Particle in a three dimensional box, rigid rotor, and Wave mechanics of systems with variable potential energy- simple harmonic oscillator-solution of wave equation – selection rules.

## UNIT 3

Hydrogen atom-solution of  $R(r)$ ,  $\theta(\theta)$  and  $\phi(\phi)$  equations-probability density in orbital-shapes of orbital. Perturbation theory-time independent Perturbation (only first order perturbation is to be dealt with) - application to ground state energy of helium atom - Variation principle – applications – calculation of zero point energy of harmonic oscillator.

## UNIT 4

Valence bond approach – directed valence – Polyatomic molecules and hybridisation. Covalent bond – calculation of ionic and covalent bond contributions in hydrogen molecule - Molecular orbital theory – LCAO approximation – hydrogen molecule ion – hydrogen molecule (fundamental concepts only).

## UNIT 5

Treatment of analytical data : Classification of errors - Determinate and indeterminate errors - Minimisation of errors - Accuracy and precision - Distribution of random errors - Gaussian distribution - Measure of central tendency - Measures of precision - Standard deviation - propagation of error

Significant figures and computation rules - Control charts - Regression analysis - Linear least squares analysis.

**PRESCRIBED BOOKS:**

1. Ideas of Quantum Chemistry by Lucjan Piela, Elsevier Amsterdam 2007.
2. Introductory Quantum Chemistry by A.K.Chandra, Mc.Graw Hill 1974.

3. Quantum chemistry by R.K.Prasad, Wiley Eastern 1992.
4. Forman S. Acton, Numerical Methods that Work, Mathematical Association of USA, Washington D. C., 1990.

**REFERENCE BOOKS:**

1. Molecular Quantum Mechanics by P.W. Atkins, 2nd Ed. Oxford 1983.
2. Quantum Mechanics in Chemistry by M.W. Hanne, 2nd Ed. Benjamin 1969.
3. Quantum Chemistry by Levine, 2nd Ed, Allyn and Bacon 1974.

**Course: Inorganic Chemistry- I**

**Code: SOC/SAC-102**

### **UNIT – I**

#### **Chemical Bonding:**

VSEPR theory in explaining the structures of simple molecules. MO theory for simple molecules/ions (Homo and Hetero nuclear molecules) and octahedral, tetrahedral coordination compounds. Role of 'P' and 'd' orbital in pi- bonding.

Term symbols: Russel – Saunders coupling – derivation of term symbols for various configurations.

### **UNIT – II**

#### **Chemistry of main group elements**

General trends in properties – Boron hydrides, carboranes, intercalation compounds, nitrogen – phosphorous, Boron – nitrogen and sulphur – nitrogen cyclic compounds.

### **UNIT – III**

#### **Coordination compounds:**

Crystal field theory – Crystal field splitting patterns in Octahedral, tetrahedral, tetragonal, square planar, square pyramidal and trigonal bipyramidal geometries – Determination of crystal field splitting energy – calculation of crystal field stabilization energies – Factors affecting crystal field splitting energies – spectrochemical series – Jahn – Teller effect – Ligand field theory.

### **UNIT – IV**

#### **Electronic Spectra of transition metal complexes**

Electronic configurations and Spectroscopic terms. Selection rules- break down of selection rules, Slater – Condon parameters, Racah parameters, Term separation energies for  $d^n$  configurations, Orgel and Tanabe Sugano diagrams for  $d^1$  to  $d^9$  configurations. Calculations of  $Dq$ ,  $B$  and  $\beta$  parameters.

### **UNIT-V**

#### **Organometallic Chemistry**

Organometallic chemistry of d-block elements: 18-electron rule, concept of hapticity; synthesis, structure and bonding of homo and heteroleptic metal-carbonyls, nitrosyls, alkyls, alkenes, allyl, alkynes, and arenes. Synthesis and reactivity of Fischer and Schrock carbenes. Homogeneous catalysis involving organometallics-oxidative addition and reductive elimination reactions -



hydrogenation, isomerisation and hydroformylation. Heterogeneous catalysis - Ziegler Natta polymerization.

**Prescribed Books:**

1. Concise inorganic chemistry IV edition by J.D.Lee Black well publications
2. T.S. Swain and D.S.T. Black, Organometallic chemistry
3. P.L.Pauson Organometallic chemistry

**Reference Books:**

Advanced inorganic chemistry by F.A. Cotton and R.G.Wilkinson, IV Edition, Johnwiley and sons, Newyork, 1980.

Inorganic Chemistry by J.E. Huhey, III edition, Harper International Edition, 1983.

Theoretical Inorganic Chemistry II edition by M.C. Day and J. Selbin, Affiliated – East – West press Pvt, Ltd., New Delhi.

**Course: Inorganic Chemistry Lab–I**

**Code: SOC/SAC-105**

Inorganic Qualitative analysis

Books suggested: Vogels text book of Inorganic qualitative analysis, pearson education.

## Semester I

Course: Organic Chemistry-I

Paper Code: SOC/SAC-103

### UNIT – I:

Types of organic reactions, types of reagents: Electrophiles and Nucleophiles.

**Reactive Intermediates:** Generation, structure, stability and reactivity of carbanion, carbocation, free radicals, carbenes and nitrenes.

**Aromaticity:** Concept of aromaticity, Huckel and Craig's rules for aromaticity, Aromaticity of benzenoid aromatic compounds: Five membered, six membered and fused systems. Nonbenzenoid aromatic compounds: Cyclopropenyl cation, cyclobuta dienyl dication, cyclopentadienyl anion, tropylium cation and cyclooctatetraenyl di anion, azulenes, fulvenes, annulenes. Homo aromaticity, Anti aromaticity and Pseudo aromaticity.

**Aromatic nucleophilic substitutions:**  $S_NAr$ ,  $S_N1$  and benzyne mechanisms. Reactivity: Effect of substrate, leaving group and attacking nucleophile.

### UNIT - II:

**Aliphatic Nucleophilic Substitutions:**  $S_N1$ ,  $S_N2$  and  $S_Ni$  mechanisms. Reactivity: Effect of substrate, attacking nucleophile, leaving group and reaction medium. Substitution reactions of ambident nucleophiles, anchimeric assistance, the neighbouring group mechanism: neighbouring group participation by O, N, S, halogens, aryl groups, alkyl and cycloalkyl groups in nucleophilic substitution reactions. Sigma, Pi bond participation in acyclic and bicyclic systems (Non classical carbocations). Nucleophilic substitution at allylic, trigonal and vinylic carbons.

### UNIT – III:

#### Stereochemistry

Optical activity, molecular dissymmetry and chirality, elements of symmetry, Fisher's projection - D,L- and R,S- configurations - relative and absolute configurations - optical isomerism due to asymmetric carbon atoms - optical isomerism in biphenyls, allenes and spirans- optical isomerism of nitrogenous compounds, racemisation and resolution.

Geometrical isomerism: E,Z -configurations, properties of geometrical isomers.

Conformational analysis: Conformations of acyclic molecules – alkanes and substituted alkanes- compounds having intramolecular hydrogen bonding. Conformations of cyclohexane, mono and disubstituted cyclohexanes and decalins, effect of conformations on reactivity.

### UNIT - IV: Chemistry of Heterocyclic Compounds

Structure, reactivity and synthesis of **three membered heterocycles**: (a) Oxirane: Sharpless method, Shi epoxidation, Jacobsen epoxidation (b) Aziridine: Corey-Chaykovsky reaction, Wenker synthesis, Hoch-Campbell synthesis. **Four membered heterocycles**: (a) Oxetane: Peterno-Buchi reaction, Intermolecular Williamson-Ether synthesis (b) Azetidine. **Five membered heterocycles**: (a) Pyrrole: Paal Knorr, Hantzsch Methods (b) Thiophene: Paal Knorr, Hinsberg method (c) Furan: Paal Knorr, Fieser-Benary Industrial Method (d) Pyrazole (e) Imidazole (f) Oxazole (g) Thiazole. **Benzofused Heterocycles**: (a) Indole (b) Benzothiophene (c) Quinoline.

#### UNIT – V:

##### Chemistry of Natural Products:

Isolation, structure elucidation and synthesis of Terpenoids:  $\alpha$ -Pinene and  $\alpha$ -Terpineol; Flavonoids: Quercetin and Genistein.

##### Prescribed Text Books/Reference Books:

1. Advanced Organic Chemistry: Reactions Mechanisms and Structure, 4<sup>th</sup> edition, by Jerry March, John Wiley and Sons publishers.
2. Organic Chemistry Vol. I (Sixth Ed.) and Vol. II (Fifth Ed.) by I.L. Finar, ELBS.
3. Organic Chemistry (Fifth Edn.) by Morrison and Boyd, PHI, India.
4. Stereochemistry of Organic compounds by Ernest L. Eliel, Samuel H. Wilen, Wiley publishers.
5. Advanced Organic Chemistry, Part A and Part B, by Francis A. Carey, R. J. Sundberg, Springer publications
6. Name Reactions in Heterocyclic Chemistry by Jie Jack Li, Wiley Interscience.
7. T. W. Graham Solomons and C.B. Fryhle, Organic Chemistry, 10<sup>th</sup> edition, Wiley.
8. Jonathan Clayden, Nick Greeves, Stuart Warren: Organic Chemistry 2nd Edition, Oxford, 2014.

**Course: Organic Chemistry Lab– I**

**Code: SOC/SAC-106**

**Max. Marks: 50 (Practical+Record+Viva)**

**Title of the practical:** Synthesis of six organic compounds involving one or two stages.

**Books Suggested for Practicals:**

1. Vogels text book of Practical Organic chemistry, V<sup>th</sup> edition by B.S.Furniss, A.J. Hannaford, P.W.G. Smith and A.R.Tatchell, Pearson Education, 1989

**UNIT 1**

**Classical Thermodynamics:**

Brief review of first and second laws of thermodynamics - Entropy change in reversible and irreversible processes - Entropy of mixing of ideal gases - Entropy and disorder – Free energy functions - Gibbs-Helmholtz equation - Maxwell partial relations - Conditions of equilibrium and spontaneity - Free energy changes in chemical reactions: Van't Hoff isotherm - Van't Hoff isochore - Clausius Clapeyron equation - partial molar quantities - Chemical potential - Gibbs-Duhem equation –Nernst heat theorem – Third law of thermodynamics and its applications.

**UNIT 2**

**Statistical Thermodynamics**

Introduction: Concept of ensembles, partition functions and distributions, micro canonical, canonical and grand canonical ensembles, canonical and grand canonical partition functions, Boltzmann, Fermi-Dirac and Bose-Einstein distributions. Thermodynamic probability and most probable distribution-Ensembles-Maxwell-Boltzmann distribution.

**UNIT 3**

**Solid State Chemistry**

X-Ray diffraction studies: Bragg's equation – Crystal structure determination- lattice type and lattice dimensions – crystal Defects - Theories of Specific heats of solids- Band theory of solids-- band gaps in metals, semiconductors and insulators applications- photo sensors, light-emitting diodes (LEDs) - intrinsic and extrinsic semiconductors, doped materials.

**UNIT 4**

**Surface chemistry**

Adsorption of gases and vapors on solids: Adsorption time - the Langmuir adsorption isotherm- kinetic derivation –Statistical derivation of Langmuir adsorption isotherm -Adsorption entropies - lateral interaction - The BET and related isotherms - derivation of the BET equation -Properties of the BET equation - thermodynamics of adsorption - Chemisorption and Catalysis.

**UNIT 5**

**Chemical kinetics-** Theories of reaction rates – collision theory – limitation; transition state theory – effect of ionic strength – Debye – Huckle theory – primary and secondary salt effects –

effect of dielectric constant of solvent-ion-ion interaction–Effect of substituent– Hamett equation – limitations – Taft equation –specific and general acid-basic catalysis – Skrabal diagram – Catalysis by enzymes - Michelis-Menten kinetics - fast reactions – flow systems – temperature and pressure jump methods – relaxation.

**Reference Books:**

- Physical chemistry volumes 2<sup>nd</sup> edition by K.L.Kapoor published by Macmillan 2005.
- Physical chemistry, Gilbert W. Castellan 3<sup>rd</sup> edition published by Narosa publishing house.
- Physical chemistry 7<sup>th</sup> edition, 2002 by Atkins and Paula published by Oxford University press.
- Advanced Physical chemistry by Gurdeep Raj published by GOEL publishing house.

**Prescribed Books:**

1. Kinetics and Mechanisms of chemical transformations, J Raja ram, J C Kuriacose, published by Macmillan India Ltd.
2. Thermodynamics for chemists by Samuel Glasstone published by Litton educational publishing.

**Course: Physical Chemistry Lab – I**

**Code: SOC/SAC-107**

**Course Contents:**

1. Critical Solution Temperature of partially miscible liquids – Phenol – Water System.
2. Effect of electrolyte (NaCl) on Miscibility temperature.

## **SEMESTER II**

**Course: General Chemistry-II**

**Code: SOC/SAC-203**

### **UNIT 1**

**Microwave spectroscopy:** Rotational spectra of diatomic molecules – Rigid rotor-Selection Rules -isotopic effect- Second order stark effect and its applications - Non-rigid rotator - spectrum of non-rigid rotator - poly atomic molecules - linear, symmetric top and asymmetric top molecules (only spectral features)

### **UNIT 2**

**Infrared spectroscopy:** Infrared spectra of diatomic molecules-harmonic and anharmonic oscillators- Selection rules- overtones-combination bands- Calculation of force constant, anharmonicity constant and zero point energy- Fermi resonance, Simultaneous vibration-rotation spectra of diatomic molecules.

### **UNIT 3**

**Raman Spectroscopy** – Raman effect- Classical and quantum mechanical explanations- Rotational Raman and Vibrational Raman spectra.

**Visible and ultraviolet spectroscopy:** - Electronic Spectra of diatomic molecules - Vibrational coarse structure-intensity of spectral lines-Franck Condon principle-applications, Rotational fine structure-band head and band shading, Charge transfer spectra.

### **UNIT 4**

#### **Molecular symmetry and group theory:**

The concept of groups, symmetry operations and symmetry elements in molecules, matrix representations of symmetry operations, point groups, irreducible representations - Axioms of group theory – group multiplication tables for  $C_{2v}$  and  $C_{3v}$  Point groups – character tables.

### **UNIT 5**

Great Orthogonality theorem and its proof- Application of group theory to atomic orbitals in ligand fields, molecular orbitals, hybridization - Classification of normal vibrational modes, selection rules in vibrational and electronic spectroscopy - Woodward-Hoffmann rules.

## **PRESCRIBED BOOKS**

1. Fundamentals of Molecular spectroscopy: by C.N.Banwell
2. Introductory Group Theory for Chemists – George Davidson
3. Group theory for chemistry – A.K.Bhattacharya
4. Molecular spectroscopy by B.K.Sharma
5. Vibrational Spectroscopy by D.N.Sathyanarayana New Age Int. Pub.

## **REFERENCE BOOKS**

1. Chemical Analysis by H.A.Laitinan and W.E.Harris, McGraw Hill.
2. Group theory and its applications to chemistry by K.V. Raman Tata Mc Graw Hill, 1990.
3. Symmetry and Structure by S.F.A. Kettle, Wiley 1985.
4. Chemical Applications of Group Theory by Cotton 3rd Ed., Wiley1990



### UNIT I

**Chemistry of Transition elements:** Classification- LNCs and HNCs, Isoelectronic and Iso lobar relationships, electron counting rules: Wade's rule. Comparative study of the first second and third transition series. Metal cluster compounds favourable conditions for their Formation – structure and bonding in the following halide and carboxylate metal – cluster compounds  $\text{Re}_2\text{Cl}_8^{2-}$ ,  $\text{Mo}_2\text{Cl}_8^{4-}$ ,  $\text{Re}_2(\text{RCOO})_4(\text{H}_2\text{O})_2$ ,  $\text{Cr}_2(\text{RCOO})_4(\text{H}_2\text{O})_2$ ,  $\text{Cu}_2(\text{RCOO})_4(\text{H}_2\text{O})_2$ ,  $\text{Cr}_2\text{Cl}_9^{3-}$ ,  $\text{Mo}_2\text{Cl}_9^{3-}$ ,  $\text{W}_2\text{Cl}_9^{3-}$ ,  $\text{Re}_3\text{Cl}_9$ ,  $\text{Re}_3\text{Cl}_{12}^{3-}$ ,  $\text{Mo}_6\text{Cl}_8^{4+}$ ,  $\text{Nb}_6\text{X}_{12}^{2+}$  and  $\text{Ta}_6\text{X}_{12}^{2+}$ .

### UNIT II

**Chemistry of Inner transition elements:** Chemistry of Lanthanide electronic configurations – oxidation states – Lanthanide contraction –its consequences – magnetic *and spectral properties* – occurrence, extraction and separation techniques (fractional crystallization, precipitation, ion-exchange, solvent-extraction and thermal decomposition, selective reduction and oxidation). Use of lanthanides and their compounds. Chemistry of Actinides: Synthesis of Trans uranium - electronic configurations – oxidation states position in the periodic table – actinide contraction – comparison of magnetic and spectral properties of actinides with those of lanthanides.

### UNIT III

**Metal Ligand Equilibria in solution:** Stepwise and overall formation constants, trends in stepwise constants factors affecting the stability of metal complexes – chelate effect – Determination of stability constants of complexes – spectrophotometric method and pH –metric method. Stability correlations – Irving – William's series.

### UNIT IV

**Inorganic Reaction Mechanism:** Inert and labile complexes-Explanation of lability on the basis of CFSE. Substitution reactions of metal complexes – D.Id, Ia and A mechanisms – ligand replacement reactions of octahedral complexes- Acid Hydrolysis, Anation base hydrolysis of cobalt(III) complexes - ligand replacement reactions of square planar complexes of platinum (II) –

trans effect mechanism of trans effect (Theories) – Mechanism of redox reactions – outer sphere mechanism, cross reactions and Marcus – Hush equation, inner sphere mechanism, complementary and non – complementary reactions.

#### **UNIT V:**

**Nuclear Chemistry:** Origin of the elements - Nuclear stability and nuclear binding energy - Nuclear forces - Nuclear Reactions - Artificial radioactivity - Transmutation of elements - Fission, fusion and spallation - Nuclear energy - Separation and uses of isotopes - Radiochemical methods - Principles of determination of age of rocks and minerals- Radio-carbon dating - Hazards of radiation and safety measures .

#### **REFERENCE BOOKS:**

1. Chemistry of Lanthanides by T.Moeller, Chapman and Hall
2. Man-made Transuranium elements by G.T.Seaborg.
3. Mechanisms of Inorganic Reactions in solution by D.Benson. MC graw Hill London, 1968.
4. Inorganic Chemistry by J.E. Huhey, III edition, Harper international edition, 1983.
5. Theoretical Inorganic Chemistry II edition by M.C. Day and J.

#### **Prescribed books**

1. Concise inorganic chemistry IV edition by J.D.Lee Black well publications, 19
2. Selbin, Affiliated – East – West press Pvt, Ltd., New Delhi.

**Course:Inorganic Chemistry Lab –II**

**Code: SOC/SAC-205**

1. Inorganic Quantitative analysis.

**Books suggested:** Vogels Inorganic qualitative analysis, Pearson education

**UNIT I: Aromatic Electrophilic Substitutions:** The arenium ion mechanism, orientation and reactivity, Aromatic electrophilic substitution reactions: Nitration, amination, sulfonation, halogenations. Friedel - Crafts reactions, Reimer - Tiemann reaction, Vilsmeier - Haack reaction, Gatterman reaction.

**Aliphatic Electrophilic Substitutions:**  $S_E^1$ ,  $S_E^2$  and  $S_E^i$  mechanisms. Reactivity - effect of substrate, leaving group and solvent. Reactions: Hydrogen exchange, migration of double bonds, halogenation of aldehydes, ketones, carboxylic acids, acyl halides, sulphoxides and sulphones. Haloform reaction, Haller-Bauer reaction, Transmetallation.

**UNIT II: Mechanism and applications of some name reactions:** Grignard, Reformatsky, Perkin, Cannizaro, Mannich, Diels-Alder, Sandmeyer reactions. Michael addition, Openauer oxidation, Clemmensen reduction, Meerwein-Pondorf-Verley (MPV) reduction, Benzoin condensation, Hydroboration.

**UNIT III: Molecular Rearrangements:** Mechanism and migratory aptitude of **Rearrangements to electron deficient carbon:** Pinacol-pinacolone, Wagner-Meerwein and Benzil-Benzilic acid rearrangements. **Rearrangements to electron deficient nitrogen:** Beckmann, Hofmann, Curtius, Schmidt and Lossen rearrangements. **Rearrangements to electron deficient oxygen:** Baeyer-Villiger and Dakin rearrangements. **Other rearrangements:** Neber and Favorski rearrangements.

**UNIT IV: Organic Spectroscopy:**

**UV Spectroscopy:** Various electronic transitions, selection rules, effect of solvent on electronic transitions, absorption laws, chromophores, auxochromes. Absorption shifts: bathochromic, hypsochromic, hyperchromic and hypochromic shifts. Woodward-Fieser rules for conjugated dienes and carbonyl compounds.

**Infrared Spectroscopy:** Basic principle, types of molecular vibrations, fingerprint region and identification of functional groups.

**Nuclear Magnetic Resonance Spectroscopy ( $^1\text{H-NMR}$ ):** Basic principle, chemical shift and its measurement, factors affecting the chemical shift and assignment of chemical shifts.

**Mass Spectroscopy:** Basic principle, nitrogen rule and fragmentation pattern of carbonyl compounds and alcohols.

#### **UNIT-V**

#### **Chemistry of Natural Products:**

Isolation, structure elucidation and synthesis of alkaloids: Atropine and Nicotine. Purines: Caffeine. Configuration and ring structures of glucose and fructose. Anomeric effects.

#### **Prescribed Text Books/Reference Books:**

1. Advanced Organic Chemistry: Reactions Mechanisms and Structure, 4<sup>th</sup> edition, by Jerry March, John Wiley and Sons publishers.
2. Organic Chemistry Vol. I (6<sup>th</sup> Edn.) and Vol. II (5<sup>th</sup> Edn.) by I.L. Finar, ELBS.
3. Organic Chemistry (Fifth Edn.) by Morrison and Boyd, PHI, India.
4. Advanced Organic Chemistry, Part A and Part B, by Francis A. Carey, R. J. Sundberg, Springer publications
5. T.W. Graham Solomons and C.B. Fryhle, Organic Chemistry, Tenth Edn, Wiley.
6. Jonathan Clayden, Nick Greeves, Stuart Warren: Organic Chemistry, Second Edition, Oxford, 2014.
7. Organic spectroscopy by William Kemp, Third edition, McMillan
8. Introduction to spectroscopy, 5<sup>th</sup> edition, by Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, Cengage Learning publishers.

**Course: Organic Chemistry Lab - II**

**Code: SOC/SAC-206**

**Max. Marks: 50 (Practical+Record+Viva)**

**Title of the practical:** Functional group identification (mono or di substituted) of organic compounds and preparation of its derivatives (at least two solid derivatives).

#### **Suggested Books:**

- 1) Vogels text book of Practical Organic Chemistry, V edition by B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Pearson Education.

**UNIT I**

**Nuclear Magnetic Spectroscopy**

Magnetic properties of molecules – theories of molecule magnetic susceptibility – measurement of magnetic structure susceptibility – Principle and theory of NMR elucidation spectroscopy – Nature of spinning particle and its interaction with magnetic field – experimental technique.

**UNIT 2**

**Electron Spin Resonance Spectroscopy**

Electrons spin Principle and experimental technique – g-factor; Resonance: line shapes and line width – hyperfine interactions - applications of ESR studies to the structure of free radicals - Metal complexes and biological systems.

**UNIT 3**

**Polymer chemistry**

Classification of polymers - Free radical, ionic and Zeigler -Natta Polymerisation – kinetics of free radical polymerisation - Techniques of polymerisation - Glass transition temperature - Factors influencing the glass transition temperature. Number average and Weight average, Molecular weights –molecular weights determination concept of distribution.

**UNIT 4**

**Photochemistry**

Laws of Photochemistry - Fluorescence – delayed fluorescence; E (osine) and P (yrin) type phosphorescence, Jablonski diagram , photo physical process – intersystem crossing and internal conversion, derivation of Stern-Volmer equation – Quantum yield Quenching effect – fluorescence, phosphorescence and lifetimes. Applications of Fluorescence based sensors – examples of molecular and supramolecular systems.

**UNIT 5**

**Electrochemistry:** Electrochemistry: Electrochemical cell – Galvanic and electrolytic cell concentration cell with and without transference – effect of complexation on redox potential –

ferricyanide/ferrocyanide couple: Iron(III) phenanthroline/Iron(II) phenanthroline Couple:  
Determination of standard potential-activity coefficients from EMF data.

### **PRESCRIBED BOOKS:**

1. Physical chemistry volumes 2<sup>nd</sup> edition by K.L.Kapoor published by Macmillan
2. 2005.
3. Physical chemistry, Gilbert W. Castellan 3<sup>rd</sup> edition published by Narosa
4. publishing house.
5. Physical chemistry 7<sup>th</sup> edition, 2002 by Atkins and Paula published by Oxford
6. University press.
7. Advanced Physical chemistry by Gurdeep Raj published by GOEL publishing house.

### **REFERENCE BOOKS:**

- 1) Physical Chemistry-G.W.Castellan, Narosa Publishing House, Prentice Hall
- 2) Polymer Chemistry – Fred W. Billmeyer, Wiley student edition, published by John Wiley & Sons PTE. Ltd.
- 3) An Introduction to Electrochemistry, Samuel Glasstone, An East West Edition, Affiliated East West press Pvt. Ltd.

**Course: Physical Chemistry Lab – II**

**Code: SOC/SAC-207**

1. Relative strengths of acids by studying the hydrolysis of ethylacetate / methyl acetate
2. Determination of equilibrium constant of  $KI_3 \rightleftharpoons KI + I_2$  by partition coefficient method and determination of unknown concentration of potassium iodide.
3. Potentiometric titration of Ferrous ammonium sulphate with potassium dichromate.
4. Decomposition of Composition of Cuprammonium cation.

### **Reference Books:**

1. Practical Experiments in Physical Chemistry by Alexander Finlay.
2. Experiments in Chemistry by D.V.Jagardam., Himalaya Publishing House, 2003.
3. Physical Chemistry experiments by P. Ghosh.

## SEMESTER – III

**Course:** Organic Reaction Mechanism, Pericyclic Reactions and Photochemistry  
**Paper Code:** SOC-301 w.e.f 2019-2020

### UNIT-I

**Radical substitution mechanisms:** Reactivity for aliphatic substrates, reactivity at bridgehead, Reactivity in aromatic substrates, neighboring group assistance in free radical reactions, reactivity in the attacking radical, effect of solvent on reactivity, halogenation at an alkyl carbon and allylic carbon, hydroxylation at aromatic carbon by means of Fenton's reagent, oxidation of aldehydes to carboxylic acids, formation of cyclic ethers with  $\text{Pb}(\text{OAc})_4$ , Reed reaction, Kolbe reaction and Hunsdiecker reaction.

### UNIT-II

**Elimination reactions:** Mechanisms of  $\text{E}_2$ ,  $\text{E}_1$ , and  $\text{E}_{1\text{CB}}$ , reactivity-effects of substrate, attacking base, leaving group and medium, Stereochemistry of eliminations in acyclic and cyclic systems, orientation in eliminations - Saytzeff and Hoffman rules and pyrolytic syn elimination.

### UNIT-III

#### **Addition Mechanisms:**

**Addition to carbon-carbon multiple bonds:** Addition reactions involving electrophiles, nucleophiles and free radicals, cyclic mechanisms. Orientation and reactivity, Hydrogenation of double and triple bonds, Hydroboration, Birch reduction, addition of oxygen and  $\text{N}_2\text{O}_4$ .

**Addition to carbon-hetero atom multiple bonds:** Mechanism and reactivity, reductions of carbonyl compounds, carboxylic acids, esters, nitrites, addition of Grignard reagents, Tollen's reaction, Wittig reaction and Prins reaction.

### UNIT-IV

#### **Pericyclic reactions:**

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3 Butadiene, 1,3,5- Hexatriene, allyl system, classification of pericyclic reactions. Woodward- Hoffman correlation diagram method. FMO and perturbation of molecular (PMO) approach for the explanation of pericyclic reactions under thermal and photochemical conditions.

**Electrocyclic Reactions:** Conrotatory and disrotatory motions.  $4n$  and  $4n+2$   $\pi$  electrons systems.

**Cycloadditions:** Antarafacial and suprafacial additions, notation of cycloadditions, 2+2, 4+2 additions and chelotropic reactions.

**Sigma tropic rearrangements**-suprafacial and antarafacial shifts of H, Sigmatropic shift involving carbon moieties, (3.3) and (5.5) sigmatropic rearrangements. Claisen, Cope, Oxy-cope and aza-Cope rearrangements. Ene reaction

#### **UNIT-V**

##### **Organic Photochemistry:**

Photochemistry of carbonyl compounds-  $n-\pi^*$  and  $\pi-\pi^*$  transitions. Norrish type I and Norrish type II cleavages, Paterno-Buchi reactions, Photoreduction, photochemistry of enones- Hydrogen abstraction, rearrangement of  $\alpha,\beta$ -unsaturated ketones and cyclohexadienones, photochemistry of unsaturated systems (Olefins)-cis-trans isomerisation, dimerization and hydrogen abstractions and additions, acetylenes-dimerisation, Dienes - Photochemistry of 1,3 butadienes, di- $\pi$ -methane rearrangement. Photochemistry of aromatic compounds - Excited state of benzene and its 1,2-, 1,3-, 1,4- additions. Photo-Fries rearrangement, Photo-Fries reactions of anilides, photosubstitution reactions of benzene derivatives.

##### **Suggested Text/Reference Books:**

- 4) Advanced Organic Chemistry: Reactions Mechanisms and Structure by Jerry March, Mc.Graw Hill and Kogakush.
- 5) Molecular reactions and Photochemistry by Charles Dupey and O. Chapman, Prentice Hall.
- 6) Pericyclic reactions by S.N. Mukharji, Mcmilan.
- 7) Mechanisms and Theory in Organic Chemistry by T.H. Lowery and K.S. Richardson.
- 8) The modern structural theory in Organic Chemistry by L.N.Ferguson, Prentice Hall



**UNIT-I**

**UV Spectroscopy:** UV spectra of aromatic and heterocyclic compounds,  $\alpha$ -diketones,  $\beta$ -diketones, enediones and quinines. Applications of UV Spectroscopy-study of isomerism, determination of strength of hydrogen bonding and conformations of  $\alpha$ -substituted cyclohexanones. Steric effect in biphenyls.

**UNIT-II**

**Infrared Spectroscopy:** Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, carbonyl compounds, esters, amides, carboxylic acids, anhydrides, lactones, lactams, nitriles and conjugated carbonyl compounds. Effect of hydrogen bonding and solvent on vibrational frequencies.

**UNIT-III**

**Nuclear Magnetic Resonance Spectroscopy ( $^1\text{H-NMR}$ ):** Shielding of magnetic nuclei, chemical and magnetic equivalence of spins, spin-spin coupling, integration, the coupling constant, types of spin-spin couplings, factors influencing the coupling constant, first-order and non-first order spectra, spin system notations (ABX, AMX,  $A_2B_2$  etc.). Simplification of non-first order spectra-use of higher magnetic fields, nuclear magnetic double resonance and lanthanide shift reagents. Deuterium exchange, nuclear overhauser effect.

**UNIT-IV**

**Mass spectroscopy:** Basic Principles, instrumentation, isotope abundance, the molecular ion, metastable ions, base peak, fragment ions, even-electron rule and nitrogen rule. McLafferty rearrangement, ortho effect, *retro*-Diels-Alder reaction. Fragmentation processes-fragmentation associated with various functional groups (alkanes, cycloalkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amides, amines, alkyl chlorides and alkyl bromides).

**UNIT-V**

Structural elucidation of Organic compounds by a combined application of the UV, IR, NMR and MASS spectral data.

**Prescribed Text/Reference Books:**

1. Spectroscopic identification of organic compounds by RM Silverstein, G C Bassler and T B Morrill
2. Organic Spectroscopy by William Kemp
3. Spectroscopic methods in Organic chemistry by DH Williams and I Fleming

4. Modern NMR techniques for chemistry research by Andrew B Derome
5. NMR in chemistry - A multinuclear introduction by William Kemp
6. Spectroscopic identification of organic compounds by P S Kalsi
7. Introduction to spectroscopy, 5<sup>th</sup> edition, by Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, Cengage Learning publishers.
8. Carbon-13 NMR for organic chemists by GC Levy and O L Nelson
9. Nuclear Magnetic Resonance Basic principles by Atta-ur-Rahman

UNIT-I

**Formation of Carbon-Carbon (C-C) single bonds:**

Alkylation via enolate anions, applications of  $\alpha$ -thio and seleno carbanions, the enamine and related reactions, aldol reaction, umplong (dipole inversion) reaction. Alkylation via organometallic reagents - organo palladium, organo nickel and organo copper reagents, synthetic applications of carbenes and carbenoids, sulphur ylids.

UNIT-II

**Formation of carbon-carbon double bonds:** Sulphoxide-sulphonate rearrangement, Wittig reaction, alkenes from arylsulphonyl hydrazones, Claisen rearrangement.

**Reactions at unactivated carbon-hydrogen bonds:** The Hoffmann-Loeffler-Freytag (HLF) reaction, Barton reaction, Photolysis of organic hypohalites.

UNIT-III:

**Asymmetric Synthesis-I**

Topocity – Prochirality – Substrate selectivity – Diastereoselectivity and Enantioselectivity – Substrate controlled methods – use of chiral substrates – examples.

Auxiliary controlled methods – Use of chiral auxiliaries – Chiral enolates – alkylation of chiral imines – Stereoselective Diels – Alder reaction.

UNIT-IV:

**Asymmetric Synthesis-II**

Reagent controlled methods – Use of chiral reagents – Asymmetric oxidation – Sharpless epoxidation – Asymmetric reduction – Use of lithium aluminium hydride and borate reagents.

UNIT-V:

**Organoboranes:** Hydroboration, Preparation of Organoboranes, Reagents: Disiamyl borane, thexyl borane, 9-BBN, dicylohexyl borane, mono- and di- isopinocampheyl boranes. Functional group transformations of Organo boranes: Oxidation, protonolysis and rearrangements. Formation of carbon-carbon bonds: carbonylation, cyanoborate process, reactions of alkenyl boranes and trialkylalkynyl borates.

**Prescribed Reference/Text Books:**

1. Some Modern Methods of Organic Synthesis W. Carothers, Third Edition, Cambridge University Press, Cambridge, 1988.

2. Modern Synthetic Reactions, Herbert O. House, Second Edition, W.A. BenzamineInc, Menio Park, California, 1972.
3. Principle of Organic Synthesis- R.O.C. Norman and J. M. Coxon.(ELBS)
4. Advanced organic chemistry part A & B; Fourth edition; Francis A Cary and Richard J. Sundberg; Kluwer Academic/Plenum Publisher New York, 2000.
5. Organic syntheses via boranes / Herbert C. Brown; with techniques by Gary W.Kramer, Alan B. Levy, M. Mark Midland. New York : Wiley, 1975
6. Organic chemistry Jonathan Clayden, Nick Greeves, Stuart Warren, 2nd Edition, 2012, Oxford University Press.
7. Stereochemistry of organic compounds — Principles & Applications by D. Nasipuri, New Age International Publishers.
8. Stereochemistry of Carbon compounds by Ernest L Eliel & Samuel H. Wilen, Wiley publishers.
9. Stereochemistry: Conformation & Mechanism by P S Kalsi, New Age International Publishers.
10. The third dimension in organic chemistry, by Alan Bassendale
11. Stereo selectivity in organic synthesis by R S Ward, Wiley publishers.
12. Asymmetric synthesis by Robert Gawley and Jeffrey Aube, Elsevier publications
13. Asymmetric organic reactions by J D Morrison and H S Moscher
14. Principles in Asymmetric synthesis by Robert E. Gawley & Jeffrey Aube
15. Stereo differentiating reactions by Yoshiharu Izumi, Academic press.

Study of isolation, stereochemistry, synthesis, biogenesis and biological properties of the following classes of natural products from plants, animal, and microbial sources and biopolymers.

**Unit-I:** Acetogenins and shikimates Microbial metabolites : Penicillin -G, Cephalosporin-C and Streptomycin

**Unit-II:** Terpenes: Forskolin, Taxol and Azadirachtin

**Unit-III:** Alkaloids: Morphine, Reserpine and Vincristine

**Unit-IV:** Biopolymers & Peptides:  $\alpha$ -Aminoacids, their general properties and synthesis, synthesis of peptides by Merrifield solid phase synthesis. Chemistry of Oxytocin and Dolostatin-10.

**Unit V:** Physical Properties, occurrence, Isolation, Structural elucidation and synthesis of Vitamin A, Vitamin E, Vitamin K.

**Reference Books:**

- 1) Organic chemistry, Volume 2. Stereochemistry and chemistry of Natural products I.L.Finlar 5th Edition ELBS, 1975 (overall and for Unit I A, Morphine and Unit IV)
- 2) Chemical aspects of Biosynthesis, Johan Mann. Oxford University Press, Oxford 1996
- 3) Chemistry of Natural Products: A Unified approach N.R.Krishna Swamy, University press (INDIA) Ltd., Orient loangman limited. Hyderabad 1999 (overall and for certain aspects of Azadirachtin, Morphine, Reserpine)
- 4) Introduction to Organic Chemistry, A Streitwieser. CH Heathcock and E.M/Kosover IV edn, MC Milen 1992 (For Merrifield synthesis of peptides and also other aspects of Unit IV)
- 5) Primary literature for Unit IB Forskolin, Taxol, Azadirachtin Unit III (Minus morphine) and dolostatin-10. Details and copy of the relevant material are available with the Department of organic chemistry, FD and W Andhra University, Visakhapatnam.
- 6) Chemistry of Natural products by S V Bhat, B.A. Nagasampagi.

## Semester: III      Practicals

### Organic Chemistry Practical-I

Code: SOC- 305

**Max. Marks: 100 (Practical+Record+Viva)**

**Title of the practical:** Multi stage organic synthesis involving three or four stages and chromatographic techniques.

**Suggested Books:**

- 1) Vogels text book of Practical Organic Chemistry, V edition by B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Pearson Education

### Organic Chemistry Practical – II

Code: SOC-306

**Max. Marks: 50 (Practical+Record+Viva)**

**Title of the practical:** Estimation of organic compounds

- 1) Estimation of Glucose
- 2) Estimation of Sucrose
- 3) Estimation of Phenol
- 4) Estimation of Aniline

**Suggested Books:**

- 1) Practical organic chemistry, Fourth edition by F.G. Mann and B. C Saunders, Pearson Edn.

## SEMESTER: IV

**Course:** Modern Synthetic Methodology in Organic Chemistry

**Paper Code:** SOC-401

w.e.f 2019-2020

### UNIT - I

**Modern Synthetic Methods:** Baylis-Hillman reaction, Henry reaction, Nef reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction and Ugi reaction. Brook rearrangement; Tebbe olefination. Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi and Sonogashira, Nozaki-Hiyama, Buchwald-Hartwig, Ullmann coupling reactions, directed ortho metalation.

### UNIT-II

**Multicomponent Reactions:** Ugi, Passerini, Biginelli, Hantzsch and Mannich reactions.

**Metathesis:** Grubb's 1st and 2nd generation catalyst, Olefin cross coupling metathesis (OCM), ring closing metathesis (RCM), ring opening metathesis (ROM), applications.

### UNIT-III

**Oxidation:** Metal based and non-metal based oxidations of (a) alcohols to carbonyls (Chromium, Manganese, aluminium, silver, ruthenium. DMSO, hypervalent iodine and TEMPO based reagents). (b) phenols (Fremy's salt, silver carbonate) (c) alkenes to epoxides (peroxides/per acids based), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation. (d) alkenes to diols (Manganese, Osmium based), Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification, (e) alkenes to carbonyls with bond cleavage (Manganese, Osmium, Ruthenium and lead based, ozonolysis) (f) alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, selenium, chromium based allylic oxidation) (g) ketones to ester/lactones (Baeyer-Villiger)

### UNIT-IV

**Reduction:** (a) Catalytic hydrogenation (Heterogeneous: Palladium/Platinum/Rhodium/Nickel etc; Homogeneous: Wilkinson). Noyori asymmetric hydrogenation. (b) Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium, Zinc, Titanium and Samarium (Birch, Pinacol formation, McMurry, Acyloin formation, dehalogenation and deoxygenations) (c) Hydride transfer reagents from Group III and Group IV in reductions. (i)  $\text{NaBH}_4$  triacetoxyborohydride, L-selectride, K-selectride, Luche reduction;  $\text{LiAlH}_4$ , DIBAL-H and Red-Al.

### UNIT-V

**Newer methods in organic synthesis:**

Phase-transfer catalysis – principle, types of phase transfer catalysts, mechanism and applications in organic synthesis.

Ionic liquids: Introduction and applications in organic synthesis (illustrate with two examples).

Nanomaterials: Introduction, methods of preparation, applications in organic synthesis

**Prescribed Books:**

1. Some Modern Methods of Organic Synthesis W. Carothers, Third Edition, Cambridge University Press, Cambridge, 1988.
2. F. A. Cary and R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edition, Springer, 2009.
3. M. B. Smith, Organic Synthesis, 2nd Edition, 2005
4. J. Tsuji, Palladium Reagents and Catalysts, New Perspectives for the 21<sup>st</sup> Century, John Wiley & Sons, 2003.
5. I. Ojima, Catalytic Asymmetric Synthesis, 2<sup>nd</sup> edition, Wiley–VCH, New York, 2000.
6. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press, 2001.
7. R. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.
8. L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.
9. Green chemistry, Theory and Practical, Paul T. Anastas and John C. Warner.
10. New trends in green chemistry By V.K. Ahulwalia and M. Kidwai.
11. Organic Synthesis: Special techniques. V.K. Ahulwalia and Renu Aggarwal



**UNIT-I****<sup>13</sup>C NMR spectroscopy**

CW and PFT techniques. Types of <sup>13</sup>C NMR spectra: undecoupled, proton- decoupled and offresonance decoupled (ORD) spectra. <sup>13</sup>C chemical shifts, factors affecting the chemical shifts, chemical shifts of organic compounds. Calculation of chemical shifts of alkanes, alkenes and alkynes. Homonuclear (<sup>13</sup>C-<sup>13</sup>C J) and heteronuclear (<sup>13</sup>C-<sup>1</sup>H J and <sup>13</sup>C- <sup>2</sup>H J) coupling. Applications of <sup>13</sup>C-NMR spectroscopy: Structure determination.

**UNIT-II**

**2D-NMR techniques:** Principles of 2D NMR, Classification of 2D-experiments. Correlation spectroscopy (COSY) HOMO COSY (<sup>1</sup>H-<sup>1</sup>H COSY), TOCSY (Total Correlation Spectroscopy), Hetero COSY (<sup>1</sup>H, <sup>13</sup>C COSY, HMQC), long range <sup>1</sup>H, <sup>13</sup>C COSY (HMBC), Homonuclear and Heteronuclear 2D-J-resolved spectroscopy, NOESY.

**UNIT-III**

**Optical Rotatory Dispersion (ORD) and CD Spectroscopy:** Optical rotation, circular birefringence, circular dichroism and Cotton effect. Plain curves and anomalous curves. Empirical and semiempirical rules-The axial haloketone rule, the octant rule, Helicity rule. Application of the rules to the study of absolute configuration and conformations of organic molecules.

**UNIT-IV****Structure determination and stereochemistry of natural products by spectral methods**

Spectroscopic techniques IR, UV, <sup>1</sup>H NMR, <sup>13</sup>C NMR, COSY, HETEROCOSY, NOESY, 2D INADEQUATE and MS in the structure elucidations of natural products: flavones, biflavones, flavanones, isoflavones, coumarins, quinolines, isoquinolines.

**UNIT-V**

**Study of the following solved problems:** Mass, IR, <sup>1</sup>H, <sup>13</sup>C NMR, HOMOCOSY, HECTOR, DEPT, 2D-INADEQUATE and NOE of Geraniol, INEPT of menthol, APT of apparicine, Heteronuclear 2D-J resolved spectrum of stricticine, NOESY of buxaquamarine, HETEROCOSY of strictanol, 2D-INADEQUATE of α-picoline and β-methyl tetrahydranfuran.

**Suggested Text books:**

1) Spectroscopic Methods in Organic Chemistry. Forth Edition D.M. Williams and I. Fleming Tata - McGraw Hill, New Delhi, 1990 for all spectral methods. Except ORD and CD and ESR.

2) Organic Spectroscopy, Second Edition, W.Kemp, ELBS Macmillan, 1987 for ORD and CD and ESR.

**Books for Reference:**

1) Book 2 mentioned above.

2) Applications of absorption spectroscopy of Organic Compounds J.R.Dyer, Prentice Hall of India, New Delhi, 1984.

3) Spectrometric identification of Organic Compounds, Fourth Edition, R.M.Silverstein: G.C.Vassillir and T.C. Merrill, John Wiley, Singapore, 1981.

4) For ORD and CD "Applications of Optical rotation and Circular Dichroism", G.C. Barret, in "Elucidation of Organic structures by Physical and Chemical Methods" Part I (Eds) K.W. Bentley and G.W.Kirty John Wiley, 1972, Chapter VIII (only those aspects mentioned in the syllabus).

**UNIT-I**

**Organo Silanes:** Synthetic applications of trimethylsilyl chloride dimethyl-t-butylsilyl chloride, trimethylsilyl cyanide, trimethylsilyl iodide and trimethylsilyl triflate, synthetic applications of silyl carbanion and  $\beta$ -silyl carbonium ions.

**UNIT-II**

**Polymers:** Introduction to organic polymers, general properties and classification of polymers. Methods of polymerization: (a) Addition polymerization: Definition, synthesis and applications, vulcanization. (b) Condensation polymerization: Definition, synthesis and applications (c) Radical polymerization: Definition, synthesis and applications. (At least two examples in each category). Ziegler-Natta polymerization.

**UNIT - III****Synthetic Strategies I**

Synthetic Strategies; Introduction, Terminology: target, synthon, synthetic equivalent, functional group interconversion (FGI), functional group addition, functional group elimination. Linear and convergent synthesis. Criteria for selection of target. Retrosynthetic analysis and synthesis involving chemoselectivity, regioselectivity, reversal of polarity and cyclizations. Order of events in synthesis by retrosynthetic approach, explanation with examples Salbutamol, Propoxycaïne and Dinocap.

**UNIT - IV****Synthetic Strategies II**

Introduction to one group C-C and C-X disconnections. One group C-C disconnections, Alcohols and carbonyl compounds. One group C-X disconnections, Carbonyl compounds, alcohols, ethers and sulphides.

Protecting groups- Principles of protection of alcohols, amine, carbonyl and carboxyl groups.

**UNIT-V:****Synthetic Strategies-III**

Introduction to two group C-C and C-X disconnections, Two group C-X disconnections; 1,1-difunctionalised, 1,2-difunctionalised and 1,3-difunctionalised compounds. Two group C-C disconnections; Diels-Alder reaction, 1,5-difunctionalised compounds, Michael addition and Robinson annulation. Control in carbonyl condensations, explanation with examples oxanamide and mevalonic acid.

**Suggested Books for Reference:**

1. Some Modern Methods of Organic Synthesis W. Carruthers, Third Edition, Cambridge University Press, Cambridge, 1988.
2. Organic Synthesis: The disconnection approach, S. Warrant John Wiley & sons, New York, 1984.
3. Modern Synthetic Reactions, Herbert O. House, Second Edition, W.A. Benzamine Inc. Menio Park, California, 1972.
4. Principle of Organic Synthesis- R.O.C. Norman and J. M. Coxon.(ELBS)
5. Organic Synthesis: Special techniques. V.K.Ahulwalia and Renu Aggarwal.
6. Organic Synthesis by C Willis and M Willis
7. Problems on organic synthesis by Stuart Warren

**UNIT-I**

Isolation, structure, stereochemistry, synthesis, biosynthesis and biological properties of Prostaglandins: PGE<sub>1</sub>, PGE<sub>2</sub> and PGE<sub>3</sub>; Structure, stereochemistry, synthesis and biological properties of podophyllotoxin, etoposide and rotenone.

**UNIT-II**

Isolation, structure, stereochemistry, synthesis, and biological properties of steroids: cholesterol, progesterone, ergosterol and stigmasterol.

**UNIT-III**

Isolation, structure, stereochemistry, synthesis, and biological properties of Alkaloids: strychnine, colchicines and camptothecin.

**UNIT-IV**

Nucleic acids: Basic concepts of the structures of RNA and DNA and their hydrolysis products nucleotides, nucleosides and heterocyclic bases.

**UNIT-V**

Enzymes: general nature, nomenclature and classification of enzymes. Cofactors, specificity of enzyme action, mechanism of enzyme action.

**Reference Material:**

- 1) Organic Chemistry, Volume 2, Stereochemistry and chemistry of natural products, I.L. Finar, 5<sup>th</sup> Edition. ELBS.
- 2) Chemical Aspects of Biosynthesis, John Mann, Oxford University Press, Oxford, 1996
- 3) Chemistry of Natural Products. A Unified Approach, N.R. Krishnaswamy, University Press (India) Ltd., Orient Longman Limited, Hyderabad, 1999.
- 4) Chemistry of natural products, S. V. Bhat, Narosa Publishing House, 6<sup>th</sup> reprint 2010.

**Organic Chemistry Practical – I**

**Code: SOC-405**

**Max. Marks: 150**

**Title of practical:** Separation of binary organic mixture, identification of functional groups and preparation of its derivatives (At least two solid derivatives for each compound).

**Organic Chemistry Practical – II:**

**Max. Marks: 50**

Comprehensive Viva

**Code: SOC-406**

**Suggested Books:**

- 1) Vogels text book of Practical Organic Chemistry, V edition by B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Pearson Education

# Dr. B. R. Ambedkar University - Srikakulam

Department of Chemistry

M.Sc.(Final) Analytical Chemistry Syllabus

III Semester

## Paper - I: Separation Methods – I

(Effective from 2019-2020 Admitted batch)

### Unit – I Chromatography - 1

**Chromatography:** classification of different chromatographic methods, methods of development-Elution development, Gradient elution development, displacement development, and frontal analysis.

Principles of chromatography, different migration, adsorption phenomena, partition, adsorption coefficient, retardation factor, retention time and volume, column capacity, temperature effects, partition isotherm.

### Unit - II Chromatography – 2

Dynamics of chromatography-efficiency of chromatographic column, zone spreading, High Equivalent Theoretical Plate (HETP), Van Deemter equation, resolution, choice of column, length and flow velocity, qualitative and quantitative analysis.

**Column chromatography (adsorption chromatography):** principles, general aspects, adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications.

### Unit - III Chromatography – 3

**Gel Exclusion chromatography or Gel filtration chromatography:** principles, properties of xerogels, apparatus and detectors, resolution of gel type, applications to organic compounds.

**Capillary Electrophoresis :** Principle, Details of the Instrument, Applications to Inorganic and Organic compounds.

**Gas chromatography:** Theory, Instrument description of equipment and different parts, columns (packed and capillary columns), detector specifications-thermal conductivity detector, flame ionization detector, electron capture detector, nitrogen-phosphorus detector, photo ionization detector, programmed temperature gas chromatography; applications in the analysis of gases, petroleum products etc., other detectors used their Principles and Applications.

## Unit – IV Chromatography – 4

***Inorganic molecular sieves:*** structure of zeolites, crystals, types of sieves, application in the separation of gases including hydrocarbons, ion exclusion-principles and applications,

Counter current chromatography-principles and application, Affinity chromatography-principles and applications

### GC-MS – Introduction

Instrumentation – GC – MS interface – Mass spectrometer (MS) Instrument operation, processing GC – MS data – ion chromatogram Library searching – Quantitative measurement – sample preparation Selected ion monitoring – Application of GC-MS for Trace constituents. Drugs analysis, Environmental analysis and others.

## Unit – V Chromatography – 5

***Liquid-liquid partition chromatography:*** principle, supports, partitioning liquids, eluents, reverse phase chromatography, apparatus, applications

***High performance liquid chromatography:*** Theory, Instrument description of the different parts of the equipment, columns, detectors-UV detector, refractometric detector, Fluorescence detector, Diode Array detector, applications in the separation of organic compounds, names of other detectors used their Principles and Applications.

***LC-MS*** – Introduction – Instrumentation – liquid chromatograph – Mass spectrometer Interface – Instrumental details – Processing LC-MS data – ion chromatograms – Library searching – Quantitative measurements.

Sample preparation – selected ion monitoring. Application of LC-MS for Drug analysis, Environmental samples and others.

### Text books:

1. R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
2. M.N. Sastri, Separation methods, Himalaya Publishing Company, Mumbai

### Reference books:

1. E. Helfman, Chromatography, Van Nostrand, Reinhold, New York
2. E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.
3. Chemical separation methods, John A Dean, Von Nostrand Reinhold, New York
4. R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
5. H.M Mc Nair and J. M. Miller, Basic Gas Chromatography, John Wiley, New York
6. W. Jeumings, Analytical Gas chromatography, Academic Press, New York
7. H. Eugelhardt (ed), Practice of HPLC, Springer Verrag, Berrin



**Dr. B. R. Ambedkar University - Srikakulam**  
**Department of Chemistry**  
**M.Sc.(Final) Analytical Chemistry Syllabus**  
**III Semester**

**Paper- II: Quality control and Traditional methods of Analysis-I**

(Effective from 2019-2020 Admitted batch)

**Unit – I: Quality control in Analytical Chemistry**

- (a) **Characteristics of an analysis:** quality of an analytical procedure, limit of detection, sensitivity, safety, cost measurability, selectivity and specificity, quality control-principles of Ruggedness test, control charts, Youden plot, and ranking test.
- (b) **Evaluation and reliability of analytical data:** limitation of analytical methods, accuracy, precision, errors in chemical analysis, classification of errors, minimization of errors, significant figures, computations and propagation of errors.
- (c) **Statistical analysis:** Mean deviation, Standard deviation, coefficient of variance, normal distribution, F test, T test, rejection of results, presentation of data.
- (d) **Quality assurance and management systems:** elements of quality assurance, quality assurance in design, development, production and services, quality and quantity management system, **ISO 9000** and **ISO 14000** series-meaning of quality, quality process model, customer requirement of quality calibration and testing, statistical process control, process control tools, control chart, statistical quality control, acceptance sampling.

**Unit – II: Quality control in Analytical Chemistry and Introduction to Decomposition techniques in analysis**

Good laboratory practices (GLP) – need for GLP, GLP implementation and organization, GLP status in India. Brief out line of ICH guide lines on drug substances and products. Principle of decomposition and Dissolution. Difference between dissolution / decomposition of Organic and Inorganic substances. Importance of Decomposition Techniques in Analysis.

**Decomposition techniques for Organic Compounds analysis**

Principles of solubility of organic compounds, non polar, polar solvents.

Recrystallisation methods and application of solubility and Recrystallisation.

### **Unit – III Decomposition techniques for Inorganic Compounds analysis**

Principle of Dissolution of an inorganic substance.

Decomposition of samples with acids –  $\text{H}_2\text{O}$ ,  $\text{HCl}$ ,  $\text{HF}$ ,  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$  and  $\text{HClO}_4$

Decomposition of samples by fusion, Principle and with two examples each

Alkali Fusion---  $\text{Na}_2\text{CO}_3$ ,  $\text{NaOH}$ ,

Acidic Fusion--- Sodium Hydro Sulphate, Sodium Pyro Sulphate

Oxidation Fusion--- $\text{Na}_2\text{O}_2$ , Sodium Chlorate

Reductive Fusion  $\text{Na}_2\text{CO}_3 + \text{Na}_4\text{BO}_4$

What is Sintering process, How is it different from Fusion.

Fusion with alkali carbonates, alkali hydroxides, Sodium Peroxide

Decomposition of samples by sintering with sodium peroxide, sodium carbonate.

Principles of decomposition at high temperatures, high pressures .

Principles of Microwave and ultrasonic decomposition techniques.

### **Unit – IV Oxidant systems – Principles and applications in analysis**

Analytical chemistry of some selected oxidant systems – formal, standard and normal potentials in various media, species responsible for the oxidation properties, stability of the solutions, standardization, requirement for the selections of the oxidants, selection of suitable indicators for Oxidant systems.

a) Inorganic Systems Mn (III), Mn (VII), Ce (IV), Cr (VI), V (V), periodate, iodate,

b) Organic Systems chloramine-T.

### **Unit – V Organic Functional group analysis**

Classification of functional groups with suitable examples.

Determination of:

- 1) Functional groups imparting acidic nature – thiol, enediol, phenolic hydroxyl.
- 2) Functional groups imparting basic nature – Aliphatic and Aromatic primary, secondary and tertiary amines – hydrazine derivatives.
- 3) Functional groups which impart neither acidic nor basic nature – Aldehydes, Ketones, Nitro, Methoxy, Olifinic.

**Text books:**

1. Technical methods of analysis – Griffin, Mc Graw Hill Book Co.
2. Chemical Separation and measurements – D.G Peterseti, John M.Haves Sanders Co.
3. Chemical analysis – H.A Laitinan, Mc Graw Hill Book Co.
4. Newer redox titrants – Berka, Zyka and Vulterin, Pergamon Press
5. Volumetric Analysis, Vol III – I.M Kolthoff and R. Belcher, Interscience Public, New York
6. Vogel's Text Book of Inorganic Quantitative Analysis – J. Bassett et al, ELBS
7. Organic functional groups – S. Siggia

**Reference Books:**

1. D.A Skoog, D.M West and F.J Holler, Analytical Chemistry, An Introduction, Sanders College Publishing, New York
2. K.V.S.G Murali Krishna, An Introduction ISO 9000, ISO 1400 Series, Environmental Management
3. Quality Assurance and Good Laboratory Practices, Prof. Y. Anjaneyulu, In Now Publication, New York
4. Quality Assurance in Analytical Chemistry – G.Kateman and F.W Pijpers, John Wiley and Sons, New York
5. Quantitative Chemical Analysis – I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London
6. Decomposition Techniques in Inorganic Analysis – J.Dolezal, P.Povondra, Z.Sulcek

**Dr. B. R. Ambedkar University - Srikakulam**  
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**III Semester**  
**Paper – III: Applied Analysis-I**

(Effective from 2019-2020 Admitted batch)

***Unit – I Analysis of Ores-1***

- (a) General techniques of analysis applied to complex materials - Scope of metallurgical analysis -  
General methods of dissolution of complex materials - Various chemical methods for the effective separation of the constituents in the complex materials.
- (b) Analysis of ores: Iron ore- Analysis of the Constituents – Moisture , loss of ignition, Total Iron, ferrous Iron ,Ferric Iron, alumina , silica, Titania, Lime, Magnesia, Sulphur, phosphorous, manganese, alkalies, combined water, Carbon in blast furnace, flue dust and sinter.
- (c) Manganese Ore - Analysis of the Constituents – Total Manganese, MnO<sub>2</sub>, SiO<sub>2</sub>, BaO, Fe<sub>2</sub> O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, CaO, P and S

***Unit – II Analysis of Ores-2***

- (d) Chromite Ore - Analysis of the Constituents – Chromium, SiO<sub>2</sub>, FeO, Al<sub>2</sub>O<sub>3</sub> CaO,& MgO.
- (e) Phosphate rock Ore - Analysis of the Constituents - CaO,P<sub>2</sub>O<sub>5</sub>, F, SiO<sub>2</sub>,CO<sub>2</sub>,S, Na<sub>2</sub>O, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub> O<sub>3</sub>, Mgo,K<sub>2</sub>O,Cl,MnO. Organic carbon, Moisture, Loss of ignition.
- (f) Aluminium Ore (Bauxite) - Analysis of the Constituents – Silica, Alumina, Fe<sub>2</sub>O<sub>3</sub>,Titania, MnO, P<sub>2</sub>O<sub>5</sub>, CaO, MgO, vanadium, zirconium, and alkalies.

***Unit – III Analysis of Finished Products – I***

- (a) Analysis of steel for C, Si ,S, P, Mn, Ni, Cr; Mg and analysis of blast furnace slag .  
(b) Analysis of refractory materials: fire clay, flour spar, and magnesite

(c) Analysis of fluxes - limestone and dolomite.

#### **Unit – IV Analysis of Finished Products – II**

(a) Chemical Analysis of cement-silica,  $\text{NH}_4\text{OH}$  group, ferric oxide, alumina, lime, magnesia, Sulphide Sulphur,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$ , free CaO in Cement and Clinker,  $\text{SO}_3$  and loss on ignition.

(b) Analysis of oils - saponification number, iodine number, and acid number..

(c) Analysis of soaps - moisture, volatile matter, total alkali, total fatty matter, free caustic alkali or free fatty acids, sodium silicate, chloride.

(d) Analysis of paints-vehicle and pigment,  $\text{BaSO}_4$ , total lead and lead chromate

#### **Unit – V Assessment of water Quality**

Sources of water, classification of water for different uses, types of water pollutants and their effects,

Analytical methods for the determination of the following ions in water:

Anions:  $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{CN}^-$ ,  $\text{S}^{2-}$

Cations:  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Cr}^{3+}$ ,  $\text{As}^{5+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Hg}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Co}^{2+}$

Determination of Dissolved oxygen (D.O), Biochemical Oxygen Demand (BOD) and

Chemical Oxygen Demand (COD), standards for drinking water.

#### **Text books**

1. Handbook of Analytical Control of Iron and Steel Production, Harrison John, Wiley 1979
2. Standard methods of Chemical Analysis, Welcher
3. Technical Methods of Analysis, Griffin, Mc Graw Hill
4. Commercial Methods of Analysis, Foster Dee Sneel and Frank M. Griffin, Mc Graw Hill Book Co.
5. Water Pollution, Lalude, Mc Graw Hill
6. Environmental Chemistry, Anil Kumar De, Wiley Eastern Ltd.
7. Environmental Analysis, S.M. Khopkar (IIT Bombay)

**Dr. B. R. Ambedkar University - Srikakulam**  
**Department of Chemistry**  
**M.Sc.(Final) Analytical Chemistry Syllabus**  
**III Semester**  
**Paper – IV: INSTRUMENTAL METHODS OF ANALYSIS - I**

(Effective from 2019-2020 Admitted batch)

**Unit – I : Spectroscopic Methods - 1**

*UV-Visible Spectroscopy:* laws of absorption, deviation from Beer's law, single and double beam spectrophotometers-instrumentation, sources of radiation, detectors, qualitative analysis by absorption measurements, general precautions in colorimetric determinations, determination of certain metal ions by using ligands –  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{NH}_4^+$ ,  $\text{Cr}^{3+}$ ,  $\text{Cr}^{6+}$ ,  $\text{Co}^{3+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Ni}^{2+}$  and anions –  $\text{NO}_2^-$ ,  $\text{PO}_4^{3-}$  using suitable reagents, simultaneous determinations of dichromate and permanganate in a mixture, spectrophotometric titrations, principle of diode array spectrophotometers.

**Unit – II : Spectroscopic Methods - 2**

*Spectrofluorimetry:* Theory of fluorescence, phosphorescence, factors affecting the above, quenching, relation between intensity of fluorescence and concentration, instrumentation, application with reference to  $\text{Al}^{3+}$ , chromium salts, fluorescence, thiamin (B1) and riboflavin (B2) in drug samples.

*Infrared spectroscopy:* units of frequency, wavelength and wave number molecular vibrations, factors influencing vibrational frequencies, instrumentation, sampling techniques, detectors, characteristic frequencies of organic molecules, qualitative and quantitative analysis with reference to (petroleum refinery and polymer industry), selected molecules like CO,  $\text{CO}_2$ , non-destructive IR method for the analysis of CO and other organic compounds, principles of Fourier transform IR.

**Unit – III : Spectroscopic Methods - 3**

*NMR Spectroscopy:* resonance condition, origin of NMR spectra, instrumentation, chemical shift, factors affecting chemical shift, shielding, spin-spin splitting, mechanism for spin-spin coupling, interpretation of NMR spectra of typical organic compounds, factors influencing NMR spectra, fast chemical reactions, magnitude of I, nuclei with quadrupole moments, FT NMR, study of isotopes other than proton- $^{13}\text{C}$ ,  $^{15}\text{N}$ ,  $^{19}\text{F}$ ,  $^{31}\text{P}$ ,  $^{11}\text{B}$ , double resonance, spin tickling, shift reagents, applications.

## **Unit – IV : Spectroscopic Methods - 4**

**ESR Spectroscopy:** principle, g value, hyper fine splitting, qualitative analysis, Kramers degeneracy, fine splitting, instrumentation, introduction to double resonance technique, difference between ESR and NMR spectra, quantitative analysis, application to study of free radicals and other analytical applications.

**Raman Spectroscopy:** Raman effect and spectra, differences between Raman spectra and IR spectra, instrumentation, Raman spectra of CO, CO<sub>2</sub>, N<sub>2</sub>O, H<sub>2</sub>O.

## **Unit – V : Mass Spectrometry and -X Spectroscopy**

**Mass Spectrometry:** Principle, basic instrumentation, energetics of ion formation, types of peaks observed, resolution, qualitative analysis, molecular weight determination, quantitative analysis, advantages

**X-ray Spectroscopy (XRF):** chemical analysis by X-ray spectrometers, energy dispersive and wavelength dispersive techniques, evaluation methods, instrumentation, matrix effects, applications.

### **Text Books:**

1. Instrumental methods of analysis – H.H Willard, Meritt Jr. and J.A Dean
2. Principles of instrumental analysis – Skoog and West
3. Vogels Textbook of Quantitative Inorganic analysis – J. Basset, R.C Denney, G.H Jefferey and J.Madhan
4. Instrumental methods of analysis – B.K Sarma, Goel Publishing House, Meerut
5. Instrumental methods of Analysis – Chatwal and Anand
6. Instrumental methods of Analysis – Ewing
7. Handbook of ICP
8. The ICP – Bogdain B.

### **Reference Books:**

1. Applications of ICP-MS, A.R Date and A.L Glay, London (Eds), Blackie, London
2. A. Moutaser and D.W Golightly (Eds), ICP in Analytical Atomic Spectrometry, VeH Publishers, New York
3. G.I Moore, Introduction to ICP emission Spectrometry in Analytical Spectroscopy, Elsevier, Amsterdam

# Practical

## Practical – 1: Classical Methods of Analysis

1. Water Analysis
  - (i) Analysis of water for total hardness ( $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$ )
  - (ii) Analysis of water for Chloride ( $\text{Cl}^-$ )
  - (iii) Analysis of water for Alkalinity ( $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ )
  - (iv) Analysis of dissolved oxygen in drinking water and sewage water
  - (v) Analysis of Chemical Oxygen demand (COD) in drinking water and sewage water
2. Fertilizer Analysis
  - (i) Analysis of fertilizer for ammonia, nitrate and phosphate
3. Analysis of iron ore
  - (i) Complete analysis of iron ore
  - (ii) Analysis of iron ore (with special reference to percentages of Fe (II) and Fe (III) present in the sample)
4. Complexometric titrations
  - (i) Analysis of Zinc in Zinc ore by using EDTA
  - (ii) Analysis of nickel by EDTA
  - (iii) Analysis of limestone or dolomite
5. Analysis of Oils, fats and Soaps
  - (i) Analysis of oil for the determination of saponification value, acid value and iodine value
  - (ii) Analysis of soaps for moisture content and total alkali.
6. Analysis of Coal
  - (i) Moisture content
  - (ii) Volatile matter
  - (iii) Fixed carbon
  - (iv) Ash content



## **Demonstration Experiments**

### **Practical – 1**

1. Determination of ion-exchange capacity of a given anion or cation exchange resin
2. Separation of a mixture of indicators using TLC.
3. Separation of a mixture of carbohydrates using paper chromatography
4. Separation of a mixture of Cu, Ni, Zn and Mn by paper chromatography
5. Determination of BOD of water
6. Analysis of coal – moisture content, volatile organic carbon, ash content.

# **Dr. B. R. Ambedkar University - Srikakulam**

## **Department of Chemistry**

### **M.Sc.(Final) Analytical Chemistry Syllabus**

#### **IV Semester**

Paper-1: Separation Methods – II  
(Effective from 2019-2020 Admitted batch)

#### **Unit – I Chromatography - 6**

**Paper chromatography:** principle, papers as a chromatographic medium, modified papers, solvent systems, mechanism of paper chromatography, experimental technique, different development methods-ascending, descending, horizontal, circular spreading, multiple development, two dimensional development, reverse phase paper chromatographic technique-visualization and evaluation of chromatograms, applications.

**Thin layer chromatography:** principle, chromatographic media-coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, types of development, visualization methods, documentation, applications in the separation, HPTLC-principle, technique, applications.

#### **Unit – II Chromatography – 6**

**Ion Exchange:** principles of ion-exchange systems, synthetic ion-exchange resins, properties of anion and cation exchange resins, ion-exchange mechanism, ion-exchange equilibria, selectivity, ion-exchange capacity, applications of ion-exchangers in different fields.

**Ion exchange chromatography:** Principle, Equipment, Application Specifically Separations of Lanthanides, Actinides, amino acids.

#### **Unit-III Ion chromatography & Solvent Extraction**

**Ion chromatography:** principles of separation, instrumentation, detectors, separation of cations and anions, applications in the analysis of water and air pollutants.

**Solvent Extraction:** principles and processes of solvent extraction, Distribution Law and Partition coefficient, nature of partition forces, different types of solvent extraction systems – Batch extraction, Continuous extraction, Counter current extraction, solvent extraction systems, applications in metallurgy, general applications in analysis and pre-concentration, special extraction systems like crown ethers, super fluid and surfactant extractions-examples.

## Unit – IV Sampling of Solids and Liquids

**Sampling:** Basis of sampling, purpose of sampling, homogeneous and heterogeneous samples, statistical criteria for good sampling, sample size, sampling unit, gross sample, laboratory sample.

**Sampling of Solids:** Cone and Quartering method, Long pile and alternative shovel method, precautions in preservation of solid samples, sampling of metals and other solids rods, wires, sheets, plates, especially Gold, Silver, Iron and other metals.

**Sampling of different types of liquids:** different sampling techniques, sampling of drinking water, industrial effluents, precautions in sampling and preservation of collected liquid samples.

## Unit – V Sampling of Gases and Importance of Analytical chemistry

**Sampling of gases:** sampling and Preconcentration by adsorption or absorption method, instantaneous monitoring, sampling in samplers and subsequent monitoring, different types of gas samplers, precautions in preservation of samples, systematic sampling and random sampling.

**Importance of Analytical Chemistry to Industrial Research:** Importance of Qualitative and Quantitative analysis in research and development, industries and other branches of science.

Development and validation of an analytical method, units, concentrations, calculations, standards, chemical reactions, expressions of concentrations, importance of separation methods with examples.

### Text books:

1. R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
2. Separation methods, M.N Sastri, Himalaya Publishing Company, Mumbai

### Reference books:

1. E. Helfman, Chromatography, Van Nostrand, Reinhold, New York
2. E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.
3. Chemical separation methods, John A Dean, Von Nostrand Reinhold, New York
4. R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
5. E.Stahl, Thin layer chromatography, Academic Press, New York
6. James, G.Tartor (Ion chromatography)

**Dr. B. R. Ambedkar University - Srikakulam**  
**Department of Chemistry**  
**M.Sc.(Final) Analytical Chemistry Syllabus**  
**IV Semester**

**Paper – II: Traditional Methods of Analysis - II**

(Effective from 2019-2020 Admitted batch)

**Unit – I Precipitation methods - 1**

- (a) Crystal habit and super saturation, nucleation and crystal growth, homogeneous and heterogeneous nucleation, solubility and particle size, colloids, completeness of precipitation, effect of excess precipitant, pH, complex formation, temperature, purity of precipitates, aging.
- (b) *Co-precipitation and post precipitation* : theory of adsorption of salts having an ion in common with the main precipitate, co-precipitation in colloidal precipitates, adsorption of solvents, mixed crystal formation by occlusion and entrapment, re-precipitation with examples, Post-precipitation – theory of post-precipitation, examples of post-precipitation, conditions for obtaining pure and quantitative precipitates.
- (c) **Precipitation Titrations**: Principle, Indicators for precipitation titrations, determination of halides.

**Unit – II Precipitation methods - 2**

- (a) *Precipitation from Homogeneous Solution (PFHS)*: theory of PFHS, methods of PFHS – increase in pH, decrease in pH, cation release, anion release, reagent synthesis, change in oxidation state, photochemical reactions, precipitation from mixed solvents. Applications of PFHS methods.
- (b) *Gravimetric determinations*: nature of species, preparation of solutions, limitations, interferences, inorganic precipitants-chloride and sulphate, organic precipitants dimethyl glyoxime (DMG), oxine, benzidine, salicylaldehyde, benzoin oxime, sodium tetraphenyl boron, tetraphenyl arsonium chloride.
- (a) *Electro-gravimetric analysis*: principle, important terms in electrogravimetry, decomposition voltage or decomposition potential, over voltage and their importance, instrumentation, electrolysis at constant current, determination of  $\text{Cu}^{2+}$  by constant current electrolysis, electrolysis at controlled potentials, determination of Cu, Pb, Sn in brass and bronze by controlled potential electrolysis.

### **Unit – III Reductant system – Principles and applications in analysis**

Analytical chemistry of some selected reductant systems – formal, standard and normal potentials in various media, stability of the solutions, species responsible for the reduction properties, standardization, requirement for the selection of the reductants, selection of suitable indicators for various reductant systems,

- (a) Inorganic Systems – Cr (II), V (II), Ti (III), Sn (II), Fe (II) in  $H_3PO_4$  and hydrazine,
- (b) Organic Systems – hydroquinone and Ascorbic acid.

### **Unit – IV Analysis of some selected Drugs:**

Basic considerations of drugs – Classification

Determination of the following Drugs:

- 1) Acetyl salicylic acid ( Antipyretic – Analgesic )
- 2) Testosterone, progesterone and cortisone (Steroids and corticoids)
- 3) Sulphadiazine ( sulphadiazine)
- 4) Phenobarbitone (Barbituric acid derivatives)
- 5) Chloramphenicol, Benzyl penicillin and Tetracycline (Antibiotics)
- 6) Thiamine (B1), Riboflavin (B2) and ascorbic acid (c) [Vitamins]
- 7) Isoniazid ( Antimicrobial agents)
- 8) Methyldopa (Antihypertensive agents)
- 9) Metronidazole (Antiamoebic agents).

### **Text books:**

- 1. Technical methods of analysis – Griffin, Mc Graw Hill Book Co.
- 2. Chemical Separation and measurements – D.G Peterseti, John M.Haves Sanders Co.
- 3. Chemical analysis – H.A Laitinan, Mc Graw Hill Book Co.
- 4. Newer redox titrants – Berka, Zyka and Vulterin, Pergamon Press
- 5. Volumetric Analysis, Vol III – I.M Kolthoff and R.Belvher, Interscience Public, New York
- 6. Vogel's Text Book of norganic Quantitative Analysis – J.Bassett et al, ELBS
- 7. Pharmaceutical analysis – T. Higuchi, Brochmann hausfen

### **Reference Books:**

- 1. D.A Skoog, D.M West and F.J Holler, Analytical Chemistry, An Introduction, Sanders College Publishing, New York
- 2. Quantitative Chemical Analysis – I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London

# Dr. B. R. Ambedkar University - Srikakulam

## Department of Chemistry

### M.Sc.(Final) Analytical Chemistry Syllabus

#### IV Semester

#### Paper – III: Applied Analysis – II

(Effective from 2019-2020 Admitted batch)

#### Unit – I Analysis of non-ferrous alloys and Analysis of soils

(b) Analysis of non-ferrous alloys:

- (i) Brass – Analysis of the constituents – Cu, Zn, Sn, Pb and Fe.
- (ii) Bronze - Analysis of the constituents – Cu, Sn, Zn, Pb and Fe.
- (iii) Solder - Analysis of the constituents – Sn, Pb and Sb.

(c) Analysis of soils: sampling, determination of moisture, total N, P, Si, lime, humus nitrogen, alkali salts, soil absorption ratio.

#### Unit – II : Analysis of Ferro alloys :

- (i) Ferro silicon - Analysis of the constituents – Si, C, P, S
- (ii) Ferro vanadium - Analysis of the constituents – V, C, P, S, Si, Al.
- (iii) Ferro manganese - Analysis of the constituents – Mn, S, C, P, Si
- (iv) Silico manganese - Analysis of the constituents – Mn, S, C, P, Si
- (v) Ferro chromium - Analysis of the constituents – Cr, C, Si.

#### Unit – III Analysis of Soil, Fertilizer and Fuel and introduction to air pollution

(a) Analysis of fertilizers: ammonical fertilizers, Phosphate fertilizers, Nitrate fertilizers.

(b) Analysis of fuels: solid fuels-coal, proximate analysis, ultimate analysis, heating value, grading of coal based on Ultimate Heat Value(UHV).

(c) Composition of pure air, classification of air pollutants, toxic elements present in dust and their sources – collection of air samples.

#### Unit – IV Assessment of Air Quality

Sources, effects, control of pollution and chemical analysis for the following.

(a) Primary pollutants:

- (i) Carbon compounds - Carbon monoxide(CO) and Carbon dioxide(CO<sub>2</sub>).

- (ii) Sulphur compounds- sulphur dioxide ( $\text{SO}_2$ ), Sulphur trioxide ( $\text{SO}_3$ ) and Hydrogen Sulphide ( $\text{H}_2\text{S}$ ).
  - (iii) Nitrogen compounds - nitric oxide ( $\text{NO}$ ), and nitrogen dioxide ( $\text{NO}_2$ ),
  - (iv) Hydrocarbons - Aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH).
  - (v) Particulate matter - Respirable and Suspended particulate matter, Inorganic and Organic particulates.
- (b) Secondary pollutants - ozone ( $\text{O}_3$ ), peroxy acetyl nitrate (PAN), peroxy benzyl nitrate (PBN)
- (c) Standards for ambient air quality.

### **Unit- V Kinetic Methods of Analysis & Non aqueous Titrimetry**

- (a) Kinetic methods of analysis: introduction, slow reactions, catalyzed reactions, methods of determination of catalyst concentration, extrapolation method for the determination of catalyst, variable time method, fixed time method, examples for the determination of toxic metals and anions using some typical kinetic reactions.
- (b) Non aqueous titrimetry : Classification of solvents and titrations for non aqueous titrimetry- Types of reactions - Indicators .
- (i) Determination of acids
  - (ii) Determination of bases
  - (iii) Karl-Fisher reagent for the determination of moisture content in drugs and other samples.

### **Text books**

1. Chemical analysis – H.A Laitinan, Mc Graw Hill Book Co
2. Standard methods of Chemical Analysis, Welcher
3. Technical Methods of Analysis, Griffin, Mc Graw Hill
4. Commercial Methods of Analysis, Foster Dee Sneel and Frank M. Griffin, Mc Graw Hill Book Co.
5. Environmental Chemistry, Anil Kumar De, Wiley Eastern Ltd.
6. Environmental Analysis, S.M Khopkar (IIT Bombay)
7. Environmental Air Analysis, Trivedi and Kudesia, Akashdeep Pub.

# Dr. B. R. Ambedkar University - Srikakulam

## Department of Chemistry

### M.Sc.(Final) Analytical Chemistry Syllabus

#### IV Semester

#### Paper - IV: Instrumental Methods of Analysis -II

(Effective from 2019-2020 Admitted batch)

#### **Unit – I: Atomic Absorption Spectroscopy and Flame photometry**

**(a) Flame photometry:** theory, instrumentation, combustion flames, detectors, and analysis of Na, K, Ca, Mg

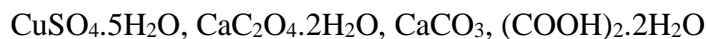
**(b) Atomic Absorption Spectroscopy:** theory, instrumentation, flame and non-flame techniques, resonance line sources, hollow cathode lamp, instrumentation, chemical and spectral interferences, applications with special reference to analysis of trace metals in oils, alloys and toxic metals in drinking water and effluents

**Unit – II: Inductively coupled plasma spectrometer(ICP-AES, ICP-MS):** principles, instrumentation, plasma, AES detectors, quadrupole mass spectrometers, difference between the two detectors, analysis methods for liquids and solids, applications in the analysis of trace and toxic metals in water, geological and industrial samples.

**Arc and Spark spectrographic Direct analysis of solid for metals.**

#### **Unit – III Thermal methods of Analysis**

**(a)** Thermo gravimetry-theory, instrumentation, applications with special reference to



**(b)** Differential thermal analysis-principle, instrumentation, difference between TG and DTA - applications with special reference to the clays and minerals, coals (fuels)

**(c)** Differential scanning calorimetry-principle, instrumentation, applications to inorganic materials like chlorates and per chlorates, ammonium nitrate, organic compounds and Drugs.

#### **Unit- IV : Electro analytical Methods of Analysis - 1**

**(a) Voltametry and polarographic analysis :** principle of polarography, residual current, migration current, diffusion current, half-wave potential, Ilkovic equation, instrumentation, Dropping mercury electrode (DME), advantages and disadvantages of DME, qualitative and quantitative analysis of inorganic ions-Cu, Bi, Pb, Cd, Zn, AC polarography, pulse polarography

**(b) Anode stripping voltametry:** principle, instrumentation, Hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltametry.



(c) *Coulometric analysis*: principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I<sup>-</sup> and S<sup>2-</sup> by using I<sub>2</sub> liberations and Ce<sup>4+</sup> liberation in solutions

#### **Unit – V Electro Analytical and Radio chemical methods of analysis - 2**

(a) *Ion Selective Electrodes*: reference electrodes - hydrogen electrode, calomel electrode, silver chloride electrode; indicator electrodes – hydrogen and glass electrodes, theory of membrane potentials and liquid junction potentials, types of ion selective electrodes, basic properties, potentials and construction, calibration of ion selective electrodes, ion selective electrodes with fixed membrane sites, silver, lead, cadmium, sulfide, fluoride, cyanide and glass electrodes, applications in the analysis of air and water pollutants, principles of liquid membrane, gas sensing and enzyme based electrode

(b) *Radio chemical methods of analysis*: detection and measurement of radioactivity, introduction to radioactive tracers, applications of tracer technique, isotope dilution analysis - applications, activation analysis – application, advantages and disadvantages, radio carbon dating technique

#### **Text Books:**

1. Instrumental methods of analysis – H.H Willard, Meritt Jr. and J.A Dean
2. Principles of instrumental analysis – Skoog and West
3. Vogels Textbook of Quantitative Inorganic analysis – J. Basset, R.C Denney, G.H Jefferey and J.Madhan
4. Instrumental methods of analysis – B.K Sarma, Goel Publishing House, Meerut
5. Instrumental methods of Analysis – Chatwal and Anand
6. Instrumental methods of Analysis – Ewing

#### **Reference Books:**

W.Wendtlandt, Thermal Analysis, John Wiley Sons, New York

## Practical

### Practical – II ( Instrumental Methods of Analysis)

1. pH metry
  - (i) Determination of alkalinity in a colored effluent using pH metric end point.
  - (ii) Determination of purity of commercial HCl, H<sub>2</sub>SO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub> and CH<sub>3</sub>COOH and using pH metric end point.
2. Conductometry
  - (i) Determination of a mixture of strong acid and week acid present in a colored effluent
3. Potentiometry
  - (i) Determination of Cr (VI) with Fe (II) using potentiometric end point
  - (ii) Determination of a mixture of Ce (IV) and V (V with Fe (II) using potentiometric end point
4. Spectrophotometry
  - (i) Determination of Fe (III) using KSCN
  - (ii) Determination of nitrite in drinking water samples
  - (iii) Determination of phosphate in fertilizer
  - (iv) Simultaneous determination of Cr (VI) and Mn (VII) in a mixture without separation
5. Flame photometry  
Determination of Na, K and Li.