MANGALORE UNIVERSITY
B.Sc. PROGRAMME
REVISED SYLLABUS [2024-25 ONWARDS}
COURSE PATTERN AND SCHEME OF EXAMINATION

CORE SUBJECT: CHEMISTRY

PREAMBLE

The Under-Graduate Board of Studies (UG BOS) in Chemistry has revised and prepared the syllabi (CBCS based) for the Six Semesters of B.Sc. Chemistry Programme to be implemented by Mangalore University from the year 2024-25. The syllabus includes core subject courses, discipline elective courses and skill enhancement courses carrying a total of 36, four and two credits respectively in the semesters I to VI of the programme.

A detailed skeleton of the entire programme is provided below for the benefit of the aspiring under graduate students.

Programme Structure for the Bachelor of Science (B.Sc.)

Semester	Course 1	Course 2	Course 3	Elective/ Optional	Language	Compulsory	Total Credit	Total Working hour
I	5 (3T+2P)	5 (3T+2P)	5 (3T+2P)	--	3+3	2	23	4+4+4+4+4+4+4+4+4+2=34
II	5 (3T+2P)	5 (3T+2P)	5 (3T+2P)	--	3+3	2	23	4+4+4+4+4+4+4+4+4+2=34
III	5 (3T+2P)	5 (3T+2P)	5 (3T+2P)	2	3+3		23	4+4+4+4+4+4+4+4+4+2=34
IV	5 (3T+2P)	5 (3T+2P)	5 (3T+2P)	2	3+3	2	25	4+4+4+4+4+4+4+2+4+4+2=36
V	8[(2x3T)+2P]	8[(2x3T)+2P]	8[(2x3T)+2P]	--		2	26	4+4+4+4+4+4+4+4+4+4+2=38
VI	8[(2x3T)+2P]	8[(2x3T)+2P]	8[(2x3T)+2P]	--		2	26	4+4+4+4+4+4+4+4+4+4+2=38
Grand Total							146	214

Practical Papers 2 credits – 4 contact hours

The details of courses offered under the core subject 'Chemistry' is given below. Other important aspects such as basis for internal assessment, pattern of theory question papers and the approximate dates of the internal examinations are also provided.

Core/ Elective	Course Code	Title of the Paper	Instruction Hours	Duration of the Exam (Hrs.)	Max. Marks			Credits
					Exam	IA	Total	
I Semester B.Sc.								
Group I Chemistry	BSCCHCS101	Chemistry Theory-I	4	3	80	20	100	3
	BSCCHPS101	Chemistry Practicals-I Volumetric Analysis	4	4	40	10	50	2
Total number of Credits for Core Subject (Chemistry) in I Semester: 05								
II Semester B.Sc.								
Group I Chemistry	BSCCHCS201	Chemistry Theory-II	4	3	80	20	100	3
	BSCCHPS201	Chemistry Practicals-II Qualitative Organic Analysis and Chromatography	4	4	40	10	50	2
Total number of Credits for Core Subject (Chemistry) in II Semester: 05								
III Semester B.Sc.								
Group I Chemistry	BSCCHCS301	Chemistry Theory-III	4	3	80	20	100	3
	BSCCHPS301	Chemistry Practicals-III Qualitative Analysis of Inorganic Salt mixture	4	4	40	10	50	2
Group II Discipline Elective (optional)	BSCCHES301	Laboratory Reagents, Domestic Chemicals and Safety	2	2	40	10	50	2
Total number of Credits for Core Subject (Chemistry) in III Semester: 05 Discipline Elective in III Semester: 02								
IV Semester B.Sc.								
Group I Chemistry	BSCCHCS401	Chemistry Theory-IV	4	3	80	20	100	3
	BSCCHPS401	Chemistry Practicals-IV Physical Chemistry Experiments	4	4	40	10	50	2
Group II Discipline Elective (optional)	BSCCHES401	Chemistry in Everyday Life	2	2	40	10	50	2
*Compulsory Skill/Practical	BSCCHSS401/ 501/601	Internship/Mini Project **(May be offered in IV or V or VI Semester)**	2	--	40	10	50	2
Total number of Credits for Core Subject (Chemistry) in IV Semester: 05 Discipline Elective in IV Semester: 02; *Compulsory/Skill/Practical: 02 (May be offered in either IV, V or VI Semester)								

V Semester B.Sc.								
Group I Chemistry	BSCCHCS501	Chemistry Theory-V	4	3	80	20	100	3
	BSCCHCS502	Chemistry Theory-VI	4	3	80	20	100	3
	BSCCHPS501	Chemistry Practicals-V Gravimetric analysis and Physical Chemistry Experiments	4	4	80	20	100	2
*Compulsory Skill/Practical	BSCCHSS401/ 501/601	Internship/Mini Project **(May be offered in IV or V or VI Semester)**	2	--	40	10	50	2
Total number of Credits for Core Subject (Chemistry) in V Semester: 08 *Compulsory/Skill/Practical: 02 (May be offered in either IV, V or VI Semester)								
VI Semester B.Sc.								
Group I Chemistry	BSCCHCS601	Chemistry Theory-VII	4	3	80	20	100	3
	BSCCHCS602	Chemistry Theory-VIII	4	3	80	20	100	3
	BSCCHPS601	Chemistry Practicals- VI Organic Preparations and Instrumental Methods	4	4	80	20	100	2
*Compulsory Skill/Practical	BSCCHSS401/ 501/601	Internship/Mini Project **(May be offered in IV or V or VI Semester)**	2	--	40	10	50	2
Total number of Credits for Core Subject (Chemistry) in VI Semester: 08 *Compulsory Skill/Practical: 02								
Total number of Credits for Core Subject (Chemistry) from I to VI Semester: 36 Discipline Elective: 04 *Compulsory Skill/Practical: 02 (May be offered in either IV, V or VI Semester)								

OBJECTIVES OF THE SYLLABUS

The revised syllabus is designed to provide both theoretical and practical knowledge in the field of chemistry with a special focus on skill enhancement. The syllabus takes into account the requirements of higher education, maintaining the quality of education and student competency level on par with national and international standards. The syllabus is structured to ensure that the students become aware of the practical applications of chemistry knowledge to build careers in the scientific field.

The syllabus aims to enable students to:

- To acquire knowledge and skills in the field of chemistry
- To generate manpower trained in chemistry to meet the need of industry and academia and to pursue higher studies
- To appreciate, understand and use the scientific method in the solving of problems

- To develop the ability to disseminate chemical information effectively
- To acquire good laboratory skills and practice safety measures while handling chemicals
- To understand safe disposal of chemical waste contributing to environmental sustainability
- To apply chemical knowledge to real world situations
- To develop their personality with the necessary skills
- To get good placement

Program Outcome

By the end of the program, the students will be able to

- Understand the applications of chemistry in various fields.
- Get the broad and balanced knowledge of chemistry.
- Develop practical skills which can be applied in actual practice.
- Get the knowledge necessary for employment and higher education.

Basis for Internal Assessment, Pattern of Theory Question Papers and Practical Examination

1. Basis of Internal Assessment in Theory and Practicals

The internal assessment marks in theory papers shall be based on two tests. The tests shall be at least 1 hour duration each and to be conducted after 6 and 12 weeks after the start of a semester. The average of the two tests shall be taken as the internal assessment marks in theory papers.

The practical internal assessment marks shall be based on one test and continuous evaluation during the practical classes. The practical test shall be conducted after 10 weeks after the start of a semester. The average of the test and continuous evaluation shall be taken as the internal assessment marks in practicals.

1. Theory Question Papers Pattern

Theory Question Papers shall carry 80 marks. The Question Paper shall consist of Parts A and B, as detailed below.

Part A: Part A Shall contain 12 short answer type questions (Q. No 1'a' to 'l') drawn from all the 4 units (3 questions per unit) carrying 2 marks each. 10 questions are to be answered (10x2=20 marks.)

Part B: Part B shall contain eight questions (Q. Nos 2 to 9) carrying 15 marks each drawn from all the four units (2 questionsper units). There shall be four divisions per question. The students are required to answer 4 questions, choosing one full question from each unit (4x15=60 marks).

	Unit I		Unit II		Unit III		Unit IV	
Q. Nos. (Max. Marks: 15)	2	3	4	5	.6	7	8	9
Marks Splitting	3+4+4+4	3+3+4+5	3+4+4+4	3+3+4+5	3+4+4+4	3+3+4+5	3+4+4+4	3+3+4+5

3. Scheme of Practical Examination and Valuation Procedure for B.Sc. Chemistry Practicals

First Semester B.Sc. Chemistry Practicals–I

Duration: 4 Hours **Max. Marks: 40 (Practical-30 & Class Record-10)**

Valuation Scheme

The practical examination shall consist of the following:

Q1. Exercise set for procedure writing **10 Marks**

Outline of the procedure including calculations to be written within the first 15 minutes.

Any one of the exercises may be given for this purpose, irrespective of whether the Candidate has carried out experiment or not.

Estimation of manganese in pyrolusite by volumetric method.

2. Estimation of glucose using iodine and sodium thiosulphate.
3. Estimation of vitamin-C.
4. Determination of acetic acid in Vinegar using NaOH.
5. Determination of alkali content in antacid tablet using HCl

Q2. Exercise to be set for actual estimation **20 Marks**

Any one of the following exercises is to be set for actual estimation. Examiners shall provide the candidates a detailed procedure for the exercise set:

1. Preparation of standard decinormal solution of sodium carbonate and standardization of hydrochloric acid and estimation of sodium hydroxide in solution.
2. Preparation of standard decinormal solution of potassium biphthalate and standardization of sodium hydroxide solution and estimation of hydrochloric acid in solution.
3. Preparation of standard decinormal solution oxalic acid and standardization of potassium permanganate solution and estimation of Mohr’s salt in solution.

4. Preparation of standard decinormal solution of ferrous ammonium sulphate (Mohr's salt) and standardization of potassium dichromate solution and estimation of ferric chloride in solution.

5. Preparation of standard decinormal solution of potassium dichromate and standardisation of sodium thiosulphate solution and estimation of copper sulphate in solution.

6. Estimation of a mixture of oxalic acid and sulphuric acid in a solution using potassium permanganate solution and standard sodium hydroxide solution.

Note: a) AR/GR chemicals should be used for preparing the stock solutions and reagents.

b) At least grade B pipette should be used.

c) The candidates must be provided with 250cm volumetric flask and 25 cm pipettes.

d) The different volumes (in the range 20-30 cm^3) of 1N solutions meant for estimation should be pipetted out by the examiners in 250 cm^3 volumetric flasks so that not more than 3 candidates in a batch get the same value of 1N solutions distributed.

1. Class Records **10 Marks**

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded: 7 Marks

Minimum ten exercises should be recorded. Marks are to be reduced proportionately for recording lower number of exercises as follows:

No. of exercises recorded	**Marks to be awarded**
10 and above	7
9	6
8	5
7	4
6	3
Less than 6	0

Repeated recording of the same experiments should not be considered.

ii) Marks for neatness: 3 Marks

2. Procedure Writing **10 Marks**

Essential details of procedure = 6 marks

Tabulation and calculation = 4 marks

3. Actual Estimation **20 Marks**

i) **Titre values** **16 Marks**

Errors	**Standardization** (Marks)	**Estimation** (Marks)
±0.2 cm^3	8	8
±0.3 cm^3	7	7
±0.4 cm^3	5	5
±0.5 cm^3	4	4
±0.6 cm^3	3	3
Any other value	2	2

NOTE: Candidates should retain only three titre values on each set of titrations out of which two concordant values are to be considered. All other values must be struck off by the candidates. If a candidate records more than three titre values, first three values are to be considered and extra titre values are to be ignored. In case the candidate records only one titre value, only 50% of the marks are to be awarded in each case. Examiners are requested to bring this to the notice of the candidates. Every burette reading shall be attested by one of the examiners.

ii) Calculations **4 Marks**

Normality of prepared solution	1 Mark
Normality of link solution	1 Mark
Final step	2 Marks

Second Semester B.Sc. Chemistry Practicals–II

Duration: 4 Hours **Max. Marks: 40 (Practical-30 & Class Record-10)**

Valuation Scheme

The practical examination shall consist of the following:

Q1. Exercise set for procedure writing **10 Marks**

Outline of the procedure to be written within first 15 minutes. Any of the exercise in the syllabus under chromatography may be given for this purpose, irrespective of whether the candidate has carried out the experiment or not.

A. Thin Layer Chromatography

1. Separation of green leaf pigments.

2. Separation of mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

B. Paper Chromatography: Ascending and Circular

1. Separation of mixture of phenylalanine and glycine, alanine and aspartic acid, Leucine and glutamic acid; Spray reagent – Ninhydrin.
2. Separation of mixture of D,L-alanine, glycine, L- Leucine using n-butanol-acetic acid-water (4:1:5); Spray reagent – Ninhydrin.

C. Column Chromatography:

1. Separation of Fluorescein and methylene blue.
2. Separation of leaf pigments from spinach leaves.

Q2. Exercise set for organic analysis **20 Marks**

Any one of the following compounds may be given for analysis:

Resorcinol, Oxalic acid, Urea, Thiourea, Benzoic acid, p-Cresol, p-Toluidine, Chlorobenzene, Bromobenzene, Nitrobenzene, Benzaldehyde, Acetophenone, Benzamide, Aniline.

1. Class Records **10 Marks**

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded: 7 Marks

Minimum ten exercises should be recorded. Marks are to be reduced proportionately for recording lower number of exercises as follows:

No. of exercises recorded	**Marks to be awarded**
10 and above	7
9	6
8	5
7	4
6	3
Less than 6	0

Repeated recording of the same experiments should not be considered.

ii) Marks for neatness: 3 Marks

2. Procedure writing **10 Marks**

i) Essential details of procedure: 8 Marks

ii) Calculations: 2 Marks

3. Organic analysis **20 marks**

Preliminary tests:	1 Mark
Physical constant (M.P/B.P):	3 Marks (less than 3% error)
Detection of element:	4 Marks (tests for N, S and halogens)
Solubility Tests:	4 Marks
Reactions of functional group:	6 Marks (any two)
Name and structure:	2 Marks

Third Semester B.Sc. Chemistry Practicals–III

Duration: 4 Hours **Max. Marks: 40 (Practical-30 & Class Record-10)**

Valuation Scheme

The practical examination shall consist of the following:

Q1. Written viva on qualitative analysis

a) Any one confirmatory test for acid radical-2 marks

b) Complete group analysis of basic radicals of any one group from I to VI– 4 marks

Q2. Exercise set for inorganic qualitative analysis (24 Marks)

a) Inorganic systematic qualitative analysis of the mixture of two simple salts containing two anions and two cations using semi micro technique.

b) A simple powdered mixture of inorganic salts containing two anions and two cations is to be prepared on the spot by examiners from simple salts having the following anions and cations.

Anions: CO_3^{2-}, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-} and PO_4^{3-} .

Cations: NH_4^+, Cu^{2+}, Pb^{2+}, Ag^+, Bi^{3+}, Cd^{2+}, Co^{3+}, Al^{3+}, Fe^{+3}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+ and K^+ .

Note:

1. Mixture requiring elimination of phosphate and borate radicals must be avoided (avoid cations such as Ba^{2+}, Ca^{2+}, Sr^{2+} and Mg^{2+} when borate or phosphate radicals are given).
2. Mixtures of salts which on double decomposition form precipitates insoluble in dilute HCl (like $BaSO_4$, $SrSO_4$, $PbSO_4$) should not be given.
3. Combinations like Cl^-, Br^-, I^-, NO_3^- and Br^-; NO_3^- and I^-; Cl^- and Br^-; Cl^- and I^-; Cl^- and NO_3^-; Br^- and I^- must be avoided.
4. The cations should belong to different groups. For example a combination of Ca^{2+} and Sr^{2+}; Ba^{2+} and Ca^{2+}; Ba^{2+} and Sr^{2+}; Mg^{2+} and Na^+; Na^+ and K^+; Mg^{2+} and Na^+; Al^{3+} and Mn^{2+}; Mn^{2+} and Zn^{2+}; Bi^{3+} and Cd^{2+} must be avoided.
5. AR and GR grade chemicals are used for preparing mixtures.

6. Different mixtures should be prepared and distributed to the candidates (by lots) so that not more than three candidates in a batch get the same mixture.
7. In case of cations, recording of tests are to be done until two cations are detected and confirmed.

1. Class Records **10 Marks**

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded: 7 Marks

Minimum ten exercises should be recorded. Marks are to be reduced proportionately for recording lower number of exercises as follows:

No. of exercises recorded	**Marks to be awarded**
10 and above	7
9	6
8	5
7	4
6	3
Less than 6	0

Repeated recording of the same experiments should not be considered.

ii) Marks for neatness: 3 Marks

2. Written viva on qualitative analysis: 6 Marks

a) Any one confirmatory test for acid radical: 2 Marks
b) Any one basic radical analysis : 4 Marks

Inorganic qualitative analysis

The radicals should be reported along with proper chemical tests done systematically.

Four radicals reported correctly	24 Marks
Three radicals reported correctly	18 Marks
Two radicals reported correctly	12 Marks
One radical reported correctly	06 Marks

Note:

1. For detecting only the group to which the cations belong, one mark for each correct group should be given.
2. If the acid radical is reported without the confirmatory test, only two marks to be given.
3. If more than four radicals are reported, reduce three marks for each extra radical reported.
4. In case of anions, confirmatory test is expected.
5. In case of cations confirmatory test is expected only in case of NH_4^{+}.
6. Flame test may be considered as one of the preliminary tests and not as a conclusive test for cation.
7. In case of anions, positive tests should be recorded in detail while the essential negative tests may be recorded in brief.

Fourth Semester B.Sc. Chemistry Practicals– IV

Duration: 4 Hours **Max. Marks: 40 (Practical-30 & Class record-10)**

Valuation Scheme

The practical examination shall consist of the following:

Q1. Written Viva **6 Marks**

Any one of the exercises prescribed for Practical IV excluding the actual experiment given for the examination may be given for this purpose.

Q2. Any one of the following physical chemistry experiments can be set for the actual experimental work: 24 Marks

1. Determination of density and surface tension of the given liquid (specific gravity bottle and stalagnometer to be supplied).
2. Determination of density and viscosity of the given liquid (specific gravity bottle and viscometer to be supplied).
3. Determination of molecular mass of the given non-volatile solute by Walker-Lumsden method (molecular mass of the solute should not be more than 140. Electrolyte such as KCI, NaCI, $BaCl_2$ $2H_2O$ also may be included).
4. a) Determination of miscibility temperature of the following systems.
   i) $5cm^3$ phenol+$4cm^3$ of water + $1cm^3$ of 1% NaCl solution
   ii) $5cm^3$ phenol+$3cm^3$ of water + $2cm^3$ of 1% NaCl solution
   iii) $5cm^3$ phenol+$2cm^3$ of water + $3cm^3$ of 1% NaCl solution
   iv) $5cm^3$ phenol+$1cm^3$ of water + $4cm^3$ of 1% NaCl solution
   v) $5cm^3$ phenol+$5cm^3$ of 1! NaCl solution of unknown concentration.

   b) From the data obtained, find out the unknown concentration of the sodium chloride solution graphically. (Pipettes with safety device be provided for piping out phenol).
5. Determination of specific reaction rate for the acid hydrolysis of methyl acetate at a given temperature using 0.5N HCI or 0.5N H_2SO_4 (acid to be provided by the examiners).
6. Determination of 1% of toluene in a mixture of toluene + alcohol by refractometry).

A) Class Records **10 Marks**

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded: 7 Marks

Minimum ten exercises should be recorded. Marks are to be reduced proportionately for recording lower number of exercises as follows:

No. of exercises recorded	Marks to be awarded
10 and above	7
9	6
8	5
7	4
6	3
Less than 6	0

Repeated recording of the same experiments should not be considered.

ii) Marks for neatness: 3 Marks

B. Written Viva **6 Marks**

Viva questions should be exclusively from the prescribed practical syllabus.

C. Physical chemistry experiments

Experiment 1: Density and Surface tension

Marking of density value

Errors ±1% : 10 Marks
±2% : 8 Marks
±3% : 7 Marks
±5% : 7 Marks
±10% : 3 Marks
Any other value: 2 Marks
Calculation : 2+2=4 Marks

Surface tension values

Errors upto±8% : 10 Marks
±8% to ±12% : 8 Marks
±12% to ±15% : 5 Marks
±15% to ±25% : 3 Marks
any other value : 2 Marks

Experiment 2: Density and Viscosity

Marking of density value

Errors ±1% : 10 Marks
±2% : 8 Marks
±3% : 7 Marks
±5% : 7 Marks
±10% : 3 Marks
Any other value: 2 Marks
Calculation : 2+2=4 Marks

Viscosity Values

Errors upto±5% : 10 Marks
±8% to ±7%: 8 Marks
±12%to ±9%: 5 Marks
±15%to ±12%: 3 Marks
any other value: 2 Marks

Experiment 3: Molecular Mass

Error up to ±10% : 20 marks
±10% *to* ± 15%: 18 marks
±15% *to* ± 20%: 16 marks
±20% *to* ± 25%: 12 marks
±25% *to* ± 30%: 8 marks
Any other value: 4 marks
Calculation : 4 marks

Note: Candidate shall not retain more than three values in the answer book. Out of which best two values are to be considered for valuation. If candidate records more than three values, first three recorded are be considered.

Experiment 4: Miscibility Temperature

a) 1% NaCl stock solution should be provided by the examiners.
b) Unknown concentration to be given should be in between 0.3% - 0.7%
c) Graph drawn : 4 marks
(Proportionate marks are to be deduced, if the graph is not properly drawn for the given set of points)
Error in concentration (unknown)
up to $\pm 5\%$: 20 marks
$\pm 5\% \; to \; \pm 8\%$: 18 marks
$\pm 8\% \; to \; \pm 12\%$: 16 marks
$\pm 12\% \; to \; \pm 15\%$: 12 marks
$\pm 15\% \; to \; \pm 20\%$: 8 marks
Any other value: 4 marks

Experiment 5: Chemical Kinetics

Graph drawn: 5 Marks Calculation: 5 Marks
Error up to $\pm 5\%$: 14 Marks
$\pm 5\% \; to \; \pm 10\%$: 12 Marks
$\pm 10\% \; to \; \pm 15\%$: 10 Marks
$\pm 15\% \; to \; \pm 20\%$: 8 Marks
Any other value: 3 Marks

Experiment 6: Analysis of a liquid mixture by Refractometry

a) Graph drawn: 4 Marks
Best straight line graph with at least 4 points: 4 Marks
Less than four points: 3 Marks
b) Percentage composition of the given mixture in the range
$\pm 5\%$: 20 Marks
$\pm 7\%$: 16 Marks
$\pm 9\%$: 12 Marks
$\pm 12\%$: 8 Marks
Any other values: 4 Marks

Standard binary liquid mixture of known compositions are to be prepared fresh by the candidates.

Unknown is given by the examiners.

Note: in all the above experiments if the calculation is wrong no marks to be given for calculation part, but the examiners are required to calculate the values and award the marks as per scheme.

Fifth Semester B.Sc. Chemistry Practicals–V

Duration: 4 Hours **Max. Marks: 80 (Practical-70 & Class Record-10)**

Valuation Scheme

The practical examination shall consist of the following:

Q1. Written Viva **15 marks**

Q2. Gravimetric Exercise **40 marks**

Examiners shall supply the solution in two 400cm³ beakers, for each of the candidates, such that the mass of the precipitate will be in the range of 0.2 to 0.3g. A brief outline of the procedure is to be given. The candidates are required to perform two trials each using the given solutions.

One of the following exercises may be set for the gravimetric exercise.

1. Estimation of barium as barium sulphate in barium chloride solution.
2. Estimation of copper as cuprous thiocyanate in copper sulphate solution.
3. Estimation of Ni as Nickel dimethyl glyoximate in nickel ammonium sulphate solution.
4. Estimation of iron as ferric oxide in ferrous ammonium sulphate solution.
5. Gravimetric estimation of chloride / silver as AgCl in $NaCl/AgNO_3$ solution.
6. Estimation of magnesium as oxinate in magnesium sulphate solution.

Q3. Colorimetry/Food Adulteration: **15 Marks**

One of the following experiments may be set:

a. To verify Beer-Lambert Law by Job's or Mole-ratio method

b. Detection of adulterants in any three food stuffs

Distribution of Marks

1. Class Records **10 Marks**

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded: 7 Marks

Minimum ten exercises should be recorded. Marks are to be reduced proportionately for recording lower number of exercises as follows:

No. of exercises recorded	Marks to be awarded
10 and above	7
9	6
8	5
7	4

6	3
Less than 6	0

Repeated recording of the same experiments should not be considered.

ii) Marks for neatness: 3 Marks

2. Written Viva **15 Marks**

Viva questions should be exclusively from the prescribed practical syllabus.

3. Gravimetric Exercise **40 Marks**

i) Marks for mass of precipitate

+2%	35 Marks
±3%	30 Marks
±4%	25 Marks
+5%	20 Marks
±6%	15 Marks
Any other value	10 Marks

ii) Calculation **5 Marks**

3. Colorimetry/Food Adulteration **15 Marks**

Experiment a)

i) Proper plot: 10 Marks

(Proportionate marks are to be deducted, if the graph is not properly drawn for the given set of points.)

ii) Tabulation and Calculation: 5 Marks

Experiment b)

Adulterated milk, ghee/butter, edible oil/sugar are to be given

Detecting adulterants in milk: 5 Marks

Detecting adulterants in ghee/butter: 5 Marks

Detecting adulterants in sugar/edible oil: 5 Marks

Sixth Semester B.Sc. Chemistry Practicals-VI

Duration: 4 Hours **Max. Marks: 80 (Practical-70 & Class Record-10)**

Scheme of Valuation

Q1. Exercise set for procedure writing **10 Marks**

Outline the procedure for preparation of any one of the following inorganic complexes with equation within 15 minutes.

a. Preparation of sodium trisoxalate ferrate (III), $Na_3[Fe(C_2O_4)_3]$

b. Preparation of copper tetraammine complex, $[Cu(NH_3)_4]SO_4$

c. Preparation of hexaammine cobalt (III) chloride, $[Co(NH_3)_6]Cl_2$

Q2. Prepare any one of the following organic compound, determine its melting point and present the crude and recrystallized sample for inspection. 15 Marks

a. Acetanilide
b. p-bromoacetanilide
c. Benzoic acid

Q3. Perform one of the following experiments 35 Marks

a) To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) conductometrically using standard alkali solution

b) To determine the equivalent conductance of sodium chloride by conductometric method.

c) Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the redox potential of Fe^{3+}/Fe^{2+} system on the hydrogen scale.

d) To determine the dissociation constant of a weak acid by potentiometric method

e) To determine the concentration of Cupric ions present in a solution using a colorimeter.

Q4. Viva to be conducted during practicals 10 Marks

Viva questions should be exclusively from the prescribed practical syllabus.

Distribution of Marks

1. Class Records 10 Marks

The records certified by the teacher in charge and head of the Chemistry Department should be valued by the examiners.

i) Marks for experiments recorded: 7 Marks

Minimum ten exercises should be recorded. Marks are to be reduced proportionately for recording lower number of exercises as follows:

No. of exercises recorded	Marks to be awarded
10 and above	7
9	6
8	5
7	4
6	3
Less than 6	0

Repeated recording of the same experiments should not be considered.

ii) Marks for neatness: 3 Marks

2. Procedure writing 10 Marks

Outline with essential details : 8 Marks
Chemical Equation : 2 Marks

3. Viva to be conducted during practicals 10 Marks

4. **Preparation of organic compounds 15 Marks**

i) Marks for preparation of crude sample: 7

ii) Yield (upto ±20% of theoretical value): 3 Any other value: 1
iii) Marks for recrystallization : 2
vi) Marks for melting point (upto ±3%) : 3 Any other value:1

5. Instrumental method **35 marks**

a. To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) Conductometrically using standard alkali solution

i) Graph (good plot):		10
other plots :		6
ii. Error in titrevalues :	±0.2 ml	10+10
	±0.3 ml	8+8
	±0.4 ml	6+6
	±0.5 ml	4+4
	Other values	2+2
iii. Calculation of strength:		4

b. To determine the equivalent conductance of sodium chloride by conductometric method

i) Cell constant	
Calculation:	2
Correct value:	3
ii) Equivalent conductance	
Calculation of equivalent conductance values:	15
iii. Graph (Proper plot):	10
other plot:	6
iv. Correct value of equivalent conductance at infinite dilution:	5

c. Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the redox potential of Fe^{3+}/Fe^{2+} system on the hydrogen scale

i) Graphs	(good plots)	16	(8+8)
	Other plots	8	(4+4)
ii) Error in titre value	±0.2ml	15	
	±0.3 ml	12	
	+0.4 ml	9	
	+0.5 ml	6	
	Other values	3	
iii. Calculation of redox potential		4	

d. To determine the dissociation constant of a weak acid by potentiometric method

i) Graph	(good plots)	10(5+5)
	Other plots	6 each
ii) Error in titre value	±0.2ml	15
	±0.3ml	12
	±0.4ml	9
	±0.5ml	6

	Other values	3
iii. Calculation of dissociation constant		10

e. To determine the concentration of Cupric ions present in a solution using a colorimeter (The unknown solution should be in the range of 4 to 6 mM concentration)

i) Graph	(Proper plot)	10
	Other plots	6
ii) Error in concentration	±0.2 mM	25
	±0.3 mM	20
	±0.4 mM	15
	±0.6mM	10
	Other values	5

IV/V/VI Semester B.Sc. Chemistry

Internship/Mini Project

Max. Marks: 50 (Report-40 & Internal Assessment-10)

Valuation Scheme

a) Internal Assessment: 10 Marks

Basis for Internal Assessment

Continuous Evaluation: 10 Marks

b) Evaluation of Report: 40 Marks

i) Work carried out: 20 Marks

ii) Preparation of Report: 10 Marks

iii) Presentation and Viva-Voce: 10 Marks

First Semester B.Sc.

BSCCHCS101: Chemistry Theory-I

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Learning Objectives

This course helps to understand the following basic aspects of chemistry

1. Principles of chemical kinetics and theories of reaction rate.
2. Chemical and physical characteristics of solvents.
3. Different aspects of adsorption process.
4. Nature of chemical bonds in molecules.
5. Fundamentals of reaction mechanism.
6. Basic methods of qualitative and quantitative analysis.

Course Outcome

On completion of this course, the student will be able to appreciate the following aspects.

1. Principles of chemical kinetics and different theories of reaction rate.
2. Adsorption isotherms and adsorption by liquids.
3. Physical and chemical properties of solvents.
4. Nature of bonding in organic molecules and criteria for aromaticity, resonance, hyper conjugation etc.
5. The concepts of organic reactions and techniques of writing the reaction mechanism.
6. Basics of analytical methods and chromatographic techniques.
7. Analytical skills involved in volumetric analysis.

UNIT-I

Chemical Kinetics **[5 Hours]**

Concentration dependence of rates, differential rate laws of simple chemical reactions, Zero, First, Second, n^{th} order and pseudo first order reactions. Derivation of rate constants for second order and n^{th} order reactions with equal initial concentrations. Determination of order of a reaction-Differential, Integration, Half-life period and Isolation methods. Transition state theory-Derivation of relationship between rate constant and equilibrium constant. Thermodynamic parameters of activation.

Surface Chemistry **[4 Hours]**

Adsorption of gases on solids: Freundlich and Langmuir adsorption isotherms.Multilayer adsorption-BET equation. Determination of surface area and area ofcross section of a molecule. Adsorption from solution - Gibb's Adsorption isotherm.

Solvents **[5 Hours]**

Physical properties of a solvent - density, dipole moment, specific conductance, dielectric constant. Types of solvents - classification into protic - aprotic, acidic - basic - amphiprotic, ionizing - non ionizing solvents (examples), Characteristics- liquid range, auto-ionization and solvating properties. Reactions in aqueous and non-aqueous solvents (explanation with examples). Water-hydration, hydrolysis, acid-base, reduction-oxidation, complex formation and precipitation.

Ammonia-Ammoniation, ammonolysis, acid-base, reduction-oxidation, complex formation, precipitation, alkali metals in ammonia. Levelling effect of solvents - examples.

UNIT-II

Chemical Bonding

Covalent bond-Valence bond theory-Concept of hybridization, Valence Shell Election Pair Repulsion (VSEPR) theory, Comparative study of structure and bonding between F_2O and H_2O, H_2S and H_2O, NH_3 and NF_3, ClF_3 and $XeOF_2$. **[7 Hours]**

Basic principle of Molecular Orbital Theory. Molecular orbital diagrams of homo and hetero nuclear species- N_2, O_2, CO, NO and CN^-. **[4 Hours]**

Ionic bond- Lattice energy, Born-Lande equation, Solvation and Solubility of ionic solids. Polarising power and Polarizability of ions. Fajan's rules to explain bond character, covalent character of ionic compounds, relative covalent character. Comparative trend in properties: a) Melting point-e.g: NaBr, $MgBr_2$, $AlBr_3$; LiF, LiCl, LiBr, LiI; $CaCl_2$, $HgCl_2$ b) Solubility-e.g AgF, AgCl, AgBr, AgI c) Thermal stability-e.g $BeCO_3$, $MgCO_3$, $CaCO_3$, $SrCO_3$, $BaCO_3$. Metallic Bond-Application of Band theory. **[3 Hours]**

UNIT-III

Nature of Bonding in Organic Molecules **[3 Hours]**

Localised and Delocalised bonds. Conjugation and Cross conjugation. Resonance. Aromaticity-Huckel rule, explanation with examples. Antiaromaticity. Hyper conjugation-relative stabilities of primary, secondary and tertiary carbonations. Electron displacements in covalent bond. Inductive effect and Field effect - Explanation with examples. Concepts of organic acids and bases. Relative strengths of aliphatic and aromatic carboxylic acids-Acetic acid with Chloroacetic acid, Propionic acid and Benzoic acid. Anomalous basic strength of tertiary alkyl amines. Steric effect-Relative stabilities of trans- and cis-2-butene, relative reactivities of alkyl halides in S_N2 reaction, steric hindrance in esterification of acids.

Mechanism of Organic Reactions **[7 Hours]**

Cleavage and formation of covalent bonds. Notations used to represent electron movements and directions of reactions- arrows, curved arrows, half-headed and double-headed arrows. Types of bond cleavage-homolytic and heterolytic. Substrate and reagent. Types of reagents-Electrophiles and Nucleophiles-explanation with examples. Types of organic reactions- Substitution, addition, elimination and rearrangement reactions, explanation with examples. Reactive intermediates- Carbo cations, carbanions, free radicals, carbenes, arynes and nitrenes- explanation with examples. Mechanism of Friedel–Craft's reaction, Cannizzaro reaction, Hofmann rearrangement, addition of HCN and $NaHSO_3$ to carbonyl compounds (benzaldehyde and acetophenone).

Electrophilic Addition to Carbon-Carbon Multiple Bonds **[4 Hours]**

Addition of halogens to alkenes-carbocation and halonium ion mechanisms. Stereo specificity of halogen addition. Limitations of open carbocation mechanism. Ozonolysis - Mechanism of ozonolysis of propene. Addition of hydrogen halides to alkenes- mechanism, regioselectivity and relative rates of addition. Markownikoff's and Anti-Markownikoff's addition of HBr to

propene. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes-Explanation with examples. Electrophilic addition to conjugated dienes-mechanism of addition of HBr to 1,3-butadiene, effect of temperature. Free radical addition to 1,3-butadiene. Diels-Alder reaction and its importance, 1,3-Dipolar cycloaddition and Pericyclic reaction-explanation with example.

UNIT-IV

Chromatography **[3 Hours]**

Chromatographic methods for the separation, concentration and identification of organic compounds-Thin layer, paper and column chromatography. R_f value andits significance. Principle and applications of Gas Chromatography.

Methods of Analysis **[7 Hours]**

Qualitative analysis - Sample size and techniques- macro, semi micro and micro. Types of tests-wet, dry and spot tests. Quantitative analysis -Volumetry, Gravimetry and Instrumental analytical methods. Principles of gravimetric analysis-methods of precipitation, optimum conditions for precipitation, co- precipitation and post precipitation. Solvent extraction-basic principles and applications. Errors in quantitative analysis, types of errors- determinate and indeterminate, methods of minimizing errors. Accuracy - absolute error/relative error. Precision–mean deviation /relative mean deviation, standard deviation, t-test, F-test and Q-test. Significant figures. Rules for computation of results (numerical problems to be solved wherever necessary).

Periodic Properties **[4 Hours]**

Methods of determination of atomic properties -Atomic size by Lande's method, ionization energy by discharge tube method, electron affinity from Born-Haber cycle and electronegativity from Pauling and Mulliken scales. Predicting and explaining the chemical behaviour of elements on the basis of periodic properties (metallic/non-metallic, ionic/covalent, reducing/oxidizing). Effective nuclear charge- shielding effect. Slater's rule and its applications.

BSCCHPS101: Chemistry Practicals-I

Volumetric Analysis

[Total number of Practical Hours: 4 Hours/Week (4x14=56 Hours)]

Objectives: To understand the concepts and develop the skill of volumetric analysis.

Course Outcome: After the completion of the course, the student will develop the skill of analysis by volumetric methods.

1. Microscale experiment-Two burette titration and beral pipette titration.
2. Preparation of standard sodium carbonate solution, standardization ofhydrochloric acid and estimation of sodium hydroxide in solution.
3. Preparation of standard solution of potassium biphthalate, standardization of sodium hydroxide solution and estimation of hydrochloric acid in solution.
4. Preparation of a standard solution of oxalic acid, standardization of potassium permanganate solution and estimation of Mohr's salt in solution.
5. Preparation of standard ferrous ammonium sulphate solution, standardization of potassium dichromate solution and estimation of ferric chloride in solution.

6. Preparation of standard potassium dichromate solution, standardization of sodium thiosulphate solution and estimation of copper sulphate in solution.
7. Estimation of oxalic acid and sulphuric acid in a mixture using standard potassium permanganate solution and standard sodium hydroxide solution.
8. Estimation of calcium content in lime stone as calcium oxalate by permanganometry.
9. Estimation of hardness of water by EDTA method.
10. Estimation of manganese in pyrolusite by volumetric method.
11. Determination of acetic acid in commercial vinegar using NaOH.
12. Determination of alkali content in antacid tablet using HCl.
13. Estimation of glucose using iodine and sodium thiosulphate.
14. Estimation of Vitamin C.

Reference Books

1. A Text Book of Inorganic Chemistry-P.L.Soni.2013, Sultan Chand and Sons.
2. A Text Book of inorganic Chemistry-B.R.Puri and L.R. Sharma 2000,Shobanlal Nagin Chand.
3. A text book of Inorganic chemistry-Gurdeep Raj, Krishna Prakashan , 2020.
4. A text book of Inorganic Chemistry-Sathya Prakash, 2001, S.Chand.
5. A Text Book of Quantitative Chemical Analysis- A.l.Vogel, 1989, Longman Group.
6. Physical Chemistry by Samuel Glasstone, 1982, ELBS.
7. A Text Book of Physical Chemistry by P.L.Soni , O.P. Dharmarha andU.N.Dash, 2023, Sultan Chand and Sons.
8. Physical Chemistry-Madan R.L.and Tuli G.D., 2010, S.Chand, New Delhi.
9. A Text Book of Advanced Physical Chemistry-Gurdeep Raj 2009,Goel, Meerut
10. Organic reaction mechanism by V.K.Ahluwalia and R.K.Parashar 2011, Narosa, New Delhi.
11. Organic Chemistry by S.M.Mukherji, S.P.Singh and R.K.Kapoor, 2012, New Age International.
12. A Guide Book to Mechanism in Organic Chemistry by Peter Skypes, 2003, Pearson.
13. Instrumental Methods of Chemical Analysis. Willard, Merritt, Dean andSkettle, 2004, CBS Publishers.
14. Instrumental Methods of Chemical Analysis -Gurdeep R.Chatwal and Sham K. Anand, 2011, Himalaya Publishing House.

Second Semester B.Sc.

BSCCHCS201: Chemistry Theory-II

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Learning objectives

This course helps to understand the following aspects of chemistry

1. The structure and properties of solids, Liquid Crystals and Gases.
2. General characteristics and properties of s and p block elements.
3. The reaction intermediates of organic reactions and predicting the reaction mechanism.
4. Basic concepts of electrophilic and nucleophilic reactions.
5. Characteristics of chemical compounds of industrial importance.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. Molecular structure of solids and their properties.
2. Different types of liquid crystals and their pplications.
3. Thermodynamic properties of gases.
4. Applications of chemicals in daily life.
5. General characteristics and properties of s and p block elements.
6. Organic reaction pathways and writing the reaction mechanism.
7. Basic concepts of electrophilic and nucleophilic substitution reactions.

UNIT-I

Solid State [**7 Hours**]

Laws of crystallography: Law of constancy of interfacial angle-explanation taking hexagonal crystal system as an example. Law of symmetry. Elements of symmetry- axis of symmetry, plane of symmetry and centre of symmetry- explanation taking cubic crystal system as an example. Law of rationality of indices. Miller indices- calculation of Miller indices for different planes in a cubic crystal system. Bravais lattices. X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl and determination of Avogadro number. Caesium Chloride, Zinc blende structures (numerical problems to be discussed).

Liquid Crystals [**2 Hours**]

Explanation, classification with examples - smectic, nematic, cholesteric, disc shaped and polymeric. Structures of nematic and cholesteric phases- molecular arrangements in nematic and cholesteric liquid crystals. Application of liquid crystals in LCDs and thermal sensing.

Gaseous State [**5 Hours**]

Maxwell's distribution of molecular velocities- explanation with graph. Mostprobable, average and RMS velocities and the relation between them. Qualitative discussion of the collision number, mean free path and collision diameter. Critical phenomena: P-V isotherms of real gases – Andrews's isotherms of carbon dioxide. Continuity of states- principles. Isotherms of van der Waal's equation. Relationship between critical constants and Van der Waals constants-derivation

of the expressions for a, b, T_C, P_C and V_C, Law of corresponding states- statement, reduced equation of state- derivation of the equation.

UNIT II

s-Block Elements [**6 Hours**]

Hydrogen-position of hydrogen in the periodic table. Hydrides-types, preparation, properties and applications. Structure of NaH and BeH_2. Complex hydrides- $LiAlH_4$, $NaBH_4$. Preparation and applications. Comparative study of Li and Be with other members of the same group. Comparative study of lattice energy, enthalpy of formation, enthalpy of hydration and solubilities of alkali metal and alkaline earth metal halides, hydroxides and sulphates. Comparison of standard reduction potentials and reducing properties of alkali metals and alkaline earth metals. Complexation tendencies of alkali metals with crown ether, Cryptates.

p-Block Elements [**8 Hours**]

Comparative study of p-Block elements and their compounds-comparison between Boron and other members of the group.

Boranes: Diborane-Preparation, properties, structure and bonding, chemical evidences for the presence of bridge hydrogen. B_4H_{10}, B_5H_9, Preparation and structure, Styx number, Wade's rule-Closo, Nido and Arachno boranes. Silicates-types, basic units, structure and applications. Hydrazine and hydroxylamine-structure and reducing property. Hypo phosphorous acid, phosphorous acid, phosphoric acid, orthophosphoric acid, meta phosphoric acid and pyro phosphoric acid- structure. Halogens in positive oxidation state. Inter halogen compounds-ICl, BrF_3, IF_5 and IF_7 - preparation, properties, structure and uses. Noble gases- Structure and bonding in: Clathrates, XeF_2, XeF_4, XeF_6 and XeO_3.

UNIT-III

Reactions Involving Intermediates **[6 Hours**]

Generation, stability and mechanism of reactions-

i) Carbocations - Dienone-phenol rearrangement

ii) Carbanions- Perkin reaction, Aldol condensation and Claisen condensation

iii) Free radicals- Sandmeyer's reaction

iv) Nitrenes - Hofmann rearrangement, Curtius rearrangement

v) Carbenes-Reimer-Tiemanreaction

vi) Arynes-Benzyne mechanism for the conversion of Bromobenzene toaniline.

Methods of determination of reaction mechanism-Product analysis, intermediates, isotope effects, kinetic and stereo- chemical studies.

Nucleophilic Substitution at Saturated Carbon [**2 Hours]**

Mechanism of S_N1 and S_N2 reactions with suitable examples and energy profile diagrams. Stereochemistry and factors affecting S_N1 and S_N2 reactions.

Elimination Reactions [**2 Hours**]

Mechanism of E1 and E2-Explanation with suitable examples, evidences, orientation and stereochemistry. Hoffmann and Saytzeff rules.

Aromatic Electrophilic and Nucleophilic Substitutions [**4 Hours**]

Aromatic electrophilic substitution-General mechanism with energy profile diagram. Role of σ and π - complexes. Activating and de-activating substituents, Orienting influence, ortho-para ratio. Nucleophilic aromatic substitution reactions- Addition-elimination and Elimination-addition mechanism.

UNIT-IV

Industrial Chemistry [**14 Hours**]

Fuels: Composition, production and applications of natural gas, water gas, producer gas, LPG and bio gas.

Propellants: Characteristics and applications.

Glass: Raw materials, manufacture-tank furnace, steps in manufacture and annealing of glass. Types of glasses: composition and uses of - hard, soft, Pyrex, jena, flint, safety, optical, fibre, coloured and Crooke's glasses.

Cement: Raw materials, manufacture of cement, mechanism of setting of cement. RCC composition and uses.

Ceramics: Raw materials used in modern ceramics, stages in ceramic making, glazing, applications of porcelain.

Paints: Constituents of paints and their functions with examples. Manufacture of white lead and lithopone.

Refractories: Characteristics, classification with examples and applications.

Abrasives: Naturalabrasives, synthetic abrasives, characteristics and applications. Silicon carbide and boron nitride- structure and production.

Cane sugar: Outline of production and composition, molasses, its composition.

Paper: Production of wood pulp and preparation of paper.

Chemical fertilizers: Primary nutrients, different types of fertilizers, importance, production of urea, CAN and superphosphate of lime.

BSCCHPS201: Chemistry Practicals-II

Qualitative Organic Analysis and Chromatography

[Total number of Practical Hours: 4 Hours/Week (4x14=56 Hours)]

Objectives

To understand the concepts and develop the skill of qualitative analysis.

Course Outcomes

After the completion of the course, the student will develop the skill of chromatographic technique and qualitative organic analysis.

I. Systematic qualitative analysis of mono and bifunctional organic compounds. Determination of melting point/boiling point. Preparation of suitable solid derivative. Following compounds may be given - Resorcinol, oxalic acid, urea, thiourea, thiophenol, benzoic acid, salicylic acid, phenol, p-cresol, aniline, p-nitroaniline, p-toluidine, benzaldehyde, ethyl methyl ketone, acetophenone, benzophenone, chlorobenzene, bromobenzene,nitrobenzene and benzamide. [**8 Weeks**]

II. Thin Layer Chromatography: Any two of the following. [**2 Weeks**]

Determination of Rf values and identification of organic compounds,

a) Separation of green leaf pigments (Spinach leaves may be used),

b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone,2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60)

c) Separation of a mixture of dyes using cyclohexane and ethyl acetate(8.5: 1.5)

III. Paper Chromatography: Ascending and Circular. Any two of the following: [**2 Weeks**]

Determination of Rf values and identification of organic compounds,

a) Separation of a mixture of phenylalanine and glycine, Alanine and aspartic acid, Leucine and glutamic acid. Spray reagent-ninhydrin.

b) Separation of a mixture of D, L-alanine, glycine, and L-Leucine using n- butanol, acetic acid-water (4:1:5). Spray reagent-ninnydrin,

c) Separation of monosaccharides-mixture of D-galactose and D- fructose using n-butanol:acetone: water (4:5:1), Spray reagent - aniline hydrogen phthalate.

IV. Column Chromatography **[2 Weeks]**

a) Separation of fluorescein and methylene blue.

b) Separation of leaf pigments from spinach leaves.

References

1. Analytical Chemistry-John H. Kennedy, 1997, Saunders College, New York.
2. Instrumental Methods of Chemical Analysis. Willard, Merritt, Dean andSkettle, 2004, CBS Publishers.
3. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal and Sham K. Anand, 2011, Himalaya Publishing House.
4. A Text Book of Inorganic Chemistry by P.L.Soni.2013, Sultan Chand and Sons.
5. A Text Book of Inorganic Chemistry by B. R. Puri and L. R. Sharma and K. C. Kalia, 1993, Shoban Lal Nagin Chand.

6. A Text Book of Inorganic Chemistry by Gurdeep Raj, 2020, Krishna Prakash
7. A Text Book of Inorganic Chemistry by Sathya Prakash, 2001, S.Chand.
8. Concise Inorganic Chemistry by J. D. Lee, 2022, Wiley India.
9. Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharma and K.C. Kalia.2014,
10. Selected Topics in Inorganic Chemistry by R. L.Madan, Malik, G.D.Tuli, 2000, S.Chand and Company.
11. Engineering Chemistry by B. K. Sharma, 2020,Krishna Prakashan
12. Industrial Chemistry by B. K.Sharma, 2023, Krishna Prakashan
13. Organic Reaction Mechanism by V. K. Ahuwalia and R. K. Parashar, 2011, Narosa Publishing.
14. Organic Chemistry by S.M.Mukherji, S.P.Singh R.P.Kapoor and R.Das, 2017, New Age.
15. A Text Book of Qualitative Analysis- A. l. Vogel, 2010, Pearson.

Third Semester B.Sc.

BSCCHCS301: Chemistry Theory-III

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

This course helps to understand the following basic aspects of chemistry:

1. The general characteristics and properties of d and f block elements.
2. The characteristic properties and occurrence of lanthanides and actinides in nature and their uses.
3. Various liquid mixtures and their separation techniques.
4. Chemistry of phenols, ethers, epoxides, structure and reactivity of carbonyl compounds.
5. Concepts of acids and bases with respect to various compounds.
6. Nano-chemistry and the applications nano-materials, food technology and corrosion.
7. Thermodynamics and its applications to physical and chemical systems.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. Distinguish between d and f block elements by studying their general properties.
2. Understand the concept of lanthanides, actinides and their comparisons.
3. Understand the principles of thermodynamics and its applications to physical and chemical systems.
4. Describe the chemistry of phenols, ethers, epoxides and structure and reactivity of carbonyl compounds.
5. Gain the knowledge and skills of preparation of nano-materials.
6. Understand various liquid mixtures and their separation techniques.
7. Understand the basic concept of food technology and corrosion.

UNIT–I

Thermodynamics **[14 Hours]**

First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat Capacity, heat capacities at constant volume and pressure and their relationship. Joule's law, Joule - Thomson coefficient and inversion temperature. Bond dissociation energy and its calculation from thermo-chemical data. Temperature dependence of enthalpy. Kirchhoff's equation.

Second Law of Thermodynamics: Need for the Law, different statements of the Law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of

entropy, entropy as a state function, entropy change for an ideal gas as a function of V & T, entropy as a function of P & T, entropy change in physical changes- fusion, evaporation, sublimation and transition. Entropy changes in mixing of ideal gases. Entropy as a criterion of spontaneity and equilibrium.

Third Law of thermodynamics: Significance, unattainability of absolute zero. Gibbs and Helmholtz functions; Gibb's function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity. Variation of G with P, V and T (Illustrative problems to be worked out).

UNIT–II

Chemistry of d-Block Elements **[6 Hours]**

Introduction, General characteristics of transitional elements, general electronic configuration, stabilities of oxidation states, complexing ability, colour, magnetic property-expression for magnetic moment-spin only formula μs, calculation of μs for 3d series elements, Reasons for observed trend, Comparative treatment of 4d, 5d series with their analogues in respect of ionic radii, oxidation states, magnetic behavior and stereochemistry.

Chemistry of f-Block Elements **[4 Hours]**

Introduction, Lanthanide contraction, Causes of lanthanide contraction, Occurrence, Isolation of lanthanides by ion-exchange method, Similarities and comparison between lanthanides and actinides, Separation of neptunium, Plutonium and americium and uranium. Problems on calculation of μ_{S+L} for trivalent lanthanide ions.

Nano Chemistry **[4 Hours]**

Introduction, General methods of synthesis, characterization techniques, Scanning Electron Microscopy (SEM)-Principle and method of determination of nanomaterials, advantages over other microscopes, Fullerenes, Preparation of nanoparticle by chemical method, Applications of nanomaterials.

UNIT-III

Reactions and Reactivity of Phenols **[4 Hours]**

Comparison of acidic properties of phenols with carboxylic acids, alcohols and carbonic acid. Molecular rearrangements-Fries rearrangement, Claisen rearrangement, Synthesis of aryloxy acetic acids.

Structure and Reactivity of Carbonyl Compounds **[7 Hours]**

Structure of carbonyl group, Nucleophilic additions to carbonyl group, relative reactivities of aldehydes and ketones-explanation, Mechanism of reactions involving-Hydride shift-Tischenko reaction, i) C-C bond formation-Bucherer hydantoin synthesis, ii) C=C bond formation-Wittig

reaction, iii) C=N bond formation-addition of NH_3 derivatives, iv) C-O bond formation-Acetal synthesis, Michael addition-α, β-unsaturated aldehydes and ketones.

Ethers and Epoxides **[3 Hours]**

Chemical reactions of ethers-Cleavage and auto-oxidation with examples. Zeisel's method. Synthesis of epoxides, Acid and Base catalyzed ring opening of epoxides, Orientation of epoxide ring opening with energy profile diagram.

UNIT-IV

Acids and Bases **[3 Hours]**

Lewis concepts of acids and bases. Modern concepts of acids and bases. Usanovich concept, Lux-Flood concept. Hard and Soft Acids and Bases (HSAB): Classification of acids and bases as hard and soft. Pearson's HSAB concept and its applications.

Binary Mixtures **[7 Hours]**

Liquid-Liquid Mixtures: Ideal liquid mixtures, Raoult's law. Non-ideal system; Azeotropes: HCl-H_2O and ethanol-water systems. Partially miscible liquids: Phenol-water, trimethyl amine-water and nicotine-water systems. Lower and upper consolute (critical solution) temperature. Effect of impurity on consolute temperature. Immiscible liquids, steam distillation. Nernst distribution law: Definition and applications (Illustrative problems on steam distillation to be worked out).

Food Technology **[2 Hours]**

Introduction to food chemistry, Fundamentals of food processing, Fundamentals of milk processing, Food analysis, Food packing technology, Food laws and quality assurance.

Corrosion Chemistry **[2 Hours]**

Corrosion: Introduction, Corrosion-an electrochemical phenomenon. Types of corrosion-Galvanic corrosion, Crevice corrosion, Erosion corrosion, Stress corrosion.

BSCCHPS301: Chemistry Practicals-III

Qualitative Analysis of Inorganic Salt mixture

[Total number of Practical Hours: 4 Hours/Week (14x4=56 Hours)]

Course Learning Objective: To understand the concepts and develop the skill of inorganic salt analysis.

Course Outcome: After the completion of the course, the student will develop the skill to analyse the radicals present in inorganic salt mixtures.

Semi Micro Qualitative Analysis of Inorganic Salt Mixture

Systematic qualitative analysis of mixture of two simple inorganic salts (containing two cations and two anions)

Anions: CO_3^{2-}, HCO_3^-, SO_3^{2-}, S^{2-}, CI^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-} and PO_4^{3-}.

Cations: NH_4^+, Cu^{2+}, Pb^{2+}, Ag^+, Bi^{3+}, Cd^{2+}, Co^{3+}, Ni^{2+}, Al^{3+}, Fe^{3+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+ and K^+.

Note: First experiment should be exclusively used for explaining the basic principles of qualitative inorganic analysis and demonstration.

Reference Books

1. A Text Book of Inorganic Chemistry by P. L. Soni, 1998, Sultan Chand and Sons.
2. A Text Book of Inorganic Chemistry by Puri and Sharma, 2000, Shobanlal Nagin Chand.
3. Advanced Inorganic Chemistry by Gurudeep Raj, 2008, Goel.
4. A Text Book of Inorganic Chemistry by Sathya Prakash, 2001, S Chand & Company.
5. Engineering Chemistry by B. K. Sharma, 2001, *Krishna Prakashan.*
6. Nanomaterials by A. K. Bandyopadhyay, 2008, New Age.
7. Nano Science and Technology by V. S. Muralidharan and A. Subramania, 2009, Ane Books.
8. An Introduction to Metallic Corrosion and its Prevention by Raj Narayan, 1988, Oxford and IBH.
9. Vogel's Textbook of Practical Organic Chemistry (including Qualitative Organic Analysis by A. l. Vogel, 1974, Longman.
10. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor, 2017, New Age.
11. Food Science and Technology by P. Dev Raj, 2011, New Age.
12. A Text Book of Food and Beverage Management by Sudhir Andrews, 2008, McGraw Hill.

Discipline Elective (Optional)

BSCCHES301: Laboratory Reagents, Domestic Chemicals and Safety

[Total number of Lecture Hours: 2 Hours/Week (2x14=28 Hours)]

Course Learning Objectives

This course helps to understand the following basic aspects of chemistry:

1) Understand general laboratory protocols and safety practices.
2) Assess and minimize laboratory hazards.
3) Respond to laboratory emergencies and report incidents.
4) Explore the role of serendipity and master reagent preparation.
5) Understand the chemistry of common cleansing agents.
6) Identify the composition and uses of household items.
7) Explore the role of chemicals in cosmetics and personal care products.
8) Analyze the function of stain removers and their common types.

Course Outcomes: On completion of this course, the student will be able to appreciate the following aspects:

1) Apply standard laboratory protocols and safety practices.
2) Assess and manage laboratory hazards and emergencies.
3) Recognize the role of serendipity in scientific discoveries.
4) Prepare and safely handle laboratory reagents and equipment.
5) Understand the composition and function of cleansing agents.
6) Analyze the chemistry of common household items.
7) Evaluate the components and applications of cosmetic products.
8) Relate chemical properties to real-life applications in the home.

UNIT-I

Laboratory Safety **[4 Hours]**

Introduction. General laboratory protocols: Basic rules, Good Laboratory Practices. Chemical hazards, safety data sheets, symbols and hazard information, storage procedure, Physical hazards, Health hazards, Reaction hazards. Assessing the risks of hazards. Minimizing the risks of hazards: fume hood, ventilation, fire extinguisher, personal protective equipment's, Preparedness for emergencies from uncontrolled hazards: Importance of reporting incidents, response to common emergencies such as fires, explosions, chemical spills, chemical exposures, injuries.

Serendipity **[3 Hours]**

The role of Chance in making Scientific Discoveries What is Serendipity-Some Serendipitous Inventions in Science; Guncotton, Velcro, Plastic, X-rays, Microwave, Superglue, Mauve, Teflon, Saccharin, Stainless steel, Matches. Role of Serendipity in Drug discovery; Inventions in Chemistry that enabled the modern world.

Laboratory Reagents **[5 Hours]**

Preparation of laboratory reagents and maintenance of electrodes & common laboratory equipments. Methods of expressing concentrations of solution, Preparation of reagents for qualitative analysis of organic and inorganic compounds. Precaution and safety measures during reagent preparation. Numerical problems related to preparation of solutions.

UNIT-II

Domestic Chemicals **[12 Hours]**

Cleansing Agents: Chemical composition of soaps, detergents, dish washers, cdrain cleaners, bleaching powder, tooth paste, mouth wash, Stain removers, shampoo and stain removers-Explanation with some common examples. Preparation of soaps, detergents and bleaching powder.

Domestic Items: Safety matches, Wax candles, shoe polish, mosquito coils, household germicides and pesticides-their chemical composition. Candle preparation.

Cosmetics: Talcum powder, nail polish, thinners, skin care, hair care, lipsticks, sun protection lotions and creams, eye shadow and eyebrow pencils, antiperspirants, perfumes, antiperspirants and deodorants-explanation with examples. Preparation of perfumes.

Reference Books

1. Chemistry at Home: Exploring the ingredients in everyday products by John Emsley, 2015, Royal Society of Chemistry
2. Chemistry in daily life by Kripal Singh, Third Edition, Eastern Academy Education, 2012, PHI Learning Pvt. Ltd., New Delhi.
3. Chemistry in everyday life by Shardendu Kislaya, 2011, Discovery Publishing House Pvt. Ltd.
4. Laboratory Safety, theory and Practice, First Edition, Editors: Anthony Fuscaldo and others, 1980, Elsevier Publications.
5. Chemical Laboratory Safety and Security: A Guide to Developing Standard Operating Procedures, 2016, National Academies Press-Board on Chemical Sciences and Technology, Division on Earth and Life Studies.

6. Chemistry Laboratory Safety Manual, Indian Institute of Science Education and Research, 2018, IISER Tirupati.
7. Laboratory Safety Manual, NCBS, 2016, C-CAMP.
8. Practical Chemistry by O. P. Pandey, D. N. Bajpai, S. Giri, 2011, S. Chand and Co.
9. Vogel's Qualitative Inorganic Analysis by G. Svehla, 1979, Longman.
10. Text book of Physical Chemistry by B . R . Puri, L. R. Sharma and M. S. Pathania, 2012, Vishal Publishing Co.
11. Science and serendipity: Famous accidental discoveries, Samira Shackle, Thursday, 2nd April 2015, New Humanist.
12. The role of serendipity in drug discovery by Thomas A. Ban, Dialogues in Clinical Neuroscience, 2006, 8(3), 335–344.
13. Five Chemistry Inventions that changed the modern world-The Conversation, June 2, 2015.
14. Serendipity, Luck and Wisdom in Research by Patrick J. Hannan, 2006, iUniverse Inc.

Fourth Semester B.Sc.

BSCCHCS401: Chemistry Theory-IV

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

This course helps to understand the following basic aspects of chemistry:

1. Nomenclature, isomerism, theory of coordination compounds and metal ligand bonding.
2. Relationship between colligative properties and molecular weight of solutes.
3. Chemical equilibrium, effect of pressure, temperature and concentration on chemical equilibrium.
4. Phase equilibrium and applications of phase diagram.
5. Relationship between physical properties and molecular structure.
6. Refractometry, radiation and nuclear chemistry.
7. Reactive methylene compounds, different reagents used for the synthesis of organic compounds and reactions of carboxylic acids.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. Nomenclature, EAN rule, isomerism, theory of coordination compounds and metal-ligand bonding in transitional metal complexes.
2. Relationship between colligative properties and molecular weight of solutes.
3. Relationship between physical properties and molecular structure.
4. Basic terminology of phase equilibrium and chemical equilibrium.
5. Different reagents used for the synthesis of organic compounds and reactions of carboxylic acids and their derivatives.
6. Refractometry, its applications, radiation and nuclear chemistry.

UNIT-I

Solutions, Dilute Solutions and Colligative Properties [8 Hours]

Methods of expressing concentrations-Activity and Activity coefficients. Colligative properties; Raoult's law of relative lowering of vapour pressure. Osmosis and laws of Osmotic pressure. Elevation in boiling point and depression in freezing point. Thermodynamic derivation of the relation between elevation of boiling point and /depression of freezing point and molecular mass of solute, experimental determination of elevation in boiling point by Walker-Lumsden method and depression in freezing point by Beckmann's method (Illustrative problems to be worked out).

Physical Properties and Molecular Structure **[4 Hours]**

Optical activity, polarization (Clausius-Mosotti equation), orientation of dipoles in an electric field, dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties-para-magnetism and diamagnetism.

Refractometry **[2 Hours]**

Introduction-Abbe's Refractometer, applications of Refractometry.

UNIT-II

Coordination Compounds **[5 Hours]**

Introduction, EAN, Nomenclature, illustration with examples including geometrical and optical isomers, bridging ligands. Isomerism in coordination compounds - ionization isomerism, hydrate isomerism, coordinate isomerism, linkage isomerism. Geometrical isomerism and optical isomerism (coordination numbers 4 and 6).

Metal-Ligand Bonding in Transitional Metal Complexes **[9 Hours]**

Postulates of Valence Bond Theory (VBT), Examples for sp^3 , dsp^2 , dsp^3, d^2sp^3 and sp^3d^2 hybridization-$[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[Cu(NH_3)_4]^{2+}$, $[Fe(CO)_5]$, $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$and $[CoF_6]^{3-}$. Explanation for magnetic properties. Limitations of Valence bond theory.

Crystal Field Theory: Iimportant concepts of CFT, Crystal field splitting in octahedral, tetrahedral and square planar complexes, Jahn-Teller distortion and crystal field stabilization energy. Calculation of CFSE, weak and strong field ligands, spectrochemical series, explanation for stability, geometry, magnetic and spectral properties. Factors affecting the crystal field splitting. Limitations of CFT.

UNIT-III

Reactive Methylene Compounds **[2 Hours]**

Keto-enol tautomerism in ethyl acetoacetate and diethyl malonate, Reactions supporting keto and enol forms. Synthetic applications of reactive methylene compounds: Synthesis of alkyl acetic acids, succinic acids, keto acids, α,β-unsaturated acids (Crotonic acid) and 4-methyl uracil.

Reagents and their Synthetic Utility **[8 Hours]**

Different reagents used for the synthesis of organic compounds with reaction mechanism: i) $KMnO_4$-Oxidation of alkenes to vicinal diols, ii) OsO_4-Synthesis of cis-1,2-diols, iii) Peracids-Baeyer-Villiger oxidation, iv) $LiAlH_4$-Reduction of carbonyl compounds into alcohols, v) N-Bromosuccinimide-Allylic bromination of alkenes, vi) H_2O_2-Dakin reaction, vii) NH_2-NH_2-Wolf-Kishner reduction, viii) Zn-Hg/HCl-Clemmenson reduction, ix) CrO_2Cl_2-Étard reaction. **Explanation with an example for commonly used synthetic reagents:** O_3-Ozonolysis, Periodic

acid-Oxidation cleavage of vicinal diols into carbonyl compounds, Lead tetraacetate-Oxidative cleavage of vicinal diamines, $NaBH_4$-Reduction of carbonyl compounds into alcohols, Na/ethyl alcohol-Reduction of ester to alcohol by Bouveault-Blanc reduction.

Structure and Reactions of Carboxylic Acids and their Derivatives [4 Hours]

Structure of carboxylic acid and carboxylate ion, Effect of substituents on the acidity of aliphatic and aromatic carboxylic acids (ortho effect). Reactions of carboxylic acids with mechanism: i) Homologation-Arndt-Eistert reaction, ii) Degradation to alkyl halides-Hunsdiecker reaction, iii) Conversion to primary amines-Curtius reaction, iv) Conversion to haloacids-HVZ reaction. Preparation of derivatives of carboxylic acids-Acid chlorides, amides, esters. Reactions of acid derivatives: Conversion of acid chlorides into aldehydes-Rosenmund's reduction.

UNIT-IV

Chemical Equilibrium [4 Hours]

Derivation of relationship between equilibrium constant and free energy $\Delta G=-RTInK_p$. Thermodynamic derivation of law of mass action. LeChatelier's principle-Statement and applications-Habers process for the synthesis of ammonia. Van't Hoff's reaction Isotherm and reaction isochore (Van't Hoff equation). (Illustrative problems to be worked out).

Phase Equilibrium [7 Hours]

Phase Rule: Statement (mathematical expression) and meaning of the terms. Explanation for the terms phase, component and degrees of freedom with suitable examples for each. Derivation of phase rule from thermodynamic consideration. Explanation of phase equilibrium of one component system (Water and Sulphur system) using phase diagram. Two component system: Classification with examples. Simple eutectic system (lead-silver system)-Phase diagram and explanation, desilverisation of lead (Pattinson's Process). Solid solutions: Compound formation with congruent melting point (Mg-Zn system)-Phase diagram and explanation. Compound formation with incongruent melting point (NaCl + water system)-Phase diagram and explanation. Freezing mixtures (acetone-dry ice).

Radiation and Nuclear Chemistry [3 Hours]

Radiolysis of water (using gamma rays), radiation dosimetry, dosimeters, applications inorganic and organic reactions. Application of radioisotopes in the study of Friedel-Craft's reaction, medicine and soil fertility. Industrial applications.

BSCCHPS401: Chemistry Practicals-IV

[Total number of Practical Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

To understand the practical knowledge and skills for the determination of physical properties of organic compounds.

Course Outcomes

After the completion of the course, the student will develop the practical knowledge and skills for the determination of physical properties of organic compounds.

Determination/Study of the following **(Minimum of any 10 experiments to be carried out)**

1. Specific reaction rate for the acid catalyzed hydrolysis of methyl acetate at room temperature using 0.5N HCl or 0.5N H_2SO_4 .
2. Effect of acid strength on the hydrolysis of an ester.
3. Comparison of the catalytic strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate.
4. Rate of decomposition of potassium iodide by hydrogen peroxide.
5. The distribution of iodine between water and carbon tetrachloride.
6. The distribution of benzoic acid between benzene and water.
7. Preparation of arsenious sulphide sol and comparison of the precipitating powers of mono-, di- and tri-valent ions.
8. Density and viscosity of the given liquid (using specific gravity bottle and viscometer).
9. Percentage composition of a given mixture of glycerol and water by viscometry.
10. Density and surface tension of a liquid using stalagmometer.
11. Composition of binary liquid mixture (Alcohol & toluene) by Refractometry.
12. Percentage of NaCl present in phenol-water system.
13. Molecular weight of a non-volatile solute by Walker - Lumsden method.
14. Critical solution temperature of Phenol-water system.

Reference Books

1. Selected Topics in inorganic Chemistry by Madan, Malik, Tuli, 2000, S. Chand and Company.
2. A Text Book of inorganic Chemistry by A. K. De, 2001, New Age international.
3. Engineering Chemistry by B.K. Sharma, 2001, Krishna Publication.
4. A Text Book of Quantitative analysis by A. l. Vogel, 1989, Longman.
5. A Text Book of Inorganic Chemistry by P. L. Soni, 1998, Sultan Chand and Sons.

6. A Text Book of Inorganic Chemistry by Puri and Sharma, 2000, Shobanlal Nagin Chand.
7. A Text Book of Inorganic Chemistry by Gurudeep Raj, 2008, Goel.
8. A Text Book of inorganic Chemistry by Sathya Prakash, 2001, S Chand & Company.
9. Organic Chemistry by P. Y. Bruise, 2000, Pearson Education.
10. Physical Chemistry by Madan and Tuli, 2001, S. Chand & Company.
11. A Text Book of Advanced Physical Chemistry by Gurudeep Raj, 2001, Goel.
12. A Text Book of Physical Chemistry by B.D. Khosla, 2000, S. Chand & Company.
13. Organic Reaction Mechanism by V. K. AhIuwalia and R. K. Parashar, 2010, Narosa.
14. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor, 2012, New Age.
15. Concise Co-ordination Chemistry by R. Gopalan and V. Ramalingam, 2008, Vikas.

Discipline Elective (optional)

BSCCHES401: Chemistry in Everyday Life

[Total number of Lecture Hours: 2 Hours/Week (2x14=28 Hours)]

Course Learning Objectives

By the end of these topics, students will be able to:

1) Understand the composition and nutritional role of food components.
2) Describe food processing and preservation methods.
3) Analyze food adulteration and its health impacts.
4) Evaluate the use of artificial food colorants and chemical contaminants.
5) Recognize the need for renewable energy sources.
6) Understand the scientific principles of renewable energy systems.
7) Identify and explain the applications of alternative energy technologies.
8) Evaluate the benefits and future trends of renewable energy utilization.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1) Understand the composition and functional role of food components.
2) Apply knowledge of food processing, preservation, and additives.
3) Evaluate food safety issues and health impacts.
4) Demonstrate awareness of food laws and safe practices.
5) Understand the need for renewable energy sources.
6) Explain the scientific principles behind various renewable energies.
7) Analyze the working mechanisms and applications of renewable technologies.

UNIT-I

Food Chemistry **[6 Hours]**

Food as source of energy and structural material. Components of food Carbohydrates, Proteins, Oils and Fats. Micronutrients-Vitamins, minerals. Chemical substances used in food preparation - water, common salt, baking powder, vinegar. Food Processing. Food additives, preservatives and flavours. Explanation with examples for the preservation of food by the use of inhibitors, drying, salting, canning, pickling, smoking, packing and refrigeration. Food safety. Soft drinks-Components. Effects on health.

Food Adulteration **[4 Hours]**

Definition, common harmful effects, detection of adulteration, Prevention, Food adulteration act, artificial ripening of fruits – Explanation with examples.

Artificial food colorants **[4 Hours]**

Coal tar dyes and non-permitted colours and metallic salts. Analysis of pesticide residues in food.

UNIT-II

Chemistry for our future **[14 Hours]**

Alternative Sources of Energy: Need for the search of renewable sources of energy.

Solar Energy: Basic properties of solar energy. Applications of solar energy. Transformation of solar energy. Solar heat collectors. Solar photovoltaic collectors. Applications of solar collectors. Examples. Solar power plant.

Wind Energy: Basic properties of wind energy. Applications of wind energy. Transformation of wind energy. Wind turbines. Operative characteristics of wind turbines. Wind power plant. Utilization of wind power. Examples. Trends in wind energy utilization.

Hydro Power: Basic properties water energy. Transformation of water energy. Hydro power plant. Utilization of hydro power. Examples. Trends in hydro power utilization.

Hydrogen Energy: Production and applications.

Ocean Energy: Principles of ocean thermal energy, conversion system. Principles of wave and tidal energy conversion. Transformation of biomass energy. Applications of biomass.

Reference Books

1. Food: The chemistry of its components by Tom Coultate, 2002, The Royal Society of Chemistry.
2. Food Science and Technology by Geoffrey Campbelt-Platt, 2017, Wiley Blackwell.
3. Food chemistry by H. K. Chopra and P. S. Panesar, 2010, Narosa Publishing.
4. Chemistry at Home: Exploring the ingredients in everyday products by John Emsley, 2015, Royal Society of Chemistry.
5. Chemistry in daily life by Kirpal Singh, 2012, Eastern Academy Education, PHI Learning Pvt. Ltd, New Delhi.
6. Chemistry in everyday life by Shardendu Kislaya, 2011, Discovery Publishing House Pvt. Ltd.
7. Renewable energy sources and emerging technologies by D. P. Kothari, K. C. Singal and Rakesh Ranjan, 2016, PHI Learning Pvt. Ltd, New Delhi.
8. Solar energy: Fundamentals and applications by H. P. Garg and J. Prakash, 2000, McGraw Hill.
9. Biomass regenerable energy by D. O. Hall and R. P. Overend, 1987, Wiley-Blackwel.
10. Introduction to wind turbine aerodynamics by Alois Peter Schaffarczyk, 2014, Springler.
11. Hydrogen and fuel cells: Fundamentals, technologies and applications by Detlef Stolten, 2010, Wiley-Vest.

Compulsory Skill/Practical Paper

(May be offered in either IV or V or VI Semester)

BSCCHSS401/501/604: Internship/Mini Project Work

[Total number of Project Work Hours: 2 Hours/Week (2x14=28 Hours)]

Internship/Mini project has to be compulsorily carried out in one of the last three semesters (Semester IV or V or VI) with a workload of 2 hours per week under the supervision of a teacher. Report on the internship/Mini project has to be submitted for evaluation.

Fifth Semester B.Sc.

BSCCHCS501: Chemistry Theory-V

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

This course helps to understand the following aspects of chemistry:

1. Applications of complexes and complex formation in metallurgy, qualitative and gravimetric analysis.
2. Knowledge about magnetic properties, electronic spectra, thermodynamic and kinetic aspects of metal complexes.
3. Types conductance of electrolytes and their measurements.
4. The basic concepts of photochemistry and supramolecular chemistry.
5. Basic principles and applications of rotational and vibrational spectroscopy in structural analysis.
6. Basic knowledge of stereochemistry of organic compounds and organic compounds of nitrogen.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. The basic principles of rotational spectroscopy and its applications.
2. Types conductance of electrolytes, their measurements and Kohlrausch law.
3. Understand the basic concepts of photochemistry and photochemical reactions.
4. The basic concepts supramolecular chemistry.
5. Spectral data in the determination of structure of organic compounds.
6. The knowledge of magnetic properties, electronic spectra, thermodynamic and kinetic aspects of metal complexes.
7. The fundamentals of stereochemical aspects of organic compounds and organic compounds of nitrogen.

UNIT–I

Electrochemistry-I **[7 Hours]**

Strong and Weak electrolytes, Specific conductance, Equivalent conductance and its determination – its variation on dilution, Debye-Huckel theory, Debye-Huckel-Onsager's equation for strong electrolytes (no derivation). Transport number, definition, Hittorf's rule, determination of transport number by Hittorf's method using attackable and unattackable electrodes and moving boundary method. Kohlrausch's law and its applications & related problems.

Photochemistry **[7 Hours]**

Interaction of radiation with matter, difference between thermal and photochemical processes. Primary and secondary processes of a photochemical reaction, Laws of photochemistry: Grotthuss - Draper law, Stark - Einstein law (only statement), Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, radiative and non-radiative processes (internal conversion, inter system crossing). Quantum yield-definition, reasons for low and high quantum yield & related problems. Explanation for low and high quantum yield reactions taking combination of H_2 and Br_2 and combination of H_2 and Cl_2 as examples. Photosensitized reactions-energy transfer processes, definition of photosensitization. (e.g.: Photosynthesis in plants, dissociation of H_2, Isomerization of 2-butene and butadiene), photoinhibition.

UNIT-II

Application of Metal Complexes and Complexation **[3 Hours]**

Applications of Complexes and Complex Formation in Metallurgy: Ag, Au, Al, Ni extractions, Volumetric analysis: Complexometry, masking, demasking techniques with example, Qualitative Analysis: Test for ferrous and ferric ions, nitrate and ammonium ions, Gravimetric Analysis: Precipitation of nickel, magnesium and aluminum ions.

Thermodynamic and Kinetic aspects of Metal Complexes **[3 Hours]**

A brief outline of thermodynamic stability of metal complexes. Stepwise formation and overall formation constants and factors affecting the stability of complexes. Substitution reactions of square planar complexes, Trans effect, theories and applications of Trans effect.

Magnetic Properties of Transition Metal Complexes **[6 Hours]**

Origin of Magnetism, terms used in Magnetochemistry: Magnetic induction, Magnetic flux density, Magnetic moment and Magnetic susceptibility, Magnetic permeability. Lande's calculation of theoretical magnetic moment. μS+L, comparison of magnetic moment μs and μs+L with experimental value of μ. Magnetic behavior of substances-Types of magnetic behavior, Methods of determining magnetic susceptibility-Gouy's method. Temperature dependence of

magnetic properties, Curie temperature, Neel temperature, Application of magnetic moment data of 3d-metalcomplexes.

Supramolecular Chemistry **[2 Hours]**

Introduction, Definition, basics of supra molecular chemistry, classification of supramolecules, host and guest compounds, driving forces for the formation of supramolecular structures, Applications.

UNIT-III

Organic Compounds of Nitrogen **[4 Hours]**

Nitroarenes: Reduction in acidic, neutral and alkaline media. Mechanism of nucleophilic substitution in nitroarenes. Amines: Separation of mixture of primary, secondary and tertiary amines (Hinsberg and Hofmann's method).

Stereochemistry of Organic Compounds **[10 Hours]**

Configurational isomerism-optical, geometrical and conformational. Differences between configuration and conformation.

Optical Isomerism: Elements of symmetry, molecular chirality, stereogenic centre, chiral and achiral molecules with two stereogenic centres-Lactic acid and Tartaric acid. Enantiomers-properties, resolution of enantiomers. Diastereomers-definition & examples, threo and erythro diastereomers, meso compounds-definition and examples. Inversion (of sugars) and racemization. Relative and absolute configuration, sequence rules, D & L, R & S systems of nomenclature.

Geometric Isomerism: Determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism-conformational analysis of ethane and 1,2-dichloroethane. Conformations of cyclohexane-Newman projection.

UNIT-IV

Rotational Spectroscopy **[6 Hours]**

Derivation of equation for moment of inertia of diatomic molecule, Diatomic molecule as rigid rotor; derivation of equation for moment of Inertia of diatomic molecule, energy levels of a rigid rotor, selection rules, determination of bond length, qualitative description of non-rigid rotor, isotope effect and related problems.

Vibrational Spectroscopy **[8 Hours]**

Molecular vibrations, vibrational degrees of freedom, Hooke's law. Energy levels of a simple harmonic oscillator, selection rules, Instrumentation and measurement of IR spectrum intensity and position of IR bands, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion, Fingerprint region and functional group region.

Characteristic absorptions of various functional groups and interpretation IR spectra of simple organic compounds and related problems.

BSCCHCS502: Chemistry Theory-VI

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

This course helps to understand the following aspects of chemistry:

1. The basic principle and applications of Raman spectroscopy.
2. Fundamental's quantum mechanics.
3. Elementary idea of flame photometry and thermo analytical methods.
4. Basic principle of electronic spectra of transition metal complexes.
5. Basic aspects of preparation and properties of heterocyclic and organometallic compounds.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. Theories of Raman Effect and vibrational Raman spectra.
2. Quantum theory, quantum numbers and postulates of quantum mechanics.
3. Principle, instrumentation and applications of flame photometry and thermoanalytical methods.
4. Knowledge on electronic spectra of transition metal complexes.
5. Basic aspects of preparation and properties of heterocyclic and organometallic compounds.
6. Importance of essential and trace elements in biological processes.

UNIT-I

Elementary Quantum Mechanics [11 Hours]

Black-body radiation, Plank's radiation law, photoelectric effect, Compton effect. De-Broglie hypothesis, Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one-dimensional box. Setting up of Schrodinger wave equation for H-atom (no separation of variables or solution), quantum numbers and their importance.

Raman Spectroscopy [3 Hours]

Classical and Quantum theory of Raman effect. Concept of polarizability. Rotational and Vibrational Raman Spectra. Selection Rules.

UNIT-II

Electronic Spectra of Transition Metal Complexes [7 Hours]

Introduction, Russel-Saunder's coupling, microstates, Spectroscopic ground state for d^n system, Term symbols generated by ligands, Types of electronic spectra, Selection rules for d-d transitions, Relaxation of selection rules, Spectrochemical series. Orgel-energy level diagram for d^1 and d^9 systems, discussion of the electronic spectra of $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{+2}$ complex ions.

Organometallic Compounds [7 Hours]

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li and Hg, mononuclear carbonyls and the nature of bonding in metal carbonyls, evidences in support of back bonding, Industrial applications of organometallic compounds-Hydrogenation of alkenes-Wilkinson's catalyst, Fischer-Tropsch synthesis.

UNIT-III

Heterocyclic Chemistry [11 Hours]

Classification and nomenclature, Molecular orbital pictures and explanation for the aromatic characteristics of pyrrole, furan, pyridine, pyrazole, oxazole and thiazole. Comparison of aromaticity of pyrrole, furan and pyridine. General methods (any two) of synthesis and reactions of pyrrole, furan, pyridine, pyrazole, oxazole and thiazole, mechanism of electrophilic substitution in furan and pyrrole. Mechanism of electrophilic and nucleophilic substitution in pyridine, comparison of basicity of pyridine, piperidine and pyrrole, condensed five and six membered heterocycles-explanation with examples. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer- Indole synthesis, Skraup quinolone synthesis and Bischler-Napieralski Isoquinoline synthesis, Mechanism of electrophilic substitution reactions of indole and quinoline.

Nucleic Acids [3 Hours]

Components of Nucleic acids-Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick Model) and RNA (types of RNA),

UNIT-IV

Flame Photometry [2 Hours]

General principles, Instrumentation, Interference and applications.

Thermo Analytical Methods: [3 Hours]

Principles and applications (TG, DTA & DTG).

Bioinorganic Chemistry **[4 Hours]**

Essential and trace elements in biological processes, biological role of metals-Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Fe^{2+}, Cu^{2+}, Zn^{2+}. Effect of excess intake of metals, metallo porphyrins with reference to hemoglobin and myoglobin. Chlorophyll.

Symmetry and Point Groups **[5 Hours]**

Symmetry elements and associated symmetry operations. Types of symmetry elements-axis of symmetry, plane of symmetry, centre of symmetry, identity, rotation reflection axes. Classification of molecules based on symmetry elements-Schoenflies notation, taking the examples of H_2O, NH_3, BF_3, trans N_2F_2 and HCl.

BSCCHPS501: Chemistry Practicals-V

Gravimetric Analysis and Physical Chemistry Experiments

[Total number of Practical Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

Apply and practice skills of gravimetric estimations, solvent extraction, steam distillation effluent analysis, stereochemical study of organic compounds etc.

Course Outcomes

After the completion of the course, the student will develop the practical knowledge and skills for the gravimetric estimations, solvent extraction, steam distillation, effluent analysis, stereochemical study of organic compounds etc.

Minimum of any 10 experiments to be carried out

Inorganic Gravimetric Exercises

1. Estimation of barium as barium sulphate in barium chloride solution.
2. Estimation of copper as cuprous thiocyanate in copper sulphate solution.
3. Estimation of Ni as Nickel dimethyl glyoximate in nickel ammonium sulphate solution.
4. Estimation of iron as ferric oxide in ferrous ammonium sulphate solution.
5. Gravimetric estimation of chloride / silver as AgCl in $NaCl/AgNO_3$ solution.
6. Estimation of magnesium as oxinate in magnesium sulphate solution.
7. Solvent extraction: Separation and estimation of Mg (II) and Fe (II) ion.
8. Colorimetry:
   a. Verification of Beer-Lambert Law by Job's method
   b. Verification of Beer-Lambert Law by Mole ratio method.
9. Adulteration: Determination of adulteration in food stuffs.
10. Effluent analysis: Analysis of effluent water.

11. Steam Distillation:
    a. Steam distillation of Naphthalene from its suspension in water.
    b. Steam distillation of Clove oil from cloves.
    c. Separation of o-and p-nitrophenols by steam distillation.

Stereochemical Study of Organic Compounds *via* Models

12. R and S configuration of optical isomers.
13. E and Z configuration of geometrical isomers
14. Conformational analysis of cyclohexane and substituted cyclohexane.

Reference Books

1. Basic concepts of Analytical Chemistry by S. M. Khopkar, 1993, New Age International.
2. Instrumental methods of Chemical Analysis by B. K. Sharma, 1999, Goel.
3. Instrumental methods of Chemical analysis by Gurudeep R. Chatwal and Sham Anand, I998, Himalaya.
4. Instrumental methods of Chemical analysis by Willard, Merritt, Dean and Skettle, 2004, CBS.
5. A Text Book of Inorganic Chemistry by Gurudeep Raj, 2008, Goel.
6. A Text Book of inorganic Chemistry by Sathya Prakash, 2001, S. Chand & Company.
7. Concise Inorganic Chemistry by J. D. Lee, l998, Blackwell Science.
8. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, 2000, Shobanlal Nagin Chand.
9. Selected Topics in Inorganic Chemistry by Madan, Malik, Tuli, 2000, S. Chand & Company.
10. A Text Book of Inorganic Chemistry by A. K. De, 2001, New Age International.
11. A Text Book of Quantitative Analysis by A. I. Vogel, 1989, Longman.
12. Inorganic Polymers by G. R. Chatwal, l993, Himalaya Publishing House.
13. Theoretical Principles of Inorganic Chemistry by Manku, 2001, Tata McGraw Hills.
14. A Text Book of Inorganic Chemistry by Cotton and Wilkinson, 1992, Wiley lnterscience.
15. A Text Book of Inorganic Chemistry by Emeleus and Anderson, l992, New Age international.
16. Organic Chemistry by P. Y. Bruise, 2000, Pearson Education.
17. Agricultural Chemistry by B. A. Yagodin, 1976, Mir Publishers (Moscow).
18. Physical Chemistry by Madan and Tuli, 2001, S. Chand & Company.
19. A Text Book of Advanced Physical Chemistry by Gurudeep Raj, 2001, Goel.
20. A Text Book of Physical Chemistry by B. D. Khosla, 2000, S. Chand & Company.
21. Fundamentals of Molecular Spectroscopy by C. Banwell and E. M. McCash, 1982, Himalaya.
22. Physical Chemistry by Colin N. Banwell, l998, Himalaya Publishing.
23. Physical Chemistry by Glasstone, 1982, ELBS.

24. A Text Book of Physical Chemistry by P. L. Soni, O. P. Dharmarha and U. N. Dash, 2011, Sultan Chand and Sons.
25. Organic Spectroscopy by William Kemp, 1991, ELBS.
26. Elementary Organic Spectroscopy by Y. R. Sharma, 2013, S. Chand & Company.
27. Systematic Experiments in Chemistry by Arun Sethi, 2008, New Age Interntionl.
28. Organic Spectroscopy by S. K. Dewan, 2020, CBS.
29. Organic Reaction Mechanism by V. K. AhIuwalia and R. K. Parashar, 2010, Narosa.
30. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor, 2012, New Age International.
31. Introduction to Supramolecular Chemistry by Asim K. Das and Mahua Das, 2019, CBS.
32. Bioorganic, Bioinorganic and Supramolecular Chemistry by P. S. Kalsi, J. P. Kalsi and Ashu Chaudhary, 2007, New Age Internationl.
33. Advanced Physical Chemistry by Gurudeep Raj, 2011, Krishna Prakashan.
34. Bio-Inorganic Chemistry by K. Hussain Reddy, 2007, New Age Internationa.
35. Group Theory and Symmetry in Chemistry by Gurudeep Raj, Ajay Bhagi and Vinod Jain, 2017, Krisna Prakashana.
36. Chemical Applications of Group Theory by F. A. Cotton, 1990, Wiley.
37. Advanced Inorganic Chemistry-Vol II by S. P. Banerjee, 2015, Books & Allied.
38. Group Theory and its Applications in Chemistry-Second edition by Salahuddeen Kunju and G. Krishnan, 2015, PHI Learning.
39. Essentials of Nuclear Chemistry by H. J. Arnikar, 2016, Wiley Eastern.
40. Organometallic Chemistry by R. C. Mehrotra and A. Singh, 2000, New age International.
41. Heterocyclic Chemistry by Raj K. Bansal, 2020, New Age International,
42. Medicinal Chemistry by G.R. Chatwal, 2010, Himalaya.

Compulsory Skill/Practical Paper

(May be offered in either IV or V or VI Semester)

BSCCHSS401/501/601: Internship/Mini Project Work

[Total number of Project Work Hours: 2 Hours/Week (2x14=28 Hours)]

Internship/Mini project has to be compulsorily carried out in one of the last three semesters (Semester IV or V or VI) with a workload of 2 hours per week under the supervision of a teacher. Report on the internship/Mini project has to be submitted for evaluation.

Sixth Semester B.Sc.

BSCCHCS601: Chemistry Theory-VII

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

This course helps to understand the following aspects of chemistry:

1. Polymers, polymerization techniques and applications of polymers.
2. Electrodes, electrochemical cells, fuel cells and applications electrochemical cells.
3. Alkaloids, terpenes, fungicides and herbicides**.**
4. Fundamentals of green chemistry, composites, mass spectra.
5. Basic concept of petroleum and petrochemicals.
6. Biological importance and functions of amino acids, peptides and proteins.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. Types of polymers, polymerization techniques and applications of organic and inorganic polymers.
2. Electrodes, electrochemical cells, fuel cells and applications electrochemical cells.
3. The mechanism of interconversion, ascending and descending of carbohydrates.
4. Biological importance and functions of amino acids, peptides and proteins.
5. Alkaloids, terpenes, Pesticides, fungicides and herbicides**.**
6. Fundamentals of green chemistry, composites, mass spectrum.
7. Basic concept of petroleum and petrochemicals.

UNIT-I

Electrochemistry II **[12 Hours]**

Application of Conductivity Measurements: determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt and conductometric titrations. Reference electrodes: Calomel electrode, quinhydrone electrode and Ag/AgCl electrode. EMF of a cell and its measurements. Computation of cell EMF. Relation between ΔG and K for a cell reaction, Concentration cell with and without transport, Liquid Junction potential, Application of concentration cells-Determination of valency of ions and solubility product, Potentiometric titrations. Determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods and related problems.

Fuel Cells **[2 Hours]**

Importance, Working of Hydrogen-Oxygen fuel cell and Methanol-oxygen fuel cell.

UNIT-II

Organic Polymers **[6 Hours]**

Introduction, general classes of synthetic polymers-Addition and condensation with examples, Types of polymerizations (i) Free radical polymerization (ii) Cationic polymerization and (iii) Anionic polymerization of vinyl polymers with one example each, Zeigler-Natta polymerization. Condensation polymers-Phenol formaldehyde resins- Bakelite, urea-formaldehyde resins, Epoxy resins and polyurethanes-preparation and applications. Natural rubber-composition. Vulcanization, Synthetic rubbers: Buna-S and SBR-preparation and applications, advantages of synthetic rubbers over natural rubbers.

Inorganic Polymers **[4 Hours]**

Preparation, properties, structure and applications of silicones, fluorocarbons and phosphonitrilic halides. Production and structural features of borazine, boron nitride, sulphur nitride (SN)x and silicon carbide.

Conducting and Biodegradable Polymers **[4 Hours]**

Conducting Polymers: Introduction, definition and examples-polyaniline, polyacetylene. Mechanism of conduction. Qualitative treatment of doping, Properties-elasticity with high electrical conductivities, Engineering and biological applications

Biodegradable Polymers: Introduction, Structure and Properties, Mechanism of breakdown, Applications and uses.

UNIT-III

Alkaloids **[4 Hours]**

Classification with examples, General properties formation of salts and exhaustive methylation, physical properties and physiological activity. Structural elucidation of nicotine including synthesis. Structural formulae of atropine, cocaine and hygrine.

Terpenes **[3 Hours]**

Classification with examples, Isolation from plant sources. Structural elucidation of citral including synthesis. Structural formulae of geraniol, o-pinene and camphor.

Pesticides, Fungicides and Herbicides **[4 Hours]**

Introduction to the structure and properties of Pesticides: i) Organochlorine compounds-Heptachlor, BHC; ii) Organophosphorus Compounds-Malathion, Parathion, Endosulphan; iii) Others-Pyrethrin, Aleprin, Baygon. Herbicides: 2,4-dichlorophenoxy acetic acid. Fungicides: Bordeaux mixture, Dithoicarbamate.

Green Chemistry **[3 Hours]**

Green Chemistry for sustainable development and goals. Designing a Green Synthesis, Prevention of Waste bye products, concept of atom economy, Prevention/ minimization of hazardous/ toxic products, reducing toxicity. Green solvents-examples.

UNIT-IV

Mass Spectrometry **[6 Hours]**

Principle and instrumentation of mass spectrometer. Applications in the determination of molecular mass and isotopic abundance. Nitrogen rule, even electron rule, Meclafferty rearrangement. Differentiation between 2-methyl butanal and 3-methylbutanal by Meclafferty rearrangement.

Petroleum and Petrochemicals **[6 Hours]**

Composition of Petroleum, Petroleum refining, Fractional distillation-fractions and their uses. Cracking of Petroleum-Thermal and catalytic. Fixed bed catalytic cracking. Synthetic petrol and its production by Bergius process. Knocking, Octane number and Cetane number. Catalytic and thermal reforming. Important petrochemicals and their applications.

Composites **[2 Hours]**

Introduction, role of matrix in composites, types of matrix, different matrix materials, reinforcement, classification of composites and applications of composites in industry.

BSCCHCS602: Chemistry Theory-VIII

[Total number of Lecture Hours: 4 Hours/Week (4x14=56 Hours)]

Course Learning Objectives

This course helps to understand the following aspects of chemistry:

1. Knowledge about theory and instrumentation of colorimetry and spectrophotometry.
2. About principle and applications of different spectroscopic techniques.
3. Elementary idea of retrosynthesis.
4. Mechanism of interconversion, chain lengthening and shortening of carbohydrates.
5. Structure and functions of amino acids, peptides and proteins.
6. Knowledge about drugs, chemotherauptic agents, lipids and organosulphur compounds.

Course Outcomes

On completion of this course, the student will be able to appreciate the following aspects:

1. Theory and instrumentation of colorimetry and spectrophotometry
2. Principle and applications of different spectroscopic techniques
3. Basic concept of retrosynthesis

4. Mechanism of interconversion, chain lengthening and shortening of carbohydrates
5. Structure and functions of amino acids, peptides and proteins
6. Fundamentals of drugs, lipids and organosulphur compounds

UNIT-I

Colorimetry and Spectrophotometry [4 Hours]

Introduction, theory of colorimetry and spectrophotometry. Beer-Lambert's law, Instrumentation and applications of colorimetry and spectrophotometry.

Ultraviolet (UV) Absorption Spectroscopy [10 Hours]

Absorption Laws, Concept of molar absorptivity, energy level, types of electronic excitations, Frank-Condon principle (explanation about red shift and blue shift), presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypochromic, hyperchromic and hypsochromic shifts. UV spectra of conjugated dienes, dienones and α, β-unsaturated carbonyl compounds. Woodward Fieser's rules (Problems to be discussed).

UNIT-II

Nuclear Magnetic Resonance (NMR) Spectroscopy [11 Hours]

Introduction, NMR active nuclei, principle of NMR spectroscopy, instrumentation of PMR spectrometer, origin of spectra, solvents used, scales, chemical shift, shielding and deshielding, number of signals obtained from the sample, position of signals and factors affecting the chemical shift, spin-spin splitting, spin notation and coupling constants, area of signals, interpretation of PMR spectra of simple organic molecules and its structure such as ethyl bromide, ethanol, 2-propanol, acetaldehyde, acetone, 1,1,2-tribromo ethane, ethyl acetate, aniline, nitrobenzene and benzaldehyde.

Photoelectron Spectroscopy [3 Hours]

Basic principles, valence and core binding energies, shifts in energies due to chemical forces, photoelectron spectra of simple molecules, Koopman's theorem.

UNIT-III

Carbohydrates [7 Hours]

Monosaccharides: Interconversions of glucose and fructose, chain lengthening of aldoses (Kiliani-Fischer method), Chain shortening (Ruff degradation). Conversion of glucose and mannose-epimerisation, Mechanism of osazone formation, Amadori rearrangement, Formation of glycosides, ethers (methyl), esters (acetates). Configuration of glucose and fructose, Determination of ring size of monosaccharides (methylation and periodic acid degradation method), Elucidation of cyclic structure of D(+)-glucose, Mechanism of muta-rotation.

Amino Acids, Proteins and Peptides **[5 Hours]**

Classification based on functional group, Essential and non-essential amino acids, structure and stereochemistry of amino acids- explanation, Acid-base behaviour, isoelectric point and electrophoresis-explanation. Preparation of α- amino acids from α halogenated acids. Strecker synthesis and Gabriel synthesis. Reactions due to $–CO_2H$ and $-NH_2$ groups, Action of heat on amino acids.

Structure and nomenclature of di-, tri- and polypeptides, classification of proteins based on chemical composition and molecular shape. Peptide structure determination by end group analysis, denaturation of proteins.

Retrosynthesis **[2 Hours]**

Introduction, general terms, synthons and synthetic equivalents, target molecule, general guidelines for disconnection. Retro analysis and synthesis of benzocaine and 4-methoxy acetophenone.

UNIT-IV

Lipids **[5 Hours]**

Introduction, Classification. Fatty acids-definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic and linolenic acids). Essential fatty acids-definition with examples Triglycerides-Structure of simple and mixed glycerides. Biological importance of triglycerides. Cholesterol-Types (HDL, LDL and VLDL) Sphingolipids-Structure and biological significance of ceramide.

Drugs and Chemotherapeutic Agents **[2 Hours]**

Classification with examples. Synthesis of antipyrine, Chloramine-T, sulphathiazole and sulphanilamide.

Organo-Sulphur Compounds **[7 Hours]**

Thiols (Mercaptans): Methods of preparation (any two). Reactions-action of sodium, formation of salts, formation of thiol esters and oxidation. Uses of mercaptans.

Thioethers: Methods of preparation (any two). Reactions-Addition of halogens and alkyl halides, Oxidation and hydrolysis. Structure and uses of sulphonal.

Sulphonic acids: Methods of preparation (any two). Reactions of benzene sulphonic acid- i) involving H atom of $-SO_3H$ group ii) involving -OH group of $-SO_2OH$ group iii) involving $-SO_3H$ group iv) involving benzene ring. (One example each).

BSCCHPS601: Chemistry Practicals-VI

Organic Preparations and Instrumental Methods

[Total number of Practical Hours: 4 Hours/Week (4x14 =56 Hours)]

Course Learning Objectives

To understand the practical knowledge and skills for the instrumental experiments, preparation of organic and complex compounds.

Course Outcome

Students should be known how to select a solvent for crystallization, how crystallization should be carried out, complex compound preparation, and conduct experiments using modern instruments.

Minimum of any 10 experiments to be carried out

Organic Preparations

1. Preparation of acetanilide from aniline/benzoylation of aniline.
2. Preparation of p-bromoacetanilide
3. Nitration of acetanilide to p-nitro acetanilide and hydrolysis to p-nitroaniline.
4. Preparation of iodoform from ethanol
5. Preparation of m-dinitrobenzene
6. Preparation of adipic acid from cyclohexanol.
7. Preparation of benzoic acid from toluene/benzaldehyde.
8. Preparation of tribromoaniline from aniline and conversion to tribromobenzene.

Instrumental Methods

9. To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) conductometrically using standard alkali solution.
10. To determine the dissociation constant of a weak acid by potentiometric method.
11. To determine equivalent conductance of sodium chloride by conductometric method.
12. To determine the ionization constant of a weak acid conductometrically.
13. Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the redox potential of Fe^{3+}/Fe^{2+} system on the hydrogen scale.
14. To study the rate of inversion of cane sugar.
15. To determine the concentration of cupric ions, present in a solution using a colorimeter.

Preparation of Complexes

16. Preparation of sodium trisoxalateferrate (III), $Na_3[Fe(C_2O_4)_3]$.
17. Preparation of tetra ammine copper (II) sulphate, $[Cu\ (NH_3)_4]SO_4$.
18. Preparation of hexaaminecobalt (III) chloride, $[Co\ (NH_3)_6]Cl_3$.

Note: Principles of physical chemistry experiments, organic preparation and complex preparation are to be discussed in the laboratory.

Reference Books

1. Instrumental Methods of Chemical Analysis by Gurudeep R. Chatwal and Sham Anand, I998, Himalaya Publishing House.
2. Instrumental Methods of Chemical Analysis by Willard, Merritt, Dean and Skettle, 2004, CBS.
3. A Text Book of Inorganic Chemistry by Cotton and Wilkinson, 1992, Wiley lnterscience.
4. A Text Book of Inorganic Chemistry by P. L. Soni, 1998, Sultan Chand and Sons.
5. A Text Book of Inorganic Chemistry by Puri and Sharma, 2000, Shobanlal Nagin Chand.
6. A Text Book of Inorganic Chemistry by Gurudeep Raj, 2008, Goel.
7. A Text Book of inorganic Chemistry by Sathya Prakash, 2001, S. Chand & Company.
8. Concise inorganic Chemistry by J. D. Lee, l998, Blackwell Science.
9. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, 2000, Shobanlal Nagin Chand.
10. Selected Topics in inorganic Chemistry by Madan, Malik, Tuli, 2000, S. Chand and Company.
11. A Text Book of Inorganic Chemistry by A. K. De, 2001, New Age international.
12. Industrial Chemistry by B. K. Sharma, 2001, Goel.
13. A Text Book of Quantitative Analysis by A. I. Vogel, 1989, Longman.
14. Inorganic Polymers by G. R. Chatwal, l993, Himalaya Publishing House.
15. Theoretical Principles of Inorganic Chemistry by Manku, 2001, Tata McGraw Hills.
16. Advanced Physical Chemistry by Gurudeep Raj, 2011, Krishna Prakashan.
17. Agricultural Chemistry by B. A. Yagodin, 1976, Mir Publishers (Moscow).
18. Physical Chemistry by Madan and Tuli, 2001, S. Chand & Company.
19. A Text Book of Advanced Physical Chemistry by Gurudeep Raj, 2001, Goel.
20. A Text Book of Physical Chemistry by P. L. Soni, O. P. Dharmarha and U. N. Dash, 2011, Sultan Chand and Sons.
21. Organic Spectroscopy by William Kemp, 1991, ELBS.
22. Elementary Organic Spectroscopy by Y. R. Sharma, 2013, S. Chand & Company.
23. Systematic Experiments in Chemistry by Arun Sethi, 2008, New Age Interntionl.
24. Organic spectroscopy by S. K. Dewan, 2020, CBS.
25. Organic Reaction Mechanism by V. K. AhIuwalia and R. K. Parashar, 2010, Narosa.
26. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor, 2012, New Age International.
27. Green Chemistry by V. K. Ahluwalia, 2006, Ane Books.
28. A Hand Book of Sustainable Polymers by Vijay Kumar Thakur and Manju Kumari Thakur, 2016, CRC Press.
29. Degradable polymers, Principles and Applications by Gerald Scott, 2002, Kluwer Academic.

30. Hand Book of Biopolymers edited by Shakeel Ahmed, Suvardhan Kanchi, Gopalakrishnan Kumar, 2018, CRC Press.

Compulsory Skill/Practical Paper

(May be offered in either IV or V or VI Semester)

BSCCHSS401/501/601: Internship/Mini Project Work

[Total number of Project Work Hours: 2 Hours/Week (2x14=28 Hours)]

Internship/Mini project has to be compulsorily carried out in one of the last three semesters (Semester IV or V or VI) with a workload of 2 hours per week under the supervision of a teacher. Report on the internship/Mini project has to be submitted for evaluation.

****