



## **RANI CHANNAMMA UNIVERSITY, BELAGAVI**

**PROGRAM /COURSE STRUCTURE AND SYLLABUS**  
**As per the Choice Based Credit System (CBCS) designed**  
**in accordance with Learning Outcomes-Based Curriculum**  
**Framework (LOCF) of National Education Policy (NEP)**  
**2020**

**for**

## **Bachelor of Science/(Hons) Chemistry**



**Effective from Academic Year 2021-22 and onwards**



## **RANI CHANNAMMA UNIVERSITY, BELAGAVI**

### **BSc (Hons) Chemistry program-2022-23**

**(Revised)**

#### **BoS Committee-NEP-B.Sc (Hons) Chemistry 2022-23**

<b>S.No.</b>	<b>Name &amp; Address</b>	<b>Designation</b>
1	Prof. K. Kantharaju Chairman & Professor, Dept. of Chemistry RCUB	<b>Chairman</b>
2	Mr.A.K.Samant Govindram Seksaria Science College, Belagavi	<b>Member</b>
3	Dr. S.M.Gaonkar Basaveshwar Science College, Bagalkot.	<b>Member</b>
4	Mr.A.D.Kamath C.S.Bembalagi College, Ramdurg	<b>Co-opted Member</b>

#### **BoS Committee-NEP-B.Sc (Hons) Chemistry 2021-22**

<b>S.No.</b>	<b>Name &amp; Address</b>	<b>Designation</b>
1	Prof. K. Kantharaju Chairman & Professor, Dept. of Chemistry RCUB	<b>Chairman</b>
2	Dr.A.S.Kulkarni B.K.College, Belagavi	<b>Member</b>
3	Mr. B.I.Vasulkar B.K.College, Belagavi	<b>Member</b>
4	Dr.A.S.Jagnure G.I.Bagewadi College, Nippani	<b>Co-opted Member</b>
5	Dr.S.M.Deshpande GSS College, Belagavi	<b>Co-opted Member</b>

## **PREAMBLE**

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The Rani Channamma University envisions all its programmes in the best interest of their students and in this endeavour, it offers a new vision to all its Under-Graduate courses. It embedded Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of BSc (Hons) Chemistry offer courses in the areas of inorganic, organic, physical, industrial, materials and analytical. All the courses are having defined objectives and Learning Outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The course also offers ample of skills to pursue research as career in the field of chemistry and allied areas. As usual, B.Sc (Hons) Chemistry programme offered will continue to produce best minds to meet the demands of society.

The Rani Channamma University hopes the LOCF approach of the programme BSc (Hons) Chemistry will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

# **Syllabus & Regulations Governing the Choice-Based Credit System (CBCS) for the Four-Year (Eight Semesters) B.Sc (Hons) Chemistry Program**

## **Introduction to B.Sc (Hons.) Chemistry**

The Choice Based Credit System (CBCS) provides an opportunity to a student to choose courses from the syllabus comprising Core, Elective, Vocational and Skill based courses. It offers a flexibility of programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge. The learning outcome based curriculum framework (LOCF) will provide students with a clear purpose to focus their learning efforts and enable them to make a well judged choice regarding the course they wish to study. This will suit the present day needs of students in terms of securing their paths towards higher studies or employment.

## **Programme Structure**

**Discipline Specific Core (DSC) Courses:** First, second, third and fourth semesters will have one DSC course in each semester. Every DSC course has 6 credits and a practical component (4 credits for theory and 2 credits for practical).

Fifth and sixth semesters will have two Discipline Specific Core (DSC) courses in each semester. Every DSC course has 5 credits and has practical component (3 credits for theory and 2 credits for practical).

Seventh and eighth semesters will have three Discipline Specific Core (DSC) courses in each semester, three DSC courses have 6 credits each (4 credits for theory and 2 credits for practical).

**Open Elective (OE) Courses:** First, second, third and fourth semesters will have one OE course in each semester. Every OE course has 3 credits and with no practical component. OE courses are for other subject students (other than major and minor), and the candidate has to choose one OE from the each semester.

**Vocational Courses:** Fifth and sixth semester will have one each vocational courses of each 3 credits. In sixth semester students have 2 credits internship course (usually on research related work (basic knowledge about research, how to start, literature, journals, reviews and more can be taught and ask students to do and submit a final report for assessment). These courses can enable students to obtain the required basic research insights knowledge along with online resource or practical skills.

**Discipline Specific Elective (DSE) Courses:** Seventh and eighth semesters will have two DSE courses. In seventh semester will have one research methodology (3 credits) and another spectroscopy to meet the equivalence of first year master degree (4 credits).

In eighth semester again one DSE 4 credits theory and another research project for 4 credits need to perform one semester project work by selecting suitable problems by the mentors.

## **PROGRAMME OUTCOME from B.Sc (Hons.) Chemistry**

The B.Sc (Hons) programme in Chemistry is designed to develop in students in depth knowledge of thecore concepts and principles that are central to the understanding of this core science discipline. Undergraduates pursuing this programme of study go through laboratory work that specifically develop their quantitative and qualitative skills, provides opportunities for critical thinking and team work, and exposes them to techniques useful for applied areas of scientific study.

➤ **Knowledge: Width and depth:**

Students acquire theoretical knowledge and understanding of the fundamental concepts, principles and processes in main branches of chemistry, namely, organic, inorganic, physical, spectroscopy, analytical and biochemistry. In depth understanding is the outcome of transactional effectiveness and treatment of specialized course contents. Width results from the choice of electives that students are offered.

➤ **Laboratory Skills: Quantitative, analytical and instrument based:**

A much valued learning outcome of this programme is the laboratory skills that students develop during the course. Quantitative techniques gained through hands on methods opens choice of joining the industrial laboratory work force early on. The programme also provides ample training in handling basic chemical laboratory instruments and their use in analytical and biochemical determinations. Undergraduates on completion of this programme can cross branches to join analytical, pharmaceutical, material testing and biochemical labs besides standard chemical laboratories.

➤ **Communication:**

Communication is a highly desirable attribute to possess. Opportunities to enhance students' ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.

➤ **Capacity Enhancement:**

Modern day scientific environment requires students to possess ability to think independently as well as be able to work productively in groups. This requires some degree of balancing. The chemistry honours programme course is designed to take care of this important aspect of student development through effective teaching learning process.

➤ **Portable Skills:**

Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry with them to their new work environment after completion of chemistry honours programme. These are problem solving, numeracy and mathematical skills- error analysis, units and conversions, information retrieval skills, IT skills and organizational skills. These are valued across work environments.

**Structure of the Programme in B.Sc (Hons.) Chemistry**

The programme includes Core Courses and Elective Courses. The Core Courses are all compulsory courses (DSC).There are three types of Elective Courses – Discipline Specific Elective (DSE), Open Elective (OE), and Skill Enhancement Courses (SEC), have sub skill based and value based. In addition there are two compulsory Ability Enhancement Courses (AECC). The Core, DSE and GE Courses are six credit courses; the SEC, AEC are four credit courses.

**RANI CHANNAMMA UNIVERSITY**  
**Vidyasangama, P-B, NH-4, Belagavi. -591156**

Proposed Curricular and Credits Structure under Choice Based Credit System [CBCS] of  
Chemistry Major& One Minor Discipline Scheme for the Four Years Chemistry B.Sc.  
Undergraduate Honors Programmewith effect from 2021-22

<b>SEMESTER-I</b>										
<b>Category</b>	<b>Course code</b>	<b>Title of the Paper</b>	<b>Marks</b>			<b>Teaching hours/week</b>			<b>Credit</b>	<b>Duration of exams (Hrs)</b>
			<b>IA</b>	<b>SEE</b>	<b>Total</b>	<b>L</b>	<b>T</b>	<b>P</b>		
L1	21BSC1L1LK1	Kannada	40	60	100	4	-	-	3	2
	21BSC1L1LFK1	Functional Kannada								
L2	21BSC1L2LEN2	English	40	60	100	4	-	-	3	2
	21BSC1L2LHI2	Hindi								
	21BSC1L2LSN2	Sanskrit								
	21BSC1L2LTE2	Telugu								
	21BSC1L2LUR2	Urdu								
DSC1	21BSC1C1CHE1L	Chemistry-1	40	60	100	4	-	-	4	2
	21BSC1C1CHE1P	Chemistry Lab-1	25	25	50	-	-	4	2	4
DSC1	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
SEC1	21BSC1S1CS1	Digital Fluency	25	25	50	1	-	2	2	2
VBC1	21BSC1V1PE1	Physical Education-Yoga	25	-	25	-	-	2	1	-
VBC2	21BSC1V2HW1	Health & Wellness	25	-	25	-	-	2	1	-
OEC1	21BSC1O1CHE1	Chemistry in daily life	40	60	100	3	-	-	3	2
OEC1 A	21BSC1O1CHE1A [Only for B.Sc. in Sugar Sci & Tech]	Sugarcane Production Technology	40	60	100	3	-	-	3	2
<b>Total Marks</b>						<b>700</b>	<b>Semester Credits</b>		<b>25</b>	
<b>Note:</b> All skill enhancement course (SEC) syllabus and title should be selected time to time notice from the university and/ or NEP committee accordingly.										

SEMESTER-II										
Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
			I A	SE E	Total	L	T	P		
L3	21BSC2L3LK2	Kannada	40	60	100	4	-	-	3	2
	21BSC2L3FKL2	Functional Kannada								
L4	21BSC2L4EN2	English	40	60	100	4	-	-	3	2
	21BSC2L4HI2	Hindi								
	21BSC2L4SN2	Sanskrit								
	21BSC2L4TE2	Telugu								
	21BSC2L4UR2	Urdu								
DSC2	21BSC2C2CHE2L	Chemistry-2	40	60	100	4	-	-	4	2
	21BSC2C2CHE2P	Chemistry Lab-2	25	25	50	-	-	4	2	4
DSC2	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
AECC 1	21BSC2AE1ES	Environmental Studies	25	25	50	1	-	2	2	2
VBC3	21BSC2V3PE2	Physical Education- Sports	25	-	25	-	-	2	1	-
VBC4	21BSC2V4NC1	NCC/NSS/R&R(S &G) / Cultural	25	-	25	-	-	2	1	-
OEC2	21BSC2O2CHE2	Molecules of life	40	60	100	3	-	-	3	2
OEC2 A	21BSC2O2CHE2A [Only for B.Sc. in Sugar Sci Technol]	Sugar Factory Chemical Control	40	60	100	3	-	-	3	2
Total Marks						700	Semester Credits		25	

Exit option with Certificate (50 credits)

SECOND YEAR; SEMESTER-III										
Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
			IA	SEE	Total	L	T	P		
L5	21BSC3L5LK3	Kannada	40	60	100	4	-	-	3	2
	21BSC3L5LFK3	Functional Kannada								
L6	21BSC3L6EN3	English	40	60	100	4	-	-	3	2
	21BSC3L6HI3	Hindi								
	21BSC3L6SN3	Sanskrit								
	21BSC3L6TE3	Telugu								
	21BSC3L6UR3	Urdu								
DSC3	21BSC3CHE3L	Chemistry-3	40	60	100	4	-	-	4	2
	21BSC3CHE3P	Chemistry Lab-3	25	25	50	-	-	4	2	4
DSC3	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
SEC2	21BSC3S2AI/ 21BSC3S2CHE	Artificial Intelligence/	25	25	50	1	-	2	2	2
VBC5	21BSC3V5PE3	Physical Education- Sports	25	-	25	-	-	2	1	-
VBC6	21BSC3V6NC2	NCC/NSS/R&R (S&G) / Cultural	25	-	25	-	-	2	1	-
OEC3	21BSC3O3CHE3	Fuel chemistry & Environmental chemistry	40	60	100	3	-	-	3	2
OEC3 A	21BSC3O3CHE3A [Only for B.Sc. in Sugar Sci & Tech]	Boiler Water Management	40	60	100	3	-	-	3	2
Total Marks						700	Semester Credits		25	

SEMESTER-IV										
Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
			IA	SE E	Total	L	T	P		
L7	21BSC4L7LK4	Kannada	40	60	100	4	-	-	3	2
	21BSC4L7LFK4	Functional Kannada								
L8	21BSC4L8EN4	English	40	60	100	4	-	-	3	2
	21BSC4L8HI4	Hindi								
	21BSC4L8SN4	Sanskrit								
	21BSC4L8TE4	Telugu								
	21BSC4L8UR4	Urdu								
DSC4	21BSC4C4CHE4L	Chemistry-4	40	60	100	4	-	-	4	2
	21BSC4C4CHE4P	Chemistry Lab-4	25	25	50	-	-	4	2	4
DSC4	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
AECC 2	21BSC4AE2CI	Constitution of India	25	25	50	1	-	2	2	2
VBC7	21BSC4V5PE4	Physical Education-Sports	25	-	25	-	-	2	1	-
VBC8	21BSC4V6NC3	NCC/NSS/ R&R(S&G) / Cultural	25	-	25	-	-	2	1	-
OEC4	21BSC4O4CHE4	Electrochemistry, corrosion and metallurgy	40	60	100	3	-	-	3	2
OEC4 A	21BSC4O4CHE4A [Only for B.Sc. in Sugar Sci Technol]	Analytical Instrumentation	40	60	100	3	-	-	3	2
Total Marks						700	Semester Credits		25	

**Exit option with Diploma (100 credits)**

<b>SEMESTER-V</b>										
<b>Category</b>	<b>Course code</b>	<b>Title of the Paper</b>	<b>Marks</b>			<b>Teaching hours/week</b>			<b>Credit</b>	<b>Durati on of exams (Hrs)</b>
			<b>IA</b>	<b>SEE</b>	<b>Total</b>	<b>L</b>	<b>T</b>	<b>P</b>		
<b>Chemistry as Major Discipline</b>										
DSC5	21BSC5C5C HE5L	Chemistry-5	40	60	100	3	-	-	3	2
	21BSC5C5C HE5P	Chemistry Lab-5	25	25	50	-	-	4	2	4
DSC6	21BSC5C5C HE6L	Chemistry-6	40	60	100	3	-	-	3	2
	21BSC5C5C HE6P	Chemistry Lab-6	25	25	50	-	-	4	2	4
DSC5	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	3	-	-	3	2
			25	25	50	-	-	4	2	4
VC1	21BSC5VC1	Vocational-I	40	60	100	3	-	-	3	2
VBC9	21BSC5V5PE 5	Physical Education-Sports	25	-	25	-	-	2	1	-
VBC10	21BSC5V6N C4	NCC/NSS/R&R(S&G) / Cultural	25	-	25	-	-	2	1	-
SEC3	21BSC5S3CH E3		25	25	50	1	-	2	2	2
<b>Total Marks</b>					<b>650</b>	<b>Semester Credits</b>		<b>22</b>		

<b>SEMESTER-VI</b>										
<b>Category</b>	<b>Course code</b>	<b>Title of the Paper</b>	<b>Marks</b>			<b>Teaching hours/week</b>			<b>Credit</b>	<b>Duration of exams (Hrs)</b>
			<b>I A</b>	<b>SE E</b>	<b>Total</b>	<b>L</b>	<b>T</b>	<b>P</b>		
<b>Chemistry as Major Discipline</b>										
DSC7	21BSC6C6CH E7L	Chemistry-7	40	60	100	3	-	-	3	2
	21BSC6C6CH E7P	Chemistry Lab-7	25	25	50	-	-	4	2	4
DSC8	21BSC6C6CH E8L	Chemistry-8	40	60	100	3	-	-	3	2
	21BSC6C6CH E8P	Chemistry Lab-8	25	25	50	-	-	4	2	4
DSC6	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	3	-	-	3	2
			25	25	50	-	-	4	2	4
VC2	21BSC6VC2	Vocational-II	40	60	100	3	-	-	3	2
INT1	21BSC6 INT1L	Internship	25	50	75	-	-	2	2	2
VBC1	21BSC6V5PE 5	Physical Education-Sports	25	-	25	-	-	2	1	-
VBC2	21BSC6V6N C4	NCC/NSS/R&R (S&G) / Cultural	25	-	25	-	-	2	1	-
SEC4	21BSC6S4CH E		25	25	50	1	-	2	2	2
<b>Total Marks</b>					<b>700</b>	<b>Semester Credits</b>			<b>24</b>	
<b>Total Marks for BSC Program</b>					-	<b>Total Credits for BSC Program</b>			<b>146</b>	

\*Internship between 5<sup>th</sup> and 6<sup>th</sup> semester with 3-4 weeks

### Chemistry Subject as a Minor Discipline

<b>SEMESTER-V</b>										
<b>Category</b>	<b>Course code</b>	<b>Title of the Paper</b>	<b>Marks</b>			<b>Teaching hours/week</b>			<b>Credit</b>	<b>Duration of exams (Hrs)</b>
			<b>I A</b>	<b>SE E</b>	<b>Total</b>	<b>L</b>	<b>T</b>	<b>P</b>		
DSC5 As a Minor Subject	21BSC5C5CHE 5L	Chemistry-5	40	60	100	3	-	-	3	2
	21BSC5C5CHE 5P	Chemistry lab-5	25	25	50	-	-	4	2	4

<b>SEMESTER-VI</b>										
<b>Category</b>	<b>Course code</b>	<b>Title of the Paper</b>	<b>Marks</b>			<b>Teaching hours/week</b>			<b>Credit</b>	<b>Duration of exams (Hrs)</b>
			<b>I A</b>	<b>SE E</b>	<b>Total</b>	<b>L</b>	<b>T</b>	<b>P</b>		
DSC7 As a Minor Subject	21BSC6C6CHE7L	Chemistry -7	40	60	100	3	-	-	3	2
	21BSC6C6CHE7P	Chemistry Lab-7	25	25	50	-	-	4	2	4

**Exit option with Bachelor of Science, B. Sc. Basic Degree (146 credits)**

SEMESTER-VII											
Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)	
			I A	SE E	Total	L	T	P			
<b>Chemistry(General) as Major Discipline</b>											
DSC9	21BSC7C9CHE9L	Chemistry-9	40	60	100	4	-	-	4	2	
	21BSC7C9CHE9P	Chemistry Lab-9	25	25	50	-	-	4	2	4	
DSC10	21BSC7C10CHE10L	Chemistry-10	40	60	100	4	-	-	4	2	
	21BSC7C10CHE10P	Chemistry Lab-10	25	25	50	-	-	4	2	4	
DSC11	21BSC7C11CHE11L	Chemistry-11	40	60	100	4	-	-	4	2	
	21BSC7C11CHE11P	Chemistry Lab-11	25	-	25	-	-	4	2	4	
DSE1	21BSC7E1CHE1L	Spectroscopy-1	40	60	100	4	-	-	4	4	
DSE2	21BSC7E2CHE2L	Research Methodology	40	60	100	3	-	-	3	4	
<b>Total Marks</b>						<b>650</b>	<b>Semester Credits</b>		<b>25</b>		

<b>SEMESTER-VIII</b>										
<b>Category</b>	<b>Course code</b>	<b>Title of the Paper</b>	<b>Marks</b>			<b>Teaching hours/week</b>			<b>Credit</b>	<b>Duration of exams (Hrs)</b>
			<b>I A</b>	<b>SE E</b>	<b>Total</b>	<b>L</b>	<b>T</b>	<b>P</b>		
<b>Chemistry(General) as Major Discipline</b>										
DSC12	21BSC8C12CHE12L	Chemistry-9	40	60	100	4	-	-	4	2
	21BSC8C12CHE12P	Chemistry Lab-9	25	25	50	-	-	4	2	2
DSC13	21BSC8C13CHE13L	Chemistry-10	40	60	100	4	-	-	4	2
	21BSC7C13CHE13P	Chemistry Lab-10	25	25	50	-	-	4	2	2
DSC14	21BSC7C14CHE14L	Chemistry-11	40	60	100	4	-	-	4	2
	21BSC7C14CHE14P	Chemistry Lab-11	25	25	50	-	-	4	2	2
DSE3	21BSC8E3CHE3L	Spectroscopy-II	40	60	100	4	-	-	4	2
DSE4	21BSC8E4CHE4L	Research Project	50	100	150	-	-	8	4	2
<b>Total Marks</b>					<b>700</b>	<b>Semester Credits</b>			<b>26</b>	

**Award of Bachelor of Science (Hons) degree in a Chemistry (197 credits)**

## **Concept Note, Abbreviation Explanation and Coding:**

### **Concept Note:**

1. **CBCS** is a mode of learning in higher education which facilitates a student to have some freedom in selecting his/her own choices, across various disciplines for completing a UG/PG program.
2. A credit is a unit of study of a fixed duration. For the purpose of computation of workload as per UGC norms the following is mechanism be adopted in the University:
  - One credit (01) = One Theory Lecture (L) period of one (1) hour.
  - One credit (01) = One Tutorial (T) period of one (1) hour.
  - One credit (01) = One practical (P) period of two (2) hours.
3. Course: paper/subject associated with AECC, DSC, DSEC, SEC, VBC, OEC, VC, IC and MIL
4. In case of **B.Sc.** Once a candidate chose two courses/subjects of a particular two department in the beginning, he/she shall continue the same till the end of the degree/Hons, then there is no provision to change the course(s) and Department(s) in between.
5. A candidate shall choose **one of the Department's courses as major and other Department course as minor in fifth and sixth semester and major course will get continued in higher semester.**
6. Wherever there is a practical there will be no tutorial and vice-versa
7. A major subject is the subject that's the main focus of Core degree/concerned.
8. A minor is a secondary choice of subject that complements core major/ concerned.
9. Vocational course is a course that enables individual to acquire skills set that are required for a particular job.
10. Internship is a designated activity that carries some credits involving more than **25 days** of working in an organization (either in same organization or outside) under the guidance of an identified mentor. Internship shall be an integral part of the curriculum.
- 11. OEC: For non- chemistry students. Chemistry students have to opt for OEC from departments other than major and minor disciplines.**

### **Abbreviation Explanations:**

1. AECC: Ability Enhancement Compulsory Course.
2. DSC: Discipline Specific Core Course.
3. DSEC: Discipline Specific Elective Course.
4. SEC: Skill Enhancement Course.
5. VBC: Value Based Course.
6. OEC: Open/Generic Elective Course
7. VC: Vocational Course.
8. IC: Internship Course
9. L1: Language One
10. L2: MIL
11. L= Lecture; T= Tutorial; P=Practical.
12. MIL= Modern Indian Language; English or Hindi or Telugu or Sanskrit or Urdu

### **Program Coding:**

1. Code 21: Year of Implementation
2. Code BSC: BSC Program under the faculty of Applied Science of the University
3. Code 1: First Semester of the Program, (2 to 6 represent higher semesters)
4. Code AE: AECC, (C for DSC, S for SEC, V for VBC and O for OEC)
5. Code 1: First “AECC” Course in semester, similarly in remaining semester for such other courses
6. Code LK: Language Kannada, similarly Language English, Language Hindi, Language Telugu, Language Sanskrit, &Language Urdu
7. Code 1: Course in that semester.
8. CHE: Chemistry

**Note:** All skill enhancement course (SEC) syllabus and title should be selected time to time notice from the university and/ or NEP committee accordingly.

**ASSESSMENT METHODS**  
**Evaluation Scheme for Internal Assessment:**

**Theory:**

<b>Assessment Criteria</b>	<b>40 marks</b>
1 <sup>st</sup> Internal Assessment Test for 30 marks 1 hr after 8 weeks and 2 <sup>nd</sup> Internal Assessment Test for 30 marks 1 hr after 15 weeks. Average of two tests should be considered.	30
Assignment	10
<b>Total</b>	<b>40</b>

<b>Assessment Criteria</b>	<b>25 marks</b>
1 <sup>st</sup> Internal Assessment Test for 20 marks 1 hr after 8 weeks and 2 <sup>nd</sup> Internal Assessment Test for 20 marks 1 hr after 15 weeks. Average of two tests should be considered.	20
Assignment	05
<b>Total</b>	<b>25</b>

**Practical:**

<b>Assessment Criteria</b>	<b>25 marks</b>
Semester End Internal Assessment Test for 20 marks 2 hrs	20
Journal (Practical Record)	05
<b>Total</b>	<b>25</b>

**Question Paper Pattern:**  
**RANI CHANNAMMA UNIVERSITY**  
**Department of Chemistry**

**Duration: 2hr**

***I Semester B.Sc (Chemistry)***

**Sub:**

**Code:**

**Maximum Marks: 60**

**a. Answer any SIX Questions from Question 1**  
**b. Answer any Three in each Question from 2,3,4 and 5questions.**

<b>Q.No.1.</b>	<b>Answer any SIX Questions (Two question from each Unit)</b>  a. b. c. d, e. f. g. h.	<b>2X6=12</b>
<b>Q.No.2.</b>	<b>(Should cover entire unit-I )</b>  a. b. c. d.	<b>4X3=12</b>
<b>Q.No.3.</b>	<b>(Should cover Entire Unit-II )</b>  a. b. c. d.	<b>4X3=12</b>
<b>Q.No.4.</b>	<b>(Should cover Entire Unit-III )</b>  a. b. c. d.	<b>4X3=12</b>
<b>Q.No.5.</b>	<b>(Should cover Entire Unit-IV)</b>  a. b. c. d.	<b>4X3=12</b>

**BSc (Hons) Chemistry-Semester 1****Title of the Course: DSC-1: Subject code: 21BSC1C1CHE1L Paper: Chemistry – 1**

Number of Theory Credits	Number of lecture hours/ semester	Number of practical credits	Number of practical hours / semester
<b>4</b>	<b>56</b>	<b>2</b>	<b>56</b>
<b>Content of Theory Course 1</b>			

**Unit – 1 Analytical chemistry****14 hours**

Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method - accuracy, precision, sensitivity, selectivity, method validation. Figures of merit of analytical methods and limit of detection (LOD), Limit of quantification (LOQ)

Errors and treatment of analytical data: Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples -mean, median, range, standard deviation and variance. Numerical problems

**Titrimetric analysis:** Basic principle of titrimetric analysis. Classification, Preparation and dilution of reagents/solutions. Preparation of ppm level solutions from source materials (salts), conversion factors.

**Acid-base titrimetry:** Theory, Titration curves for all type of acid- base titrations. Quantitative applications – selecting and standardizing a titrant,

**Complexometric titrimetry:** Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA – direct and indirect determinations, Application determination of hardness of water.

**Redox titrimetry:** Titration curves, Theory of redox indicators, Applications of redox titrations.

**Precipitation titrimetry:** Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences.

**Unit - 2 Atomic structure & Periodicity of elements****14 hours**

**Atomic Structure:** Review of Rutherford's atomic model, Bohr's theory, Hydrogen atomic spectra. Derivation of radius and energy of an electron in hydrogen atom, limitations of Bohr's theory, dual behavior of matter and radiation, de Broglie's equations, Heisenberg Uncertainty principle and their related problems. Quantum numbers and their significance. Orbital shapes of *s,p,d and f* atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, Electronic configurations of the atoms (atomic number up to 54).Concept of exchange energy. Anomalous electronic configurations.

**9hrs**

**Periodic properties of elements:** Brief account on the following properties of elements with reference to s and p-block and trends in groups and periods. Effective nuclear

charge, screening effect, Slater rules, atomic and ionic radii, ionization enthalpy, electron gain enthalpy, and electronegativity, Pauling / Allred-Rochow scales of electronegativity. **5hrs**

### **Unit 3 Bonding in Organic Molecules and Mechanism of Organic reactions 14 hours**

Classification and nomenclature of organic compounds, Hybridization, Shapes of organic molecules m Influence of hybridization on bond properties.

**Nature of bonding in Organic molecules** Types of chemical bonding, Formation of Covalent bond, localized and delocalized, conjugation and cross conjugation, concept of resonance, electronic displacements: Inductive effect, Electromeric effect, Resonance and Hyper conjugation with examples. Concept of resonance and aromaticity, Huckel rule, anti-aromaticity explanation with examples. **6hrs**

### **Mechanisms of Organic Reactions-I**

Notations used to represent electron movements and directions of reactions- curly arrows, formal charges. Types of bonds breaking- homolytic and heterolytic. Types of reagents-Electrophiles, nucleophiles, nucleophilicity and basicity. Types of organic reactions- substitution, addition, elimination, rearrangement and pericyclic reactions, explanation with examples.

**Chemistry of Aliphatic hydrocarbons: Carbon-Carbon Sigma bonds** Chemistry of alkanes: Formation of alkanes, Wurtz reaction, Wurtz-Fittig reaction, Free radical substitutions Mechanism of Halogenation- relative reactivity and selectivity **8hrs**

### **Unit - 4 Gaseous State & Distribution Law**

**14hours**

**Gaseous state:** Review of kinetic theory of gases, van der Waals equation of state Boyle temperature. Molecular velocity: Maxwell's Boltzmann distribution law of molecular velocities (most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies (derivation not required). Collision frequency, collision diameter, Collision cross-section, collision number and mean free path. Critical phenomena: Andrews isotherms of  $\text{CO}_2$ , critical constants and their determination Relation between critical constants and van der Waals equation (Derivation), continuity of states, law of corresponding states. Numerical problems are to be solved wherever applicable. **8hrs**

**Distribution Law:** Nernst Distribution Law - Statement and its derivation. Distribution constant, factors affecting distribution constant, validity of Distribution Law, Modification of distribution law when molecules undergo a) Association b) Dissociation. Application of Distribution Law in Solvent extraction. Derivation for simple and multiple extraction. Principles of distribution law in Parkes Process of desilverisation of lead. Numerical Problems. **6hrs**

## **LEARNING OUTCOMES / COURSE OUTCOMES:**

### **Chemistry as Discipline Specific Course (DSC)**

#### **B.Sc. Semester –I; CHEMISTRY-1**

After successful completion of three year degree program in Chemistry a student should be able to;

1. Describe the dual nature of radiation and matter; dual behaviour of matter and radiation, de Broglie's equations, Heisenberg Uncertainty principle and their related problems.
2. Electronic configurations of the atoms.
3. Define periodicity, explain the cause of periodicity in properties, and classify the elements into four categories according to their electronic configuration.
4. Define atomic radii, ionisation energy, electron affinity and electronegativity, discuss the factors affecting atomic radii, describe the relationship of atomic radii with ionisation energy and electron affinity, describe the periodicity in atomic radii, ionization energy, electron affinity and electronegativity.
5. Explain bond properties, electron displacement effects (inductive effect, electromeric effect, resonance effect and Hyper conjugation effect). Steric effect and their applications in explaining acidic strength of carboxylic acids, basicity of amines.
6. Understand basic concept of organic reaction mechanism, types of organic reactions, structure, stability and reactivity of reactive intermediates.
7. Describe important characteristics of configurationally and conformational isomers. Practice and write conformational isomers of ethane, butane and cyclohexane.
8. Understand the various concepts of geometrical isomerism and optical isomerism. Describe CIP rules to assign E,Z notations and R& S notations. Explain D and L configuration and *threo* and *erythro* nomenclature.
9. Explain racemic mixture and racemisation, resolution of racemic mixture through mechanical separation, formation of diastereomers, and biochemical methods, biological significance of chirality.
10. Explain the existence of different states of matter in terms of balance between intermolecular forces and thermal energy of the particles. Explain the laws governing behavior of ideal gases and real gases. Understand cooling effect of gas on adiabatic expansion.
11. Describe the conditions required for liquefaction of gases. Realise that there is continuity in gaseous and liquid state.
12. Explain properties of liquids in terms of intermolecular attractions.
13. Understand principles of titrimetric analysis.
14. Understand principles of different type's titrations. Titration curves for all types of acids – base titrations.
15. Gain knowledge about balancing redox equations, titration curves, theory of redox indicators and applications.
16. Understand titration curves, indicators for precipitation titrations involving silver nitrate-Volhard's and Mohr's methods and their differences.
17. Indicators for EDTA titrations - theory of metal ion indicators. Determination of hardness of water.

## **CHEMISTRY LAB (Inorganic and Organic Analyses)**

After studying this course and performing the experiments set in it student will be able to:

1. Understand and practice the calibration of glasswares (burette, pipette, volumetric flask).
2. Basic concepts involved in titrimetric analysis, primary standard substances, preparation of standard solutions.
3. Explain the principles of acid-base, redox and iodometric titrations.
4. Work out the stoichiometric relations based on the reactions involved in the titrimetric analysis.
5. Based on principles of titrimetric analysis student can perform
6. Describe the significance of organic quantitative analysis.
7. Determine the amount of phenol, aniline, amide, ester and formaldehyde in a given solution by performing blank titration and main titrations.
8. Determine aspirin in the tablet by hydrolysis method.

### **Chemistry Lab-1: List of experiments to be conducted**

**Course code: 21BSC1C1CHE1P; Paper: Chemistry Lab-1**

#### **PART-A**

1. Determination of sodium carbonate and sodium bicarbonate in a mixture
2. Determination of alkali present in soaps/detergents
3. Determination of oxalic acid using potassium permanganate solution
4. Standardization of EDTA solution and determination of hardness of water
5. Determination of phenol/aniline by bromination method
6. Determination of acetamide/ethylbenzoate by hydrolysis method

#### **PART-B**

7. Preparation of acetanilide from aniline using Zn/acetic acid (Green method)
8. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture
9. Bromination of acetanilide (i) Conventional method and /or  
(ii) with ceric ammonium nitrate and potassium bromide (Green method).
10. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method)

#### **Examination**

In the practical examination, a batch of maximum 15 (Fifteen) students may be made. Anyone experiment from Part-A or B can be given by selection done by the students based on lots. **Viva questions must be asked on any of the experiments prescribed in the practical syllabus.**

#### **Part A: Distribution of marks**

1. Accuracy: 12 (6+6) Marks
2. Technique and presentation: 03Marks
3. Reactions and Calculations: 05 Marks
4. Viva: 05 Marks

#### **Total 25 marks**

**Deduction of marks for accuracy:  $\pm 0.4$  CC – 6 marks,  $\pm 0.6$  CC- 04 marks,  $\pm 0.8$  CC- 02 marks,  $\pm 1.0$  CC - 01 marks. Above  $\pm 1.0$  CC - 00 marks**

**Part B: Distribution of Marks:**

1. Reaction & Mechanism-04 marks,
2. Calculation of theoretical yield – 02 mark,
3. Observed yield -10 marks,
4. M.P- 004 marks,
5. Viva-Voce-5 marks,

**Total=25 marks.**

**Deduction of marks for observed yield: Less than 10% - 10 marks, 11-15% - 8 marks, 16-20% - 6 marks, 21-25 % - 4 marks & above 25% - zero mark.**

**References**

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6<sup>th</sup> edition, Third Indian Reprint, Pearson Education Pvt. Ltd.(2007).
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8<sup>th</sup> edition, Saunders College Publishing, New York (2005).
3. Analytical Chemistry, G.D. Christian, 6<sup>th</sup> edition, Wiley-India (2007).
4. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
5. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
6. Finar, I. L. *Organic Chemistry (Volume I)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
7. McMurry, J. E. *Fundamentals of Organic Chemistry*, 7<sup>th</sup> Ed. Cengage Learning India Edition, 2013
8. Organic Reaction mechanism by V. K. Ahluwalia and K. Parashar (Narosa Publishers).
9. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
10. A Guide book to mechanism in Organic Chemistry by Peter Sykes. Pearson.

**BSc Semester 1 – B.Sc/(Hons) Chemistry****Title of the Course: Open Elective (OE-1): CHEMISTRY IN DAILY LIFE****Course code: 21BSC1O1CHE1**

Courses	Credits	No. of Classes/ Week	Total No. of Lectures/ Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100
<b>Content of Theory Course 1</b>							<b>42 Hrs</b>

**Unit – 1****14 hours**

**Dairy Products:** Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. **Beverages:** Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.

**Food additives, adulterants, and contaminants-** Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.

**Artificial food colorants:** Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.

**Unit – 2****14 hours**

**Vitamins:** Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.

**Oils and fats:** Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test.

**Soaps & Detergents:** Definition, classification, manufacturing of soaps and detergents, composition and uses.

**Unit – 3****14 hours****Chemical and Renewable Energy Sources:**

Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storers.

**Polymers:** Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers

## **COURSE OUTCOMES: OEC-1 Chemistry**

On completion of the course students will be able to:

- Understand the chemical constituents in various day today materials using by a common man.
- Understand the chemical constituents in fertilizers, insecticides and pesticides, chemical explosives etc.
- Understand the chemical constituents in polymers, surface coatings etc.

### **References Text Books**

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry- Ashtoush Kar.
3. Analysis of Foods – H.E. Cox: 13.
4. Chemical Analysis of Foods – H.E. Cox and Pearson.
5. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4<sup>th</sup>ed. New Age International (1998)
6. Physical Chemistry – P 1 Atkins and J. de Paula – 7<sup>th</sup>Ed. 2002, Oxford University Press.

## **BSc Semester 1 – B.Sc (Hons) Chemistry**

**Title of the Course: Open Elective (OE-1): SUGARCANE PRODUCTION TECHNOLOGY**

**[Only for B.Sc. Sugar Science and Technology students]**

**Course code: 21BSC1O1CHE1A**

Courses	Credits	No. of Classes/ Week	Total No. of Lectures/ Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100

**Unit – I** **10**

**Hours**

### **Introduction**

Origin, History and distribution of sugarcane growing regions of India. The taxonomic classification of sugarcane. Morphology – stem of sugarcane. Economic root system and inflorescence in sugarcane and growth phases in sugarcane. Economic important cane v/s beet sugar. Major varieties of sugarcane cultivated in Karnataka and their features.

### **Ecology**

Temperature, Rainfall, Relative humidity (RH), Atmospheric CO<sub>2</sub> concentration, Sunlight, Frost, Wind, Microclimate, Effect of greenhouse gases (GHGs) on cultivation of sugarcane.

**Unit – II**

**11 Hours**

### **Basic concepts of sugarcane physiology**

Photosynthesis, factors of influencing photosynthesis, effect of temperature, photoperiod, Transpiration, Growth promoters, Growth inhibitors.

### **Soil**

Elements of Soils and their Characters; Definition of soil. Importance and functions of soils. Soil profile, soil particles, structure, texture, density, porosity, physical properties, soil pH, Electrical Conductivity and Ion exchange process.

Soil organic matter, importance, characters and carbon and nitrogen ratio and its importance. Acid soils, saline and alkaline soils, their characters, formation, problems and their management practices. Meaning of soil fertility, soil fertility deciding factors, plant nutrients and their classification. Essential nutrients, Forms of nutrients required by plant, movement of nutrients towards roots, availability of nutrients. Organics, meaning and classification / types. Nitrogen, Phosphorus and potassium fertilizers and their characters and reactions in the soil. Complex, Mixed and liquid fertilizers and micronutrient fertilizers. Soil analysis, Recommendations of fertilizers based on soil test results.

**Unit – III** **11 Hours**

**Production practices**

**Land preparation:** Preparatory tillage, green manuring and application of bulky manures, seed material and seed rate, geometry of planting and planting depth, planting period, agronomy of late planted crop, planting methods, mechanical planters, aftercare. Sugarcane based cropping and farming systems, companion cropping in sugarcane, sugarcane based farming systems.

**Nutrition and fertilizer management**

Time and method of N application, bio-fertilizers, Time and method of applying Bio-fertilizers, Ex situ composing of trash and press mud (modified Japanese method), Vermi-composting, major nutrients and micro nutrients.

**Weed management**

Integrated weed control, herbicide, antidotes or softeners, surfactants and adjuvant, control of noxious, perennial weeds and methods of weed control measures.

**Water management**

Irrigation water requirement, Evapo-transpiration (ET) Water use efficiency (WUE), Different methods of Irrigation, Furrow method of irrigation Sprinkler irrigation, and Drip or trickle Irrigation.

**Management of seed cane**

Sett treatment, agronomy of seed cane, thermotherapy or heat therapy and Three-tier seed programme. Tissue culture and its importance in seed programme.

**Unit – IV** **10 Hours**

**Ripening, cane maturity and harvesting**

Ripening methods, Methods of cane purchase, Harvest strategy, Pre-harvest maturity survey, Methods of harvest, Mechanized harvesting. Quality assessment of late harvested cane, Composition of sugarcane and juice and quality parameters of juice, Post harvest losses and measures to reduces the losses. Cost of cultivation of sugarcane.

**Management of ratoon cane**

Importance of Ratoon management Ratoon cane Management practices, Time and method of fertilizer application, yield attributes of ratoon cane, ratoon v/s plant cane. Water requirement, gap filling, trash management, management of weeds, pests, and diseases associated with ratoon effect of growth regulators on sprouting and ratoon yield.

**Pests and disease management**

**Pests:** Shoot borer, top borer, internode borer, stalk borer, gurudaspur borer, root borer, White Grubs, Termites, Scale insect: (Green), Pyrillapupusilla, Walker), White files, Non-insect pests, Biological control of sugarcane pests, parasites.

**Diseases:** Red rot, Smut, Wilt, Pineapple disease, Yellow Leaf Disease (YLD), Leaf spots, Ratoon stunning disease (RSD), Grassy Shoot Disease (GSD), Nematodes and Mosaic.

**Reference Books:**

1. Hartmann and Kester's – Plant propagation – Principles and practices – Hudscan T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. Robert L. Geneve.
2. Textbook of Plant Physiology – C. P. Malik
3. Diseases of Crop plants in India – G. Rangaswami and A. Mahadevan
4. Plant Pathology – R. S. Mehrotra
5. Practical cytology – Applied Genetics and Biostatistics – H. K. Goswami and Rajeev Goswami
6. Recent Advances in Plant Diseases Vol-1 to 5-K.M. Chandniwala
7. Introduction to Principles of Plant Pathology – R.S. Singh
8. An Introduction to Plant Anatomy – Arthur R. Eames and Laurence H. Mac Deniels.
9. Genetics and Plant Breeding – E. B. Babcock
10. Plant Taxonomy – O.P. Sharma
11. Plant Breeding – Theory and Techniques – S.K. Gupta
12. Breeding Asian Field Crops – John Milton Poehlman and Dhirendranath Borthakur.
13. Crop Production and Field Experimentation – Dr. V. G. Vaidya, K. R. Sahasrabudhe, Dr. V. S. Khuspe.
14. Agricultural Problems of India – A. N. Agrwal and Kundam Lal
15. Elementary Principles of Plant Breeding – H.K. Chaudhari
16. Trends in Agricultural Insect Pest Management – G.S. Dhaliwal and Ramesh Arora.

**SKILL ENHANCEMENT COURSE IN CHEMISTRY****Title of the Course: SEC: Course code: 21BSC1E1CS1****Paper name: Digital Fluency**

Courses	Credits	No. of Classes/Week	Total No. of Lectures/Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	02	01	11	---	---	10	10
Practical		02	22	2	25	15	40
				Total	25	25	50

## BSc Semester 2 – Chemistry (Hons)

Title of the Course: DSC-2: Subject code: 21BSC1C1CHE2LPaper: Chemistry – 2

Number of Theory Credits	Number of lecture hrs/ semester	Number of practical Credits	Number of practical hrs/ sem
4	56	2	56
Content of Theory Course 2			56Hrs

### Unit – 1 Chemical bonding, molecular structure 14hours

**Ionic Bonding:** General characteristics of ionic compounds. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Born-Landé equation and calculation of lattice energy. Born-Haber cycle and its applications.

**Polarizing power and polarizability:** Fajan's rules, ionic character in covalent compounds and percentage of ionic character.

**Covalent bonding:** General characteristics of covalent compounds. VB approach, shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures of  $\text{NO}_3^-$ ,  $\text{CO}_3^{2-}$  and  $\text{SO}_4^{2-}$ .

**Molecular Orbital Theory:** LCAO method, bonding and antibonding MOs and their characteristics for  $s-s$ ,  $s-p$  and  $p-p$  combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules:  $\text{H}_2$ ,  $\text{O}_2$ ,  $\text{N}_2$  and ions of 1<sup>st</sup> and 2<sup>nd</sup> periods:  $\text{He}_2^{+1}$ ,  $\text{O}_2^{+1}$  and heteronuclear diatomic molecules such as  $\text{CO}$ ,  $\text{NO}$  and  $\text{NO}^+$ . Comparison of VB and MO approaches. Numerical problems are to be solved wherever applicable.

### Unit - 2 Acidic Strengths of Organic compounds and Stereochemistry 14 hours

Strengths of Organic acid and bases: Comparative study with emphasis on factors effecting pKa values. Relative strength of aliphatic and aromatic carboxylic acids-Acetic acid and chloroacetic acid, acetic acid and propionic acid, acetic acid and Benzoic acid. Steric effect-Relative stability of trans and cis-2-butene.

Concept of Confirmational analysis with reference to Ethane & n-Butane with staggered & eclipsed confirmations & energy profile diagrams. 4hrs

**Stereoisomersim:** Definition of stereoisomerism, conformational isomers and configurational isomers (distinction between conformation and configuration). Newman, Sawhorse and Fischer projection formulae and their interconversions.

**Geometrical isomerism:** Definition, reason for geometrical isomerism, E and Z notation - CIP rules and examples, determination of configuration of geometric isomers by dipole moment method and anhydride formation method, *syn* and *anti* isomers in compounds containing  $\text{C}=\text{N}$ .

**Optical isomerism:** Chirality/asymmetry, enantiomerism, diastereomerism and meso compounds. R and S notations (compounds with two asymmetric centers), D and L configurations and *threo* and *erythro* nomenclature, racemic mixture and racemization,

Resolution: Definition, Resolution of racemic mixture by: i) Mechanical separation ii) Formation of diastereomers iii) Biochemical methods. Biological significance of chirality. **10hrs**

**Unit - 3 Solids & Liquid crystals** **14 hours**

**Liquid Crystals:** 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. Applications of liquid crystals in LCDs and thermal sensing. **6hrs**

**Solids:** Types of solids. Unit cell and space lattice, anisotropy of crystals, size and shape of crystals, Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry, Symmetry elements, X-Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Structure of NaCl, KCl and CsCl, Defects in crystals, glasses and liquid crystals. Numerical problems. **8hrs**

**Unit - 4 Chemical Kinetics I, Liquid state & Gravimetric Analysis** **14hours**

**Chemical Kinetics I:** Review of reaction rates, order and molecularity. Factors affecting rates of reaction: concentration, pressure, temperature, catalyst, etc. Examples for different orders of reactions. Derivation of integrated rate equations for zero and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction (numerical problems). Methods for determination of order of a reaction by half-life period and differential equation method. **3hrs**

**Liquid state:** Molecular forces and general properties of liquids.

**Surface tension:** surface tension, surface energy, effect of temperature on surface tension, shapes of liquid drops and soap bubbles, capillary action, determination of surface tension by capillary rise method, drop weight and drop number methods using stalagmometer. Effect of temperature on surface tension. Parachor, Additive and constitutive properties: atomic and structural parachor. Elucidation of structure of benzene and benzoquinone. .

**Viscosity:** Definition, viscosity coefficient, fluidity, molecular viscosity, relative viscosity and absolute viscosity, determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces.

**Refractive index:** Definition, Specific and molar refraction. Determination of refractive index using Abbe's refractometer. Additive and constitutive properties: Numerical problems are to be solved wherever applicable. **7hrs**

**Gravimetric Analysis:** Stages in gravimetric analysis, requisites of precipitation, factors influencing precipitation, co-precipitation and post-precipitation. Structure, specificity, conditions and applications of organic reagents such as salicylaldoxime, oxine, dimethylglyoxime, cupron in inorganic analysis. **4hrs**

## Reference Books

### 1. Inorganic Chemistry

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3<sup>rd</sup> ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J. J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Huheey, J. E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
5. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
6. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
7. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.
8. Mark Weller and Fraser Armstrong, 5<sup>th</sup> Edition, Oxford University Press (2011-2012)  
Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley & Sons, 1974.
9. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry*, Pearson Publication.
10. Mahan, B.H. *University Chemistry* 3<sup>rd</sup> Ed. Narosa (1998).
11. Petrucci, R.H. *General Chemistry* 5<sup>th</sup> Ed. Macmillan Publishing Co.: New York (1985).

### Organic Chemistry

1. Organic Chemistry-P. Y. Bruice, 7th Edition, Pearson Education Pvt. Ltd., New Delhi (2013).
2. Heterocyclic Chemistry- R. K. Bansal, 3rd Edition, New- Age International, New Delhi, 2004
3. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7<sup>th</sup> Ed. Cengage Learning India Edition, 2013.
4. Sykes, P.A *Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi(1988).
5. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd, New Delhi.
6. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
7. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
8. Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons(2014).
9. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
10. Organic Chemistry-F.A. Carey, 4th Edition, McGraw Hill (2000).
11. Modern Organic Chemistry - R.O.C. Norman and D.J. Waddington, ELBS, 1983
12. Understanding Organic reaction mechanisms - A. Jacobs, Cambridge Univ. Press, 1998
13. Organic Chemistry - L. Ferguson, Von Nostrand, 1985
14. Organic Chemistry - M. K. Jain, Nagin & Co., 1987
15. Organic Chemistry- Mehta and Mehta.

### Physical Chemistry

1. Barrow, G.M. *Physical Chemistry* Tata Mc Graw-Hill(2007).
2. Castellan, G.W. *Physical Chemistry* 4<sup>th</sup> Ed. Narosa(2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt.Ltd., New Delhi(2009).
4. P.W. Atkins: *Physical Chemistry*.
5. W.J. Moore: *Physical Chemistry*
6. Text Book of Physical Chemistry - P.L. Soni, S. Chand & Co., 1993
7. Text Book of physical chemistry - S. Glasstone, Macmillan India Ltd., 1982

8. Principles of Physical Chemistry - B. R. Puri, L.R. Sharma and M.S.Patania, S.L.N. Chand & Co. 1987
9. Physical Chemistry - Alberty R. A. and Silbey, R.J.John Wiley and sons, 1992
10. Physical Chemistry - G.M.Barrow, McGraw Hill, 1986
11. Physical Chemistry( 3rd Edition) - Gilbert W. Castilian, Narosa Publishing House,1985
12. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
13. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York.

#### **Analytical Chemistry**

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, JohnWiley&Sons,1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settle, F.A. *Instrumental Methods of Analysis*,7<sup>th</sup>Ed. Wadsworth Publishing Company Ltd.,Belmont, California, USA, 1988.
3. Christian, G.D; *Analytical Chemistry*, VI Ed. John Wiley & Sons, NewYork, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, Ed.New York, W.H. Freeman,2001.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

## **Content of Chemistry Lab-2: List of Experiments to be conducted**

**Title of the Course: DSC-2: Subject code: 21BSC1C1CHE2P; Paper: Chemistry Lab-2**

### **PART-A Inorganic Chemistry**

#### **A.1. TITRIMETRY**

1. Determination of carbonate and hydroxide present in a mixture.
2. Standardization of potassium permanganate solution and determination of nitrite in a water sample
3. Determination of chlorine in bleaching powder using iodometric method.

#### **A.2. GRAVIMETRY**

1. Determination of  $\text{Ba}^{2+}$  as  $\text{BaSO}_4$
2. Determination of  $\text{Cu}^{2+}$  as  $\text{CuSCN}$

### **PART-B Physical Chemistry**

1. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (Ethyl acetate, Toluene, Chloroform, Chlorobenzene or any other non-hazardous liquids).
2. Study of the variation of viscosity of sucrose solution with the concentration of a solute.
3. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (Ethyl acetate, Toluene, Chlorobenzene, any other non-hazardous liquids).
4. Study of variation of surface tension of detergent solution with concentration.
5. Determination of specific and molar refraction by Abbes Refractometer. (Ethyl acetate, Methyl acetate, Ethylene Chloride).
6. Determination of the composition of liquid mixture by refractometry. (Toluene & Alcohol, Water & Sucrose).

\*\* Standard solution is to be prepared by students for both in regular and in practical examination.

#### **Examination**

In the practical examination, a batch of maximum 15 (Fifteen) students may be made. Anyone experiment from Part-A or B can be given by selection done by the students based on lots. **Viva questions must be asked on any of the experiments prescribed in the practical syllabus.**

#### **Part A1: Distribution of marks**

1. Accuracy: 12 (6+6) Marks
2. Technique and presentation: 03Marks
3. Reactions and Calculations: 05 Marks
4. Viva: 05 Marks

#### **Total 25 marks**

**Deduction of marks for accuracy:  $\pm 0.4$  CC – 6 marks,  $\pm 0.6$  CC- 04 marks,  $\pm 0.8$  CC- 02 marks,  $\pm 1.0$  CC - 01 marks. Above  $\pm 1.0$  CC - 00 marks**

#### **Part A2: Distribution of marks**

1. Accuracy: 12 Marks
2. Technique and presentation: 03Marks
3. Reactions and Calculations: 05 Marks
4. Viva: 05 Marks

#### **Total 25 marks**

**Deduction of marks for accuracy :  $\pm 6$ mg – 12 marks,  $\pm 7$  mg- 10 marks,  $\pm 8$ mg - 08 marks,  $\pm 10$  mg - 06 marks. Above 10mg - 00 marks**

**Part B: Distribution of marks**

1. Accuracy: 12 Marks
2. Technique and presentation: 03marks
3. Graphs and Calculations: 05 Marks
4. Viva: 05 Marks

**Total 25 marks**

**Deduction of marks for accuracy: Error up to 5% - 12 marks, 6 - 10% 09 marks, 11-15% 6 marks, 16 % or above 3 marks.**

## Open Elective Course-Chemistry

**Title of the Course: OEC-2: Subject code: 21BSC1O2CHE2; Paper: Molecules of Life  
B.Sc. Semester –II**

Course	Credits	No. of Classes/ Week	Total No. of Lecture Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100

### UNIT I

#### Carbohydrates

Sugars, non-sugars, reducing and non-reducing sugars. Occurrence and general properties of glucose and fructose. Open chain and Haworth ring structures of glucose and fructose. Epimers, mutarotation and anomers.

Disaccharides: Occurrence of disaccharides (Sucrose, Maltose and Lactose).

Glycosidic linkage in disaccharides. Ring structures of sucrose, maltose and lactose.

Polysaccharides: Starch – monomer units, glycosidic linkage, components-difference in their structure (explanation only) and solubility in water. Cellulose and glycogen- monosaccharide, glycosidic linkage, structure (explanation only).

Biological importance of carbohydrates **8hrs**

#### Amino Acids, Peptides and Proteins

$\alpha$ - amino acids , general formula, zwitter ion form of  $\alpha$ - amino acid, general formula. Isoelectric point and its importance. Classification of amino acids as essential and non-essential-examples. Configuration of optically active  $\alpha$ -amino acids (found in proteins). Peptide bond. Proteins: classification based on molecular shape—fibrous and globular, examples. Structure of protein – qualitative idea about primary, secondary, tertiary, and quaternary structures (diagrams not required). Denaturation of protein. **8hrs**

### UNIT II

#### Enzymes and correlation with drug action

Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereo specificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-competitive inhibition including allosteric inhibition). **7hrs**

**Drug action-** Receptor theory. Structure-activity relationships of drug molecules, binding role of  $-OH$  group,  $-NH_2$  group, double bond and aromatic ring. **4hrs**

#### Oils and fats

Biological Importance of oils and fats. Fatty acids (saturated, unsaturated fatty acids, formation of triglycerides and general formula of triglycerides. Chemical nature of oils and fats-saponification, acid hydrolysis, rancidity and its prevention methods, refining of oils, hydrogenation of oils, drying of oils. Iodine value.

Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). **6hrs**

### **UNIT III**

#### **Nucleic Acids**

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), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation. **6hrs**

#### **Vitamins and Hormones**

Classification and biological significance, source and structure of Vitamin A, B1 (thiamine), B2 (riboflavin), B6 (pyridoxine),  $\alpha$ -tocopherol, K1 (phylloquinone), C (ascorbic acid). Deficiency diseases of vitamins,

**Hormones:** definition, classification with examples, functions and deficiency diseases of hormones. **5hrs**

#### **Course Outcome / Learning Outcome:**

After studying this paper the student would be able to

1. Acquire knowledge about different types of sugars and their chemical structures.
2. Identify different types of amino acids and determine the structure of peptides.
3. Explain the actions of enzymes in our body and interpret enzyme inhibition.
4. Predict action of drugs. Depict the biological importance of oils and fats. Importance of lipids in the metabolism Differentiate RNA and DNA and their replication. Explain production of energy in our body.

#### **Reference Books:**

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*
5. W. H. Freeman. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, 2002.

## Open Elective Course-Chemistry-2A

**Title of the Course: OEC-2A: Subject code: 21BSC1O2CHE2A;**

**[Only for B.Sc. Sugar Science and Technology students]**

**Paper: SUGAR FACTORY CHEMICAL CONTROL**

**B.Sc. Semester -II**

Courses	Credits	No. of Classes/ Week	Total No. of Lectures/Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100

### **Unit – I**

**11 Hours**

**General:** Weighment system & estimation of % cane figures – MJ/imbibition/ bagasse, Calculation for estimation of Pol in bagasse, Pol in MJ, Pol % cane

### **Unit – II**

**11 Hours**

**Milling control:** Fundamental equations for milling control, Mill extraction, fiber % cane, fiber % bagasse, Estimation of RME, Deer & RME (Mittal), Imbibition % cane, Imbibition % fibre, dilution indicator

### **Unit – III**

**10 Hours**

**Sugar balance and its losses** – Estimation of sugar losses –bagasse/filter cake/ molasses/ recovery/ unknown, Estimation of Pol balance, RS balance and total losses.

Available sugar / available molasses, General stock taking, Reduced boiling house control,

### **Unit – IV**

**10 Hours**

Boiling house recovery, Reduced BHR, Purity drop, % exhaustion, Masscuite % cane, Steam % cane

**Overall:** Preparation of daily manufacturing report (DMR),RT(8)C,RT(7)C.

### **Reference Books:**

1. Training manual for sugar mills; Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
2. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt., Ltd. Bombay
3. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India New Delhi.

### **DSC-3: Semester-III: Chemistry-3**

Number of Theory Credits	Number of lecture hrs/semester	Number of practical Credits	Number of practical hrs/ sem
4	56	2	Workload: 4 Hours/Week. 56
<b>Content of Theory Course 3</b>			<b>56Hrs</b>

### **Course objectives:**

1. Interrelationship among frequency, wavelength and wave number and importance of validation parameters of an instrumental method will be taught
2. Principle, instrumentation and applications of spectrophotometry, nephelometry and turbidometry will be taught
3. Fundamentals of separation methods and principles of paper, thin layer and column chromatography will be taught
4. Principle, types and applications of solvent extraction will be taught
5. Principle and mechanism of ion-exchange, types of resins and domestic and industrial applications of ion-exchange chromatography will be taught
6. The concept of mechanism and its importance will be taught to the student
7. Concept and importance of intermediates in organic chemistry will be taught taking proper examples
8. The various techniques for identification of reaction mechanism will be taught to the student taking proper examples
9. Concept of stereochemistry and its importance will be taught.
10. The various projection formulae and the techniques of designating the molecules into R, S, D, L will be taught taking proper examples
11. The theory and concept of Cis-, Trans-isomerism and its importance and the techniques to differentiate between them will be taught taking examples

### **Course Specific Outcomes**

After the completion of this course, the student would be able to

1. Understand the importance of fundamental law and validation parameters in chemical analysis
2. Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric, nephelometric and turbidometric methods.
3. Understand the requirement for chemical analysis by paper, thin layer and column chromatography.
4. Apply solvent extraction method for quantitative determination of metal ions in different samples
5. Utilize the ion-exchange chromatography for domestic and industrial applications
6. Explain mechanism for a given reaction.
7. Predict the probable mechanism for a reaction. Explain the importance of reaction intermediates, its role and techniques of generating such intermediates
8. Explain the importance of Stereochemistry in predicting the structure and property of organic molecules.
9. Predict the configuration of an organic molecule and able to designate it.
10. Identify the chiral molecules and predict its actual configuration.

## Syllabus

### **Unit-I Quantitative analysis-Instrumental methods** 14hrs

Electromagnetic spectrum, absorption of electromagnetic radiation Beer's law, Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures-standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation: single beam and double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Mo, Cu, Ti and  $\text{PO}_4^{3-}$ ) and numerical problems on application of Beer's law. 10hrs

**Nephelometry and Turbidometry:** Introduction, principle, instrumentations of nephelometry and turbidometry; effects of concentration, particle size and wavelength on scattering; choice between nephelometry and turbidometry, applications of nephelometry and turbidimetry (determination of  $\text{SO}_4^{2-}$  and  $\text{PO}_4^{3-}$ ) 4hrs

### **Unit-II Structure and Bonding-I** 14 hrs

#### **Structure and Bonding-I**

The ionic bond II: Structures of ionic solids, Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral) close packing. 4hrs

#### **Classification of ionic structures:**

Ionic compounds of the type  $\text{AX}$  ( $\text{ZnS}$ ,  $\text{NaCl}$ ,  $\text{CsCl}$ ), Ionic compounds of the type  $\text{AX}_2$  (Calcium fluoride (fluorite) and Rutile structure, Layer structures  $\text{CdI}_2$ , Cadmium iodide structure, Limitations of radius ratio concept, Kapustinskii equation, solvation energy and solubility of ionic solids, Numerical problems 5hrs

**Covalent bond II:** The Lewis theory, octet rule, exceptions to the octet rule, Sidgwick-Powell theory. Review of Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory:  $\text{BF}_3$  and  $\text{BF}_4^-$ ,  $\text{NH}_3$  and  $\text{NH}_4^+$ ,  $\text{ClF}_3$ ,  $\text{SF}_4$ ,  $\text{I}_3^-$  and  $\text{I}_3^+$ ,  $\text{SF}_6$  and  $\text{IF}_7$ . Limitations of VSEPR. 5hrs

### **Unit III Mechanism of Organic Reactions II** 14hrs

Carbon-carbon pi bonds: Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cB reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereo-specificity of halogen addition. Ozonolysis mechanism - ozonolysis of propene. Diel-Alder reaction and Mechanism of Allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene. 7 hrs

**Nucleophilic substitution at saturated carbon:** Mechanism of  $SN_1$  and  $SN_2$  reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting  $SN_1$  and  $SN_2$  reactions.

**Aromatic Electrophilic substitution reactions:** Mechanisms,  $\sigma$  and  $\pi$  complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction:  $SN_{Ar}$  and Benzyne mechanism with suitable examples. 7 hrs

**UNIT IV Thermodynamics and surface chemistry** 14hrs  
**First Law of Thermodynamics**

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters

**Second law of Thermodynamics**

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular interpretation of entropy, Calculation of entropy change for reversible and irreversible processes. Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation

**Third Law of Thermodynamics**

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. 9Hrs

**Surface Chemistry**

**Adsorption**

Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

**Catalysis**

Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Michaelis-Menten equation-derivation. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements. 5Hrs

## References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8<sup>th</sup> edition, Saunders College Publishing, New York (2005).
2. Analytical Chemistry, G.D. Christian, 6<sup>th</sup> edition, Wiley-India (2007).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, PHI Learning Pvt Ltd. New Delhi (2009).
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6<sup>th</sup> edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007).
5. Organic Reaction Mechanism by V.K. Ahluwalia and R.K. Parashar (Narosa Publishers)
6. Organic Chemistry by S.M. Mukherji, S.P. Sinha and R.K. Kapoor (Narosa Publishers)
7. Morrison R.N and Boyd R.N, Organic Chemistry, Darling Kindersley (India) Pvt. Ltd. (Pearson Education)
8. Finar I.L, Organic Chemistry (Volume I); Finar I.L (Volume II) Stereochemistry and the Chemistry of Natural Products., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
9. Kalsi P.S. Stereochemistry, conformation and Mechanism, Newage International
10. Eliel E. Landwilen S.H, Stereochemistry of Organic Compounds, Wiley, (London).

## PRACTICALS

**Credit Points: 2      Teaching Hours: 4 hrs**  
**Evaluation: Continuous Internal Assessment-25marks**  
**Semester End Examination: 25marks**

### Course Objectives

- 1) To impart skills related to preparation of stock and working solutions and handling of instrumental methods
- 2) To know the principle of colorimetric analysis and construction of calibration plot
- 3) To understand the chemistry involved in colorimetric determination of metal ions and anions
- 4) To determine  $R_f$  values of different metal ions present in a mixture
- 5) To impart knowledge on the importance of functional groups in organic compounds.
- 6) Techniques to identify the functional groups in a compound by performing physical and chemical tests
- 7) To record its melting point/boiling point.
- 8) To prepare suitable derivative for that compound and to characterize it.

### Course Specific outcomes

After the completion of this course, the student would be able to

- 1) Understand the importance of instrumental methods for quantitative applications  
Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples
- 2) Understand how functional groups in a compound is responsible for its characteristic property
- 3) Learn the importance of qualitative tests in identifying functional groups.
- 4) Learn how to prepare a derivative for particular functional groups and how to purify it.

### Experiments list

#### PART-A

- 1) Colorimetric determination of copper using ammonia solution
- 2) Colorimetric determination of iron using thiocyanate solution
- 3) Determination of  $R_f$  values of two or three component systems by TLC /Paper Chromatography
- 4) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution (**demonstration**)

#### PART-B

Qualitative analysis of Organic compounds such as

- 1) Salicylic acid, p-Nitrobenzoic acid, Antranilic acid, p-Chloro benzoic acid
- 2) o-Cresol, p-Cresol, Resorcinol, o-Nitrophenol, p-nitophenol
- 3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline,
- 4) Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitrotoluene, Benzamide etc. (At least 6-8 compounds to be analysed in a semester)

## **Examination**

In the practical examination, a batch of maximum 15 (Fifteen) students may be made. Anyone experiment from Part-A or B can be given by selection done by the students based on lots. **Viva questions must be asked on any of the experiments prescribed in the practical syllabus.**

### **Part A: Distribution of marks**

1. Accuracy: 12 Marks
2. Technique and presentation: 03 Marks
3. Graphs and Calculations: 05 Marks
4. Viva: 05 Marks

### **Total 25 Marks**

Deduction of marks for accuracy: Error up to 5% - 12 marks, 6 - 10% 09 marks, 11-15% 6 marks, 16 or above 3 marks.

### **Part B: Distribution of Marks:**

1. Preliminary tests and presentation - 03 marks,
2. Group test based on solubility: 02 marks
3. Distinguishing test and C.T: 10 marks (4+6)
4. Preparation of derivative: 03marks
5. Melting point of derivative: 02marks
6. Viva-Voce-5 marks

**Total=25 marks.**

## **References**

- 1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K.Thomas, 6<sup>th</sup> edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007)
- 2) Vogel's Text Book of Qualitative Chemical Analysis, ELBS

**Semester-3: BSc/B Sc (Honors)****Title of the Course: Open Elective: Fuel Chemistry and Environmental Chemistry**

Course	Credits	No. of Classes/ Week	Total No. of Lecture Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100

This course provides a broad introduction to the fundamental principles of Fuel chemistry, and Environmental Chemistry. The student will gain an understanding of basic and practical applications aspects of Fuels and environmental chemistry. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

**Course Objectives****This course will deal with**

1. Types of energy sources, concept of fuels, Petroleum and Environmental chemistry
2. Concept of different types of fuels and calorific values,
3. Basic principles of fuel sources, their preparation and applications.
4. Different types of lubricants and their applications
5. Concept of pollution, types of pollution and its prevention.

**Expected Course Outcomes**

Upon completion of the course students will be able to

1. Understand the concept of fuels, and their classifications.
2. Learn the different types of fuels and their applications.
3. Know the different types of pollution and their prevention

**UNIT-I: FUEL CHEMISTRY:****14hrs**

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification). Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications

**UNIT-II****14 hrs**

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

**UNIT-III ENVIRONMENTAL CHEMISTRY****14 hrs**

Energy and Environment: Sources of energy: coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen and geo-thermal energy. **3 hrs**

Air pollution: Major regions of atmosphere,

Air pollutants: types, sources, particle size and chemical nature. Control measures of air pollution. Photochemical smog: its constituents and photochemistry. Green house effect, global warming and ozone depletion. **4 hrs**

Water pollution, water quality standards: Water pollutants and their sources. Industrial effluents and their treatment (primary and secondary treatment). Sludge disposal. Water quality parameters for waste water, industrial water and domestic water.

Nuclear pollution: Disposal of nuclear waste, nuclear disaster and its management. **7hrs**

**Reference:**

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. Engineering Chemistry DhanpatRai& Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).
4. Environmental Chemistry, A. K. De, 6th Edn. New Age International (P) Ltd.,(2008).
5. Environmental Chemistry-S. K. Banerji, (Prentice Hall India), 1993
6. Industrial Chemistry, B.K.Sharma, 9th Edn. Krishna Prakashan Media (P) Ltd. Meerut (1997-98)

**SEMESTER III**  
**OEC3-BOILER WATER MANAGEMENT**  
**[Only For B. Sc. (Sugar Science & Technology) Students]**

Credits – 3	Max. Marks: 100
Teaching Hours / week: 4 Hours	Marks: Theory = 60
Theory Examination duration :2 Hours	Internal assessment= 40

**UNIT – I** **14 hours**

**General boiler mounting/accessories & working:** General boiler types, Water tube boiler- General parts – furnace / combustion zone / feed water tank/feed pump/ steam drum /mud drum /super heater/level indicators/ economizer/air heater/ID fan/FD fan/SA fan/ etc, High pressure & low pressure boilers

**UNIT – II** **14 hours**

**Water:** Water properties & nature, Sources of water, Use of water & basic chemistry, water related tables, Impurities in water and their effects on boiler working – scale formation – boiler tubes &economiser / carry over / Silica deposition/Super heater & turbine deposits/ Corrosion

**Water quality requirement & treatment:** General standards for boiler water/boiler feed water for high pressure as well as low pressure boilers, Objectives of boiler water treatment, External & Internal treatment

**UNIT – III** **14 hours**

**External water treatment** - Clarification, Filtration, , Chlorination, Ion exchange, De-areation, Reverse Osmosis, Silica removal, Oil removal, deareation

**Ion exchange methods:** Softner, De-alkalisation, Demineralisation application & limitation, Resin

**Membrane Technology:** Ultra filtration, Nano Filtration, Reverse Osmosis, Electro-dialysis

**UNIT - IV** **14 hours**

**Internal treatment:** Organic polymers & their role in scale inhibition, Dispersants & sludge conditioners, various chemical dosing, corrosion due to low pH, prevention of corrosion in boiler. Use of oxygen scavengers

**Boiler operations & water quality:** Boiler blow down, Reasons for boiler failures, Boiler preventive maintenance, Tubes internal chemical cleaning, water tube boilers – fire side cleaning

**REFERENCE BOOKS:**

1. Practical boiler water treatment Handbook, N. Manivasakam, By Shakti Book Services, Coimbatore
2. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
3. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.

## Semester -IV; CHEMISTRY: DSC-4: Chemistry-IV

Number of Theory Credits	Number of lecture hrs/semester	Number of practical Credits	Number of practical hrs/ sem
4	56	2	56
<b>Content of Theory Course 4</b>			<b>56Hrs</b>

**Course Objectives:** Students learn about

1. Different types of bonding in molecules/compounds/ions
2. The structures of molecules/compounds/ions based on different models/theories
3. Properties of compounds based on bonding and structure
4. The fundamentals of thermodynamics including the laws, the concept of entropy and free energy functions and their applications.
5. The concepts of surface chemistry, catalysis and their applications.
6. The theoretical and experimental aspects of chemical kinetics including basic theories of reaction rates and methods of determining order.
7. Electrochemistry dealing with electrolytes in solution. Conductance measurements and applications. Concept of ionic mobility and their determination.

**Course outcomes:** After the completion of this course, the student would be able to

1. Predict the nature of the bond formed between different elements
2. Identify the possible type of arrangements of ions in ionic compounds
3. Write Born-Haber cycle for different ionic compounds
4. Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids
5. Explain covalent nature in ionic compounds
6. Write the M.O. energy diagrams for simple molecules
7. Differentiate bonding in metals from their compounds
8. Learn important laws of thermodynamics and their applications to various thermodynamic systems
9. Understand adsorption processes and their mechanisms and the function and purpose of a catalyst.
10. Apply adsorption as a versatile method for waste water purification.
11. Understand the concept of rate of a chemical reaction, integrated rate equations, energy of activation and determination of order of a reaction based on experimental data
12. Know different types of electrolytes, usefulness of conductance and ionic mobility measurements
13. Determine the transport numbers

## Syllabus

### Unit-I Separation methods

14 hrs

**Fundamentals of chromatography:** General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase, nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version. **5 hrs**

**Paper chromatography:** Theory and applications

**Thin layer chromatography (TLC):** Mechanism,  $R_f$  value, efficiency of TLC plates, development, spray reagents, identification and detection, qualitative applications **2 hrs**

**Solvent Extraction:** Types-batch, continuous, efficiency, selectivity, distribution coefficient, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper. **4hrs**

### **Ion exchange Chromatography**

Resins, types with examples-cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion -exchange chromatography (softening of hard water, separation of lanthanides,). **3hrs**

## Unit-II Structure and Bonding-II

14hrs

### **Structure and Bonding-II**

Concept of resonance, resonance energy, hybridisation, types of hybridization,  $sp$ ,  $sp^2$ ,  $sp^3$ ,  $dsp^2$ ,  $dsp^3$ ,  $d^2sp^3$ ,  $sp^3d^2$ , with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory. **4hrs**

### **Molecular Orbital theory-II:**

Calculation of bond order, relationship between bond order, bond energy and bond length. Magnetic properties based on MOT. Examples of molecular orbital treatment for homonuclear diatomic molecules:  $He_2$ ,  $Li_2$ ,  $Be_2$ ,  $B_2$ ,  $C_2$ ,  $N_2$ ,  $N_2^+$ , and  $O_2^{2-}$  **5hrs**

### **Metallic Bonding:**

General properties of metals: Conductivity, Lustre, Malleability and cohesive force, Crystal structures of metals and Bond lengths. Theories of bonding in metals: Free electron theory, Valence bond theory, Molecular orbital or band theory of solids. Prediction of conducting properties of conductors, insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory. **5hrs**

## Unit III Reaction Intermediates and methods of identification

14hrs

- Reaction Intermediates: Generation, Stability and Reactions of,
- i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Rearrangement.
- ii) Carbanions: Perkin Reaction, Aldol condensation,
- iii) Free Radicals: Sandmeyer Reaction
- iv) Carbenes and Nitrenes: Singlet and Triplet states, their relative stability and reactions
- v) Arynes: Formation and detection **9hrs**

### **Methods for Identifying Reaction Mechanism:**

Product analysis, Isolation and identification of intermediates, stereochemical evidences, crossover experiments, isotopic studies, kinetic studies **5 hrs**

### **UNIT-IV Kinetics and Electrochemistry 14hrs**

#### **Chemical Kinetics-II**

Temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates-Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

**5 Hrs**

#### **Electrochemistry-I**

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobility and its determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems. **9hrs**

### **Reference Books**

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9<sup>th</sup> Ed., Oxford University Press(2010)
2. GWCastellan,PhysicalChemistry,4<sup>th</sup>Ed.,Narosa(2004)
3. RGMortimer,PhysicalChemistry3<sup>rd</sup>Ed.,Elsevier:Noida,UP(2009)
4. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.
5. B S Bahl, G D Tuli and ArunBahl, Essentials of Physical chemistry, S Chand & Company Ltd.
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers.
7. BN Bajpai, Advanced Physical chemistry, S Chand and Company Ltd.
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd.
9. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons.

## PRACTICALS

**Credit Points: 2**      **Teaching Hours: 4Hrs**  
**Evaluation: Continuous Internal Assessment: 25marks**  
**Semester End Examination: 25 marks**

**Course objective: To attain practical knowledge about:**

1. Analytical skills in detecting the constituents present in unknown samples by systematically carrying out the qualitative analysis.
2. The methods of determining rates of chemical reactions.
3. Designing electrochemical cells and making measurements related to it.
4. Determination of physical characteristics of electrolytes using conductivity measurements in solution.
5. Adsorption phenomenon, mechanism and basic models to explain adsorption.
6. Simple techniques like conductometry to obtain physicochemical parameters of electrolytes.

**Course outcomes:** At the end of the course student would be able to

1. Understand the chemical reactions involved in the detection of cations and anions.
2. Explain basic principles involved in classification of ions into groups in semi-micro qualitative analysis of salt mixture
3. Carry out the separation of cations into groups and understand the concept of common ion effect.
4. Understand the choice of group reagents used in the analysis.
5. Analyse a simple inorganic salt mixture containing two anions and cations
6. Use instruments like conductivity meter to obtain various physicochemical parameters.
7. Apply the theory about chemical kinetics and determine the velocity constants of various reactions.
8. Learn about the reaction mechanisms.
9. Interpret the behaviour of interfaces, the phenomena of physisorption and chemisorptions and their applications in chemical and industrial processes.
10. Learn to fit experimental data with theoretical models and interpret the data

### **Part A- Inorganic Chemistry Practicals**

Qualitative semi-microanalysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

Cations:  $\text{NH}_4^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Co}^{2+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Na}^+$ ,  $\text{K}^+$ .

Anions:  $\text{CO}_3^{2-}$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{S}^{2-}$  (Sulphide)

**Spot tests and flame tests to be carried out wherever possible.**

### **Part B- Physical Chemistry Practicals**

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. Determination of velocity constant for acid catalysed hydrolysis of methylacetate.
3. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
4. Determination of dissociation constant of weak acid by conductivity method.
5. Conductometric titration of strong acid and strong base.
6. Conductometric titration of weak acid and strong base.

### **Examination**

In the practical examination, a batch of maximum 15 (Fifteen) students may be made. Anyone experiment from Part-A or B can be given by selection done by the students based on lots. **Viva questions must be asked on any of the experiments prescribed in the practical syllabus.**

#### **Part A: Distribution of Marks:**

Preliminary tests and presentation - 04 marks,

Anions (group test + C.T + ionic reactions)  $(1+1+1) \times 2 = 6$  marks,

Cations (group test + C.T + ionic reactions)  $(1+3+1) \times 2 = 10$  marks,

Viva-Voce-5 marks,

**Total=25 marks.**

#### **Part B: Distribution of marks**

1. Accuracy: 12 Marks
2. Technique and presentation: 03 Marks
3. Graphs and Calculations: 05 Marks
4. Viva: 05 Marks

#### **Total 25 Marks**

Deduction of marks for accuracy: Error up to 5% - 12 marks, 6 - 10% 09 marks, 11-15% 6 marks, 16 or above 3 marks.

### **References**

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, 2002
2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd, Meerut.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co. New Delhi (2011).
4. Garland, C.W. Nibler, J.W. & Shoemaker, D.P. Experiments in Physical Chemistry 8<sup>th</sup> Ed.; McGraw-Hill: New York (2003).
5. Halpern, A.M. & McBane, G.C. Experimental Physical Chemistry 3<sup>rd</sup> Ed.; W.H. Freeman & Co. New York (2003).

Semester4

## **BSc/B Sc(Honors)**

**Title of the Course: Open Elective: Electrochemistry, Corrosion and Metallurgy**

Course	Credits	No. of Classes/ Week	Total No. of Lecture Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100

This course provides a broad introduction to the fundamental principles of Electrochemistry, Corrosion and Metallurgy. The student will gain an understanding of basic and practical applications in various fields of Electrochemistry, Corrosion and Metals and Alloy behaviour and manufacturing processes. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

### **Course Objectives**

**This course will deal with**

1. Types of conductance, concept of electrolytes, electrolysis, redox reactions and EMF
2. Concept of different types of electrochemical cells, Types of electrodes and electrode potential. Application of electrochemical series.
3. Basic principles and applications of conductometric, potentiometric and pH titrations.
4. Different types of Batteries their principle construction and working, lead-acid storage and lithium ion battery. Study of Fuels cells.
5. Concept of corrosion, types of corrosion and its prevention by different methods. Introduction to electroplating.
6. Introduction to ores and minerals, extraction of metals from their ores, and purification. Eg: Manganese, Titanium and Uranium.
7. Study of alloys, classification, production and uses of alloys.

### **Expected Course Outcomes**

Upon completion of the course students will be able to

1. Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.
2. Learn the different types of electrochemical cells, their symbolical representation and application of electrochemical series.
3. Apply conductometric, potentiometric and pH titrations
4. Know the principle, construction and working of batteries
5. Understand different types of corrosion and its prevention by different methods
6. Learn the methods of extraction of metals from their ores and purification

## **Unit I Electrochemistry** **14hrs**

Conductance, specific and molar conductance Types of Electrolytes, Conductivity in electrolytic solution, Electrolysis, Kohlrausch's law and its application, Equivalent Conductance of Weak electrolyte at Infinite dilution.

Oxidation -reduction reactions, electrode potential, EMF of an electrochemical cell, cell reaction, Daniel cell, dry Cells-electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell, Electrochemical series and its importance. Types of Electrodes.

Basic Principles of (i) Conductometric titrations-HCl Vs NaOH,  $\text{CH}_3\text{COOH}$  Vs NaOH (ii) Potentiometric titrations: Acid-base titration HCl Vs NaOH, Redox titration (FAS Vs  $\text{K}_2\text{Cr}_2\text{O}_7$ ) **12hrs**

**Batteries-** Primary and Secondary batteries, Battery components and their role. Working of the following Batteries-Lead acid, Lithium Storage, Batteries, Fuel cells.

**2hrs**

## **Unit II Corrosion** **14hrs**

**Corrosion:** Introduction, definition, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen overvoltage, nature of corrosion product. Environmental Factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium. **7hrs**

**Prevention of Corrosion:** Material selection-Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating. **4hrs**

**Electroplating:** Introduction, Electroplating of chromium (hard and decorative). Electroless plating: Introduction, distinction between electroplating and electroless plating processes. Electroless plating of copper. **3hrs**

## **Unit III Metallurgy** **14hrs**

**Introduction:** Ore, minerals, important ores of some common elements in India, General Principles of pyrometallurgy, roasting, Calcination, Gangue, Smelting, Flux, Gravity separation, Froth flotation process, leaching. Techniques employed for Purification of metal Distillation process, Bessemerization, Electro-refining, Van Arkel and DeBoer's filament **6hrs**

**Extraction of metals:** Extraction of Manganese (Pyrolusite) Titanium (Ilmanite) and Uranium. **4hrs**

**Alloys:** Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferroalloys; Ferrochrome, Ferro Manganese, Uses of alloy **4hrs**

## Reference Books

1. Barrow. G.M, Physical Chemistry, Tata McGraw-Hill,(2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi,(1942)
3. Text book of physical chemistry, Samuel Glasstone, 2<sup>nd</sup>Edition, Mac Millan India Ltd,(1991)
4. Principles and applications of Electrochemistry, D. R. Crow, 3<sup>rd</sup> edition, Chapmanhall London,(1988)
5. Fundamentals of electrochemical deposition, Milan Paunovic and Mordechay Schlesinger,Wiley Interscience Publications,NewYork,(1998)
6. Engineering Chemistry, VR Kulkarni and K Ramakrishna Reddy, New Age International, (2015)
7. Electrochemistry and Corrosion Science, Nestor Perez, Springer (india) Pvt. Ltd.,(2004)
8. Principles and Prevention of Corrosion, D.A. Jones ,Macmillan Publ. Co.,(1996)
9. Essentials of Materials Science and Engineering, Donald R.Askeland, Thomson Learning, 5<sup>th</sup>Edition, (2006)
10. Introduction to Engineering Materials, B.K.Agarwal,TataMcGrawHill,1<sup>st</sup>Edition
11. Material Science and Engineering,V.Raghavan,PHILearning,5<sup>th</sup>Edition
12. Engineering Materials and Metallurgy, R.K.Rajput,S.Chand-1<sup>st</sup> Edition,(2011)

**SEMESTER IV**  
**OEC 4 - ANALYTICAL INSTRUMENTATION**  
**[Only For B. Sc. (Sugar Science & Technology) Students]**

Credits – 3	Max. Marks: 100
Teaching Hours / week: 4 Hours	Marks: Theory = 60
Theory Examination duration :2 Hours	Internal assessment= 40

**Unit – I** **14 Hours**

**Spectroscopy:** General principles of absorption spectroscopy, theory of Colorimetry, Beers & Lambert Law, Instrumentation of Photoelectric Colorimeter, construction of standard curve and applications.

**Flame Photometry:** General discussion and elementary theory, Instrumentation of flames photometer, monochromators, detectors and applications

**Unit – II** **14 Hours**

**Polarimetry:** Introduction, plane polarized light, optical activity, Instrumentation of Polarimeter, types of polarimeter, Laurenzpolarimeter, Industrial polarimeter, white lamp single wedge and double wedge polarimeter, automatic polarimeter, measurement of specific rotation and determination of unknown concentration and other applications in sugar technology.

**Refractometry:** Introduction, Snell's law, specific refraction, molar refraction, Hand Refractometer, Abbe's Refractometer, experimental techniques and applications.

**Unit – III** **14 Hours**

**pH and Conductivity measurements:** Introduction sensors, Electroanalytical Sensors, different types of sensor electrodes, pH meter, standardization and pH measurements, conductivity solutions, specific and equivalent conductivity, equivalent conductivity at infinite dilution, measurement of conductivity/resistivity of solution, Conductometers, conductivity cell applications.

Laboratory equipment calibration process – Brix hydrometer, Thermometer, weight box, lab oven, Polarimeter, Refractometer, pH meter, conductivity meter, TDS meter, spectrophotometer

**Unit – IV** **14 Hours**

**Chromatography:** Introduction, Classification of chromatographic methods, introduction of terms used in chromatography,

Thin layer chromatography: Introduction of basic concept and technique, methodology, application,

Gas chromatography: General introduction of terminology, stationary phases, supports used for making GLC column

**REFERENCE BOOKS:**

1. Vogel's Textbook of quantitative inorganic revised by J. Bassett et al.
2. Instrumental Methods of Chemical Analysis by H. Kaur.
3. Instrumental methods of analysis by Strobel.
4. Practical Physical Chemistry by Findley.
5. Instrumental methods of chemical analysis by Bhal and Tuli.