J.S. UNIVERSITY SHIKOHABAD (FIROZABAD)

BACHELOR OF SCIENCE (B.Sc.)

(THREE YEAR DEGREE COURSE)

CHEMISTRY

1. Applicability

The ordinances shall apply to all four-year, eight semesters, Under-Graduate (UG) Programmes leading to the award of **B.Sc. Chemistry** Degree in the **J.S. University, Shikohabad Firozabad** from the session 2021-2022. The ordinances shall be read in conjunction with the directions issued by the University which are appended with these ordinances.

2. Definitions of Key Words

a) **Academic Year:** Two consecutive semesters. One odd and one even semester shall constitute one academic year.

b) **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses (core, elective, value added, co-curricular, skill development intradepartmental and inter-departmental.

c) **Course:** Sometimes referred to, as 'papers' is a component of a programme. A course is designed to comprise lectures/tutorials/laboratory work/field work/outreach activities/project work/vocational training/viva/seminars/term papers/assignments/presentations/self-study etc. or a combination of some of these.

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

e) **Semester Grade Point Average (SGPA):** It is a measure of academic performance in a semester

f) **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative academic performance of a student.

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

h) **Grade Point:** It is a numerical value allotted to marks obtained in a course.

i) **Grade/Score Card:** The grade cards will be given to all students at the end of any semester of a program and also on improvement of grades. It will display the course details (code, title, number of credits) grade points obtained in each course, and SGPA/CGPA.

j) **Programme:** An academic programme leading to award of a Certificate. Diploma, Degree or Degree with Research.

k) **Faculty:** Student own faculty will be the faculty from which she/he selects two major courses.

l) **Semester:** Each semester will normally consist of academic work equivalent to 90 working day (15 weeks) including examination/evaluation. The odd semester will be from July/August to December and even semester from January to May/June in every academic year.

m) **Transcript:** The Transcript issued on successful completion of all semesters of a program will display the course details (code, title, number of credits) and grade points obtained in each course, and CGPA.

3. Types of Courses

a) **Core (Major) Course:-** Core (Major) course is a course which is compulsory for a student to study, if she/he has chosen that subject as Major.

b) **Elective (Minor) Course:-** Elective (Minor) course is course which can be chosen from a pool of elective courses offered in the programme. It can be a major course of other subject.

c) **Credited Value- Added Course:** The courses add value through enhanced employability skills and have credits assigned to them and may be offered through Vocational and Co-curricular courses. These courses will be counted for calculation of SGPA/CGPA.

d) **Non- credited Value-Added Course:** The courses may be offered to add value through enhanced employability skills but do not have credits assigned to them. The performance in these courses shall not be counted for computation of 'SGPA' and 'CGPA'.

e) **Vocational/Skill development Course:** These course will be offered by the Department/Colleges in different Faculties as value added courses for enhancing employability. They will be of two types' Individual nature and progressive nature. There will be a capping on the maximum number of students in a particular course as specified by the department/colleges concerned.

f) **Co-curricular Course:** The courses will be offered by the Departments/Institutes in different Faculties of the University as value added courses for overall personality development in first six semesters. They will be fixed for each semester as prescribed in regulations / guidelines of University New education Policy (NEP). They will be qualifying in nature and their grades will not be added in CGPA.

g) **Internship:** All students of Under Graduate Programme shall be required to undertake an Internship/Them-Paper during the summer vacation between fourth and fifth semester, carrying credits as specified by BOS.

h) **Online courses / MOOCs:** They student will have the freedom to choose a similar course of equal credits from MOOCs, SWAYAM portal of UGC/Ministry of education in place of a Course offered in the semester as specified by the Department. MOOC/SWAYAM courses may be opted depending upon the availability on the government approved portal. Online papers credit maximum of 20% of the total credits required for that courses could be earned in minor/elective papers from this mode and those credits have to be added by the University in their SGPA/CGPA.

i) **Dissertation/Major Project:** All students of UG Programmes shall be required to prepare a Dissertation/Major Project in the eight semester.

4. Minimum Eligibility Requirement and process of Admission

4.1 Minimum Eligibility Requirement: A certificate of successfully completing Class XII or equivalent from any Board recognized by the State or Centre Government shall constitute the minimum prerequisite requirement for admission to the under graduate degree programmes. The respective regulations may lay down additional or higher requirements.

4.2 Admission Process: The admission of Indian Nationals shall be based on entrance test or academic merit or a combination of the two and reservation /weightage in admissions shall be as per the UP-Government rules. However, Foreign Nationals applying for admission through authorised channels shall be eligible for direct admission with a maximum capping as per University norms.

5. Program Duration and Credit Requirements

a) The under graduate degree programmes shall be spread over eight semesters (4 academic years).

b) The maximum duration for completing the certificate in faculty is 4 years. Diploma in faculty is 3 years after certificate, Bachelor of faculty is 3 years after diploma and Bachelor (research) in faculty is 2 years after Bachelor of faculty in under graduate degree programme. These will be consecutive academic years.

6. Course Structure

The course structure and course outlines of the under graduate degree programmes shall be as per the respective regulations recommended by the respective board of studies and ratified by the competent authority.

7. Attendance Requirement

Students with less than 75% attendance shall not be eligible to appear in the End of Semester Examination. However, in exceptional cases, the Principal/ Vice chancellor may grant a relaxation in the minimum attendance requirement by not more than 15% on the basis of genuine reason.

8. Examination(s) and Assessment /Evaluation:

8.1a In each semester from V^{th} to $VIII^{th}$ Student have to do Research project, In third year (V^{th} and VIth Semester) it will be a minor project and in fourth year (VIIth and $VIII^{th}$) it will be a major project. This project should be from any of the two subjects taken for that semester. This project can be interdisciplinary or in the form of Industrial training /Internship/ or Survey. Research project will be done under supervision of one faculty member; the student can opt for another supervisor from either industry, company technical institutes of research institutes.

8.2 b Student in the end of each semester will submit report/Dissertation which will be evaluated by external examiner (recommended by BOS) and supervisor with 75 marks. Continuous internal evaluation (CIA) of 25 marks in that semester will be done by supervisor. In V &VI semester it will be qualifying only. In VIIth and $VIII^{th}$ semester it will be of 4 credits and will be used in calculation of CGPA. The Principal/ Head/ Director/ Dean shall convene and coordinate the process with Practical Examinations of that department.

8.2 In all credit courses (other than Internship/ survey/minor project report and Disscrtation/major Project), there shall be continuous internal assessment of the students and semester end examination as per the scheme of examination.

8.3 The semester end examination shall have a weightage of 75 marks. Questions for this examination shall be set by a panel of examiners approved by the Board of studies and duly moderated by the Moderation Committee. The scheme of examination shall ensure that no student has to appear for examinations in more than two courses on any single day.

8.4 The continuous internal assessment shall have a weightage of 25 marks and shall be based on assignments, class test, quizzes etc. as specified by Board of studies of the subject concerned.

8.5 It shall be the duty of the Teacher teaching a particular course, to conduct internal assessment. In case more than one teacher is sharing the teaching work in a course, each teacher shall evaluate independently and a weighted average would be taken.

8.6 For the ease of computation, the assessment/evalution of each course will be out of a maximum of 100 marks (25 for internal assessment and 75 for end of semester examination) irrespective of number of credits allotted to the course. The marks shall be converted to grades

8.7 Vocational Courses

8.7 a. Memorandum of Understanding

1. Colleges are required to sign the MOUs at the local level.
2. Educational Institutions will contact nearby industries, I.T.I., Polytechnics, Engineering Colleges, Artisans, Registered Enterprises, Specialists for conducting vocational courses.
3. In order to connect with Government run Vocational Courses/Training/Internships, Educational Institutions will coordinate with the concerned departments.
4. The safety of a student in workplace should be considered while signing the MOU.
5. All possible efforts should be made to pay student honorarium, as per rules, to students during their training/internship.

8.7 b. Time Table

Training/Internship could be done during holidays or after college hours. Alternatively, a day in a week may be fixed for this activity.

8.7 c. Seat Allocation

Different Courses should be prepared by the college on the number of enrolled students. The number of seats in each course must be decided in consultation with the skill partner.

8.7 d. Examination

1. Theory examination (1 credit) will be conducted by the college, while the training/internship examination (2 credit) will be conducted by the skill partner or by the collage wherever the facility exists.

2. Skill partner/College may evaluate the skills of the student either on the basis of the work done during the training/internship or on the basis of offline/online examination.

3. Colleges will upload the marks on the portal in time after obtaining theory and skill marks.

4. The details of the Vocational Course will be entered in the marksheet/degree issued by the university.

5. In addition to it, college and skill partner may issue a joint certificate to the student.

8.7 e   Syllabus

1. Colleges will prepare the syllabus for each vocational course. Which would be then duly approved by the Syllabus Committee, Academic Council and Executive Council as per existing rules.

2. Syllabus would be formulated with the help of college/skill partner/skill development council as per the guidelines given by UGC/NSQF.

3. In trades, for which syllabi made by UGC/NSQF/Skill Development Council/Government Department are available, priority should be given to adoption of such syllabi so that the support of the respective bodies may be obtained during the time of placement/internship.

4. In different subjects, where the syllabus has been prepared by the head of the

Department/Teacher, the ratio of the General Theory of Skill/ Training/Internship/Lab will be 40:60, and for such courses the arrangements to sign MOU with the skill partners will be made by the collage administration.

5. The theory component shall be of credit (15 hours) and the skill component shall be of two credits (30 hours per credit). Thus the vocational course will be a 3 credit course in which 15 hours of theory (1 credit) and 60 hours of training/internship/lab (2 credits) will be there.

8.7 f Nature of the Syllabus

1. Syllabus can be of two types:

> i. **Individual Nature**- A syllabus that would be completed in one semester. ii. **Progressive Nature**- A syllabus the complexity/specialization would increase with each semester but will be complete in itself in each semester.

2. Students shall choose the course/syllabus as per their choice and convenience.

8.7 g Credit

A student will have to earn a minimum of three credits from vocational courses in each semester, which means six credits every year. Students may choose a vocational course with more than required credits and deposit them, but in a year six credits/in two years 12 credits will be used to obtain certificate/diploma/degree.

9.1 The formula adopted by the University for conversion of CGPA to equivalent percentage of marks is given below-

Percentage of Marks = (CGPA*10)

9.2 The following percentage to Letter Grade / Grade Points conversion scheme will be followed

Percentage	Equivalent Letter Grade	Equivalent Grade Point
>=95%	O	10
>=85% and<95%	A+	9
>=75% and <85%	A	8
>=65% and <75%	B+	7
>=55% and <65%	B	6
>=45% and <55%	C	5
>=35% and <45%	P	4
< 35%	F	0
NA	AB	0

9.3 Computation of Semester Grade Point Average (SGPA) and Cumulative Grade

Point Average (CGPA)

a) The SGPA is the ratio of sum of the product of the number of credits with the grade points scored a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a semester, i.e SGPA $(S_i) = \sum(C_i \times G_i) / \sum C_i$

Where C_i is the number of credits of the ith course and G_i is the grade point scored by the student in the course.

b) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.c.

$$CGPA = \sum(C_i \times S_i) / \sum C_i$$

Where S_i is the SGPA of the ith semester and C_i is the total number of credits in that semester.

The SGPA and CGPA shall be given be given upto 2 decimal points without rounding off. For example, if the SGPA/ CGPA is 5.2434, the final CGPA will be 5.24. Similarly, if the SGPA/CGPA is 5.2498 than also the final CGPA to be reflected in the transcript will be 5.24.

9.4 Grade Point Requirement / Minimum Standard

a) A student, in order to be eligible for the award (i) passed all the prescribed courses as laid down and completed the minimum credit requirement of the programme already defined in the ordinance; (ii) she/he has obtained a CGPA of 4.0 at the end of the programme.

b) The grade points- division mapping for UG programs will be as follows-

Grade Point Range	Division
>=6.0 and above	First
>=4.5 and <6.0	Second
>=4.0 and <4.5	Third
>4.0	Fail

c) A student shall be deemed to have cleared a course only if (i) he/she has participated in the internal assessment and has secured an overall grade at least 'P' or higher and (ii) if she/he has secured a grade at least 'P'or higher in the endsemester examination (for courses having end-semester examination). A student obtaining Grade 'F' shall be considered fail and will be required to reappear in the examination.

d) If a student fails to clear a selected course than he/she shall be allowed to clear another similar credit course in lieu thereof or the same course.

e) In case a student earns extra credits by clearing courses in addition to the minimum prescribed for the programme, all the courses and their grades will reflect in the

grade sheet. However, for the purposes of calculating the Cumulative Grade Point Average (CGPA) in the final semester, only his/her best grade will be taken into account such that the minimum credit requirements for the programme are fulfilled.

f) For awarding medals or for declaring the toppers in the course if the student gets the same CGPA, it should be resolved by considering the number of times a student has obtained higher SGPA but if it is not resolved even at this stage, the number of times a student has obtained higher grades in a paper like O, A$^+$ etc should be taken into account in rank ordering of the students in a programme. However in case of further discrepancies the final decision lies at the discretion of the head of the Department/ Controller of Examination/Examination Committe.

g) Transcript (Format) based on the above recommendations on letter grade, grade points and SGPA and CGPA may be used for each semester and a consolidated transcript indicating the performance of all semesters in the final semester transcript of the course.

9.5 Illustration of calculation of SGPA

Course	Credit	Letter Grade	Grade Point	Credit Point (Credit $\times$Grade)
Course 1	4	A	8	4*8=32
Course 2	4	A	9	4*9=36
Course 3	3	B	6	3*6=18
Course 4	2	C	5	2*5=10
Course 5	4	F	0	4*0=0
	Total ($\sum C_i$)=17			Total ($\sum(C_i \times G_i)$)=96

Thus SGPA=96/17=5.64

Illustration of calculation of CGPA

Semester 1	Semester 2	Semester 3	Semester 4
Credit:17 SGPA: 5.64	Credit:20 SGPA: 6.08	Credit: 22 SGPA:4.9	Credit: 22 SGPA:7.22

Thus, CGPA = (5.64×17+6.08×20+4.9×22+7.22×22)/81 = 5.97
Hence, equivalent percentage = (5.97×10) = 59.7
And the Division will be Second

9.6 In co curricular courses a student has to score 40 (Forty) % marks for clearing it. Grades will be indicated in the grade sheet but they will not be counted for evaluating CGPA.

9.7 Examination, Promotion and Reappearing Rules:

a) A student obtaining grades 'P' to 'O' (grade point 4 or higher) in any course shall be considered PASS in that course.

b) For non-credit courses 'Satisfactory' (grade 'P' to 'O') or 'Unsatisfactory' (Grade 'F' or 'AB' shall be indicated instead of the letter grade and these will not be counted for the computation of SGPA/CGPA.

c) All students shall be promoted automatically from odd to even semesters but for promotion from even to odd semester i.e from current year to next year. It may be that s/he earns atleast 75% credits of all the credits of current year. S/He may be promoted in this manner till VIth Semester (IIIrd year). Further promotion (to VIIth Sem) may not be allowed till s/he clears all the previous semester credits.

d) Those students who are NOT eligible for promotion shall have reappear in the end semester examination of those courses in the semester(s) in which the student has failed along with those courses in which he/she wishes to improve, within the maximum stipulated time period allowed to complete the program. The grades of internal assessment shall carry forward in such cases.

e) Those students who are eligible for promotion and wish to improve their grades, may choose to reappear in the end of semester examination to improve their grades, within the maximum stipulated time period allowed to complete the program. The grades of internal assessment shall carry forward in such cases.

f) A Student may be allowed to re-register for a semester, within the maximum stipulated time period allowed to complete the program, provided he/she satisfies one of the following conditions. In such a case there shall be fresh assessment of internal evaluation:

    i. The student is declared fail.

    ii. The student did not appear in a semester examination or he/she was not granted permission to appear in the examination.

    iii. The student had been detained by the University and subsequently has been permitted to take re-admission.

    iv. The student has own desire to abandon the performance of the semester and wishes to repeat.

g) Those students who reappear in any course/s in any semester of re-register for a semester shall have to pay the prescribed fee.

h) Cases of use of unfair means in the examination shall be dealt with as per the rules and regulations of the University.

i) Challenge evaluation shall be permitted as rules/orders of the University.

9.8 Grade Card:

A grade card shall be issued to each student at the end of every semester.

9.9 Transcript:

A Transcript shall be issued to a student on successful completion of the programme on request as per rules.

9.10   Withholding of Grade Card/Transcript

The Grade Card/Transcript of a student shall be withheld if he/she has not paid his/her dues, or if there is a case of indiscipline pending against him/her.

10. Exit option and award of Under Graduate Degree

10.1 In case the student wishes to leave after completion of one year of any Under Graduate Degree Programme, he/she shall be eligible for award of a Certificate in faculty, provided the student fulfils the following conditions:

   a) Has pursued the prescribed courses of study and has earned 46 credits as prescribed under the relevant regulations within four academic years without 'F' or 'AB' in any course.
   b) Obtained a minimum CGPA of 4.0.
   c) Paid all the dues of the University.
   d) No disciplinary proceedings are pending against him/her.
   e) Any other condition, as notified by the competent authority of the university.

10.2 In case the student wishes to leave after completion of two years of any Under Graduate Degree Programme, he/she shall be eligible for award of a Diploma in faculty, provided the student fulfils the following conditions:

   a) Has pursued the prescribed courses of study and has earned 92 credits as prescribed under the relevant regulations within six (three years after earning certificate) academic years without 'F' or 'AB' in any course. b) Obtained a minimum CGPA OF 4.0

   c) Paid all the dues of the University.

   d) No disciplinary proceedings are pending against him/her.

   e) Any other condition, as notified by the competent authority of the University.

10.3 In case the student wishes to leave after completion of three year of any Under Graduate Degree Programme, he/she shall be eligible for award of a Bachelor's Degree in faculty, provided the student fulfils the following conditions:

a) Has pursued the prescribed courses of study and has earned 132 credits as prescribed under the relevant regulations within ten (three years after diploma in faculty) academic years without 'F' or 'AB' in any course.

b) Obtained a minimum CGPA of 4.0.

c) Paid all the dues of the University.

d) No disciplinary proceedings are pending against him/her.

e) Any other condition, as notified by the competent authority of the university.

10.4 On completion of four years of any Under Graduate Degree Programme, he/she shall be eligible for award of a Bachelor's Degree (Chemistry) with Research in faculty, provided the student fulfils the following conditions:

a) Has pursued the prescribed courses of study and has earned 184 credits as prescribed under the relevant regulations without 'F' or 'AB' in any course after Bachelor's degree.

b) Obtained a minimum CGPA of 4.0.

c) Paid all the dues of the University.

d) No disciplinary proceedings are pending against him/her.

e) Any other condition, as notified by the competent authority of the university.

10.5 Students holding a Certificate of Diploma can apply for lateral entry into the second/third year respectively of an Under Graduate Degree Programme through the laid down admission process for the purpose as notified by the university.

11.1 In Programmes governed by professional councils such as AICTE, MCI, BCI and NCTE etc the norms decided by Board of studies and other competent bodies in light of recommendations by the statuary councils shall apply.

12. Interpretation clause

In case of any issue of interpretation arising during the course of implementation of these ordinances or in case of any unforeseen circumstance, decision of the Vice-Chancellor/Examination committee shall be final.

YEAR WISE STUCTURE OF GRADUATE COURSES

	Subject I	Subject II	Subject III	Subject IV	Vocational	CO-Curricular	Industrial Training/Survey/Research Project	(Minimum Credits) For the year	Cumulative (Minimum Credits)

Year	Sem.	Major 4/5/6 Credits Own Faculty	Major 4/5/6 Credits Own Faculty	Major 4/5/6 Credits Own/Other Faculty	Minor Elective 4/5/6 Credits Other Subject/Faculty	Minor 3 Credits Vocational/skDevelopment Course	Minor Co-Curricular course (Qualifying)	Major 4 Credits Inter/Inrta Faculty related to main Subject		Required for Award of Certificate/Diploma/Degree
	I	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)		1	1			
	II	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)		1	1			
	III	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)		1	1			
	IV	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)	Th-1(6) or Th1(4)+Pract-1(2)		1	1			
	V	Th-2(5) or Th2(4)+Pract-1(2)	Th-2(5) or Th2(4)+Pract-1(2)				1	I (Qualifying)		
	VI	Th-2(5) or Th2(4)+Pract-1(2)	Th-2(5) or Th2(4)+Pract-1(2)				1	I (Qualifying)		
	VII	Th-4(5) or Th-(4)+Pract-1(4)						1 (4) 1		
	VIII	Th-4(5) or Th4(4)+Pract-1(4)						1 (4) 1		

Format for syllabus development of
Skill development course

Title of course-	
Nodal Department of HEL to run course	
Broad Area/Sector-	
Sub Sector-	
Nature of course- Independent/Progressive	
Name of suggestive Sector Skill Council	
Aliened NSQF level	
Expected fees of the course-Free/Paid	
Stipend of student expected from industry	
Number of Seats-………….	
Course Code-…………….	Credits- 03(1 Theory, 2 Practical)

Max/Marks….100…….Minimum Marks………	
Name of Proposed Skill Partner (Please Specify,Name of industry,company ete for Practical/training/internship/OJT	
Job prospects- Expected Fields of Occupation where student will be able to get job after completing this course in (Plese specify name/type of industry, company etc.)	

Syllabus

Unit	Topics	General/Skill Component	Theory/ Practical/OJT/ Internship/ Training	No of theory hours (Total-15 Hours= 1 credit)	No of skill Hours (Total-60 Hours= 2 credits)	
I						
II						
III						
IV						
V						
VI						

Suggested Readings:
Suggested Digital platforms/ web links for reading-
Suggested OJT/Internship/Training/Skill partner
Suggested Continous Evaluation Methods:
Course Pre-requisites: • No pre-requisite required, open to all • To study this course, a student must have the subject……….in class/12th/ certificate/diploma • If progressive, to study this course a student must have passed previous courses of this series.
Suggested equivalent online courses:
Any remarks/ suggestions:
Notes: • Number of units in Theory/Practical may vary as per need • Total credits/semester-3 (it can more credits, but students will get only 3 credit/ semester or 6 credits/ year • Credits for Theory =01 (Teaching Hours= 15) • Credits for Internship/OJT/Training/Practical=02 (Training Hours= 60)

Programme Education Objectives (PEOs)

The PEOs of the B.Sc. program Chemistry are as follows:

PEO 1: Chemistry graduates will be well prepared for successful careers in the profession at an industry and/or in government in one or more of discipline of chemistry.

PEO 2: Chemistry graduates will be academically prepared to become licensed professional chemists in due course and will contribute effectively in serving the society.

PEO 3: Chemistry graduates will be engaged in professional activities to enhance their own achievement and simultaneously contribute in service of humankind.

PEO 4: Chemistry graduates will be successful in higher education in Chemistry.

PEO 5: Chemistry graduates will provide leadership quality to work in all kind of circumstances, diverse environment such as interdisciplinary and multidisciplinary learning systems.

BACHELOR OF SCIENCE
IN
CHEMISTRY

(Semester Pattern)
Choice Based Credit System Syllabus
Three Years Programme

COURSE OF STUDIES
(AS per U.G.C. Guidelines)

DEPARTMENT OF CHEMISTRY
J.S. UNIVERSITY, SHIKOHABAD

Semester-wise Titles of the Papers in B.Sc. Chemistry

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Bioorganic and Medicinal Chemistry					
1	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020102P	Quantitative Analysis	Practical	2
	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4
		B020202P	Biochemical Analysis	Practical	2
Diploma in Chemical Dynamics and Analytical Techniques					
2	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4
		B020302P	Physical Analysis	Practical	2
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4
		B020402P	Instrumental Analysis	Practical	2
Degree in Bachelor of Science					
3	V	B020501T	Organic Synthesis-A	Theory	4
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4
		B020503P	Qualitative Analysis	Practical	2
		B020504R	Research Project	Project	3
	VI	B020601T	Organic Synthesis-B	Theory	4
		B020602T	Chemical Energetics and Radiochemistry	Theory	4
		B020603P	Analytical Methods	Practical	2
		B020604R	Research Project	Project	3

Purpose of the Program

The purpose of the undergraduate chemistry program at the university and college level is to provide the key knowledge base and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Program's Outcomes

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
5. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
6. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
7. Students will be able to function as a member of an interdisciplinary problem solving team.

	PROGRAM SPECIFIC OUTCOMES (PSOS)
	CERTIFICATE IN BIOORGANIC AND MEDICINAL CHEMISTRY
First Year	Certificate in Bioorganic and Medicinal Chemistry will give the student a basic knowledge of all the fundamental principles of chemistry like molecular polarity , bonding theories of molecules, Periodic properties of more than 111 elements, mechanism of organic Reactions, Stereochemistry, basic mathematical concepts and computer knowledge, chemistry of carbohydrates, proteins and nucleic acids: medicinal chemistry, synthetic polymers, synthetic dyes, Student will be able to do to qualitative quantitative and bio chemical analysis of the compounds in the laboratory. This certificate course is definitely going to prepare the students for various fields of chemistry and will give an insight into all the branches of chemistry and enable our students to join the knowledge and available opportunities related to chemistry in the government and private sector services particularly in the field of food safety, health inspector, pharmacist etc. Have a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
Second Year	**DIPLOMA IN CHEMICAL DYNAMICS AND ANALYTICAL TECHNIQUES**
	Diploma in Chemical Dynamics and Analytical Techniques will provide the theoretical as well as practical knowledge of handling chemicals, apparatus, equipment and instruments. The knowledge about feasibility and velocity of chemical reactions through chemical kinetics, chemical equilibrium ,phase equilibrium, kinetic theories of Gases ,solid and liquid states, coordination chemistry, metal carbonyls and bioinorganic will enable the students to work as chemists in pharmaceutical industries. The knowledge about atomic structure, quantum mechanics, various spectroscopic tools and separation technique will make the students skilled to work in industries: Achieved the skills required to succeed in the chemical industry like cement industries, agro product, paint industries, rubber industries, petrochemical industries, food processing industries, Fertilizer industries, pollution monitoring and control agencies etc. Got exposures of a breadth of experimental techniques using modern instrumentation Learn the laboratory skills and safely measurements to transfer and interpret knowledge entirely in the working environment. monitoring of environment issues: monitoring of environmental pollution problems of atmospheric sciences, water chemistry and soil chemistry and design processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
Third Year	**DEGREE IN BACHELOR OF SCIENCE**
	Degree in Bachelor of Science programme aims to introduce very important aspects of modern day course curriculum, namely, chemistry of hydrocarbons, alcohols, carbonyl compounds, carboxylic acids, phenols, amines, heterocyclic compounds, natural products main group elements, qualitative analysis, separation techniques and analytical techniques. It will enable the students to understand the importance of the elements in the periodic table including their physical and chemical nature and role in the daily life and also to understand the concept of chemistry to inter relate and interact to the other subject like mathematics, physics, biological science etc. • Upon completion of a degree, chemistry students are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program • Various research institutions and industry people in the pharmaceuticals, polymers, and food industry sectors will surely value this course.

								Total Credits of the subject
			Subject: Chemistry					
Year	Sem.	Theory Paper	Units	Practical Paper	Units	Research Project		
1	I	Fundamentals of Chemistry	1. Molecular polarity and Weak Chemical Forces 2. Simple Bonding theories of Molecules 3. Periodic properties of Atoms 4. Recapitulation of basics of Organic Chemistry 5. Mechanism of Organic Reactions 6. Stereochemistry 7. Basic Computer system (in brief) 8. Mathematical Concepts for Chemistry	Quantitative Analysis	1. Water Quality analysis 2. Estimation of Metals ions 3. Estimation of acids and alkali contents 4. Estimation of inorganic salts and hydrated water	Nil		4+2 = 6
	II	Bioorganic and Medicinal Chemistry	1. Chemistry of Carbohydrates 2. Chemistry of Proteins 3. Chemistry of Nucleic Acids 4. Introductory Medicinal Chemistry 5. Solid state 6. Introduction to Polymer 7. Kinetics and Mechanism of Polymerization 8. Synthetic Dyes	Biochemical Analysis	1. Qualitative and quantitative analysis of carbohydrates 2. Qualitative and quantitative analysis of Proteins, amino acids and Fats 3. Determination and identification of Nucleic Acids 4. Synthesis of simple drug molecules.	Nil		4+2 = 6
2	III	Chemical Dynamics & Coordination Chemistry	1. Chemical kinetics 2. Chemical Equilibrium 3. Phase Equilibrium 4. Kinetic theories of Gases 5. Liquid states 6. Coordination Chemistry 7. Theories of Coordination Chemistry 8. Inorganic Spectroscopy and Magnetism	Physical Analysis	1. Strengths of Solution 2. Surface tension and viscosity of pure liquids 3. Boiling point and Transition temperature 4. Phase Equilibrium	Nil		4+2 = 6
	IV	Quantum Mechanics and Analytical Techniques	1. Atomic Structure 2. Elementary Quantum Mechanics 3. Molecular Spectroscopy 4. UV-Visible Spectroscopy 5. Infrared Spectroscopy 6. ^{1}H-NMR Spectroscopy 7. Introduction to Mass Spectrometry 8. Separation Techniques	Instrumental Analysis	1. Molecular Weight Determination 2. Spectrophotometry 3. Spectroscopy 4. Chromatographic Separations	Nil		4+2 = 6
	V	Organic Synthesis-A	1. Alkane and Cycloalkanes 2. Alkenes 3. Alkynes 4. Arenes and Aromaticity 5. Alcohols	Qualitative Analysis	1. Inorganic Qualitative Analysis 2. Elemental analysis and identification of functional groups 3. Separation of organic Mixture 4. Identification of organic compounds	Research Project		4+4+2 +3 =13

			6. Phenols 7. Ethers and Epoxides 8. Organic Halides					
		Rearrangements and Chemistry of Group Elements	1. Rearrangements 2. Catalysis 3. Chemistry of the Main Group Elements 4. Chemistry of Transition Elements 5. Chemistry of Lanthanides 6. Chemistry of Actinides 7. Metal Carbonyls 8. Bioinorganic Chemistry					
	VI	Organic Synthesis-B	1. Reagents in Organic synthesis 2. Organometallic Compounds 3. Aldehydes and Ketones 4. Carboxylic acids and their Functional Derivatives 5. Organic Synthesis *via* Enolates 6. Organic Compounds of Nitrogen 7. Heterocyclic Compounds 8. Natural Products	Analytical Methods	1. Gravimetric Analysis 2. Paper Chromatography 3. Thin Layer Chromatography 4. Thermochemistry	Research Project	4+4+2 +3 =13
		Chemical Energetics and Radiochemistry	1. Thermodynamics-I 2. Thermodynamics-II 3. Electrochemistry 4. Ionic Equilibrium 5. Photo Chemistry 6. Colligative Properties of Solutions 7. Surface Chemistry 8. Radiochemistry					

COURSE			SUBJECT: CHEMISTRY				Total Credits of the subject
Year	Sem.		Paper Title	Prerequisite for paper	Elective For Major Subject	Hours per Semester	
Certificate in Bioorganic and Medicinal Chemistry	I	Theory-1	Fundamentals of Chemistry	Chemistry in 12th	Yes Open to all	60	4
		Practical-1	Quantitative Analysis	Chemistry in 12th	Yes Open to all	**60**	2
	II	Theoty-1	Bioorganic and Medicinal Chemistry	Passed Sem-I, Theory paper-1	**Yes** Zoo/Bot./Physics/Math/Comp Sci	60	4
		Pracical-2	Biochemical Analysis	Opted Sem-II, Theory Ppaer-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	**60**	2
Diploma in Chemical Dynamics and Analytical Techniques	III	Theoty-1	Chemical Dynamics & Coordination Chemistry	Chemistry in 12th Physics in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Pracical-2	Physical Analysis	Opted Sem-III, Theory Ppaer-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	**60**	2
	IV	Theoty-1	Quantum Mechanics and Analytical Techniques	Chemistry in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-2	Instrumental Analysis	Chemistry in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	**60**	2
Degree in Bachelor of Science	V	Theory-1	Organic Synthesis-A	Passed Sem-I, Theory paper-	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Theory-1	Rearrangements and Chemistry of Group Elements	Passed Sem-I, Theory paper-	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Qualitative analysis	Opted Sem-V Theory Ppaer-1 &2	Yes Zoo/Bot./Physics/Math.	60	2

				Prerequisite			
3		Research Project	…………	………..	………………………	45	3
	VI	Theory-1	Organic Synthesis-B	Passed Sem-V Theory paper-1	Yes Zoo/Bot./Physics/Math	60	4
		Theory-1	Chemical Energetics and Radiochemistry	Chemistry in 12th Physics in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Analytical Methods	Chemistry in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	2
		Research Project	…………………	………………	………………………	45	3

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Bioorganic and Medicinal Chemistry					
1	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020102P	Quantitative Analysis	Practical	2
1	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4
		B020202P	Biochemical Analysis	Practical	2

Semester-1,
Paper-1 (Theory)
Course Title: Fundamentals of Chemistry

Programme/Class: Certificate in Bioorganic and Medicinal Chemistry	Year: First	Semester: First
Paper-1 Theory		Subject: **Chemistry**
Course Code:B020101T	Course Title: **Fundamentals of Chemistry**	

Course outcomes:

There is nothing more fundamental to chemistry than the chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the 100-plus elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements. Reaction mechanism gives the fundamental knowledge of carrying out an organic reaction in a step-by-step manner. This course will provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Students will gain an understanding of

- Molecular geometries , physical and chemical properties of the molecules.
- Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.
- The chapter Recapitulation of basics of organic chemistry gives the most primary and utmost important knowledge and concepts of organic Chemistry.
- This course gives a broader theoretical picture in multiple stages in an overall chemical reaction. It describes reactive intermediates , transition states and states of all the bonds broken and formed .It enables to understand the reactants, catalyst , steriochemistry and major and minor products of any organic reaction.
- It describes the types of reactions and the Kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined.
- The chapters Steriochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.

Credits: 4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:…………

| Total No. of Lectures = 60 ||

Unit	Topics	No. of Lectures
I	*Introduction to Indian ancient Chemistry and contribution of Indian Chemists, in context to the holistic development of modern science and technology, should be included under Continues Evaluation (CIE)*	10

	Molecular polarity and Weak Chemical Forces : Resonance and resonance energy, formal charge, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction.	
II	**Simple Bonding theories of Molecules** Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I_3^-, and H_3O^+. Molecular orbital theory (MOT). Molecular orbital diagrams bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions)	10
III	**Periodic properties of Atoms (with reference to s & p-block):** Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	05
IV	**Recapitulation of basics of Organic Chemistry:** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clatherates, Charge transfer complexes, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications	05
V	**Mechanism of Organic Reactions:** Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	10
VI	**Steriochemistry-**Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, disasteromers, threo and erythro diastereomers, meso compounds, resolution of enantionmer, inversion, retention and recemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial	10

	and equatorial bonds, conformation of mono substituted cyclohexane derivatives, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.	
VII	**Basic Computer system (in brief)-**Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII)**;** Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Introduction of Software languages: Low level and High Level languages (Machine language, Assembly language; QBASIC, FORTRAN) Software Products (Office, chemsketch, scilab, matlab, hyperchem, etc.), internet application.	05
VIII	**Mathematical Concepts for Chemistry** Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx, e^x, X^n, $\sin x$, $\log x$; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability	05

Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson   Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Singh J.,Yadav L.D.S.,Advanced Organic Chemistry,Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2ⁿᵈ edition, Oxford University Press, 2012.
11. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
12. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003
13. Francis**, P. G.** Mathematics for Chemists, Springer, 1984

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#

This course is compulsory for the students of following subjects: Chemistry in 12ᵗʰ Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12th

Suggested equivalent online courses:
………………………………………………………………………………………..

Further Suggestions:
………………………………………………………………………………………..

Semester-I, Paper-2 (Practical)
Course Title: Quantitative Analysis

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: First	Semester: I
Practical paper-2		Subject: Chemistry
Course Code: B020102P	**Course Title: Quantitative Analysis**	

Course outcomes:

Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products.

- Potability tests of water samples.
- Estimation of metal ions in samples
- Estimation of alkali and acid contents in samples
- Estimation of inorganic salts and hydrated water in samples

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical		**60 h**
Unit	**Topics**	**No of Lectures**
I	**Water Quality analysis** 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). **3.** Determination of Biological oxygen demand (BOD).	**16**
II	**Estimation of Metals ions** 1. Estimation of ferrous and ferric by dichromate method. **2.** Estimation of copper using thiosulphate.	**14**
II	**Estimation of acids and alkali contents** 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content – antacid tablet using HCl. **3.** Estimation of oxalic acid by titrating it with $KMnO_4$.	**14**
IV	**Estimation of inorganic salts and hydrated water** 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of calcium content in chalk as calcium oxalate by permanganometry. 3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.	**16**

Suggested Readings:
1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
3. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
4. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
5. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

6. https://www.labster.com/chemistry-virtual-labs/
7. https://www.vlab.co.in/broad-area-chemical-sciences
8. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12ᵗʰ Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the chemistry in 12ᵗʰ Class

Suggested equivalent online courses:

……………………………………………………………………………………………………..

Further Suggestions:

……………………………………………………………………………………………………..

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: 1	Semester: II
Paper-1	Elective	Subject: Chemistry
Course Code: B020201T	**Course Title: Bioorganic and Medicinal Chemistry**	

Course outcomes: Biomolecules are important for the functioning of living organisms. These molecules perform or trigger important biochemical reactions in living organisms. When studying biomolecules, one can understand the physiological function that regulates the proper growth and development of a human body. This course aims to introduce the students with basic experimental understanding of carbohydrates, amino acids, proteins, nucleic acids and medicinal chemistry. Upon completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:………

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Chemistry of Carbohydrates** : Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer's proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses). Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's &Wohl's methods) of aldoses; end-group-interchange of aldoses Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose.)	10
II	**Chemistry of Proteins:** Classification *of amino acids,* zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis. Protein denaturation/ renaturation Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions).	10
III	**Chemistry of Nucleic Acids:** Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), Nucleosides and nucleotides **(nomenclature)**, Synthesis of nucleic	05

	acids, 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	
IV	**Introductory Medicinal Chemistry :** Drug discovery, design and development; Basic Retrosynthetic approach. Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring. Mechanism of action of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), HIV-AIDS related drugs (AZT- Zidovudine	10
V	**Solid State** Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (powder method).	05
VI	**Introduction to Polymer** Monomers, Oligomers, Polymers and their characteristics, Classification of polymers : Natural synthetic, linear, cross linked and network; plastics, elastomers, fibres, Homopolymers and Co-polymers, Bonding in polymers : Primary and secondary bond forces in polymers ; cohesive energy, and decomposition of polymers. Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers and determination by (i) Viscosity (ii) Light scattering method (iii) Gel permeation chromatography (iv) Osmometry and Ultracentrifuging. **Silicones and Phosphazenes** –Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.	10
VII	**Kinetics and Mechanism of Polymerization** Polymerization techniques, Mechanism and kinetics of copolymerization,Addition or chain-growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers, Condensation or step growth-polymerization, Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes.	05
VIII	**Synthetic Dyes:** Colour and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo.	05

Suggested Readings:
1. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
2. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
4. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.
5. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
7. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
8. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
9. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
10. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
11. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
12. G. Odian: *Principles of Polymerization*, 4ᵗʰ Ed. Wiley, 2004.
13. F.W. Billmeyer: *Textbook of Polymer Science*, 2ⁿᵈ Ed. Wiley Interscience, 1971.
14. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/105/104105124/
https://nptel.ac.in/courses/103/106/105106204/
https://nptel.ac.in/courses/104/105/104105034/
https://nptel.ac.in/courses/104/103/104103121/
https://nptel.ac.in/courses/104/102/104102016/
https://nptel.ac.in/courses/104/106/104106106/
https://nptel.ac.in/courses/104/105/104105120/

This course can be opted as an elective by the students of following subjects: Chemistry in 12ᵗʰ Class

Suggested Continuous Evaluation Methods:

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper-1

Suggested equivalent online courses:
…………………………………………………………………………………………………..

Further Suggestions:
…………………………………………………………………………………………………..

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: 1	Semester: II
Subject: Chemistry		
Course Code: B020202P	Course Title: Biochemical Analysis	

Course outcomes:
This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical		60-h
Unit	**Topics**	**No of Lectures**
I	**Qualitative and quantitative analysis of Carbohydrates:** . 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Differentiate between a reducing/ nonreducing sugar 3. Synthesis of Osazones.	15
II	**Qualitative and quantitative analysis of Proteins, amino acids and Fats** 1. Isolation of protein. **2.** Determination of protein by the Biuret reaction. 3. TLC separation of a mixture containing 2/3 amino acids 4. Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch 6. To determine the concentration of glycine solution by formylation method. 7. To determine the saponification value of an oil/fat. 8. To determine the iodine value of an oil/fat	20
III	**Determination and identification of Nucleic Acids** 1. Determination of nucleic acids 2. Extraction of DNA from onion/cauliflower	12
IV	**Synthesis of Simple drug molecules** 1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. 2. Synthesis of barbituric acid 3. Synthesis of propranolol	13

Suggested Readings:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education.
3. *Vogel's Qualitative Inorganic Analysis*, Revised by G. Svehla.
4. Vogel, A.I. *A Textbook of Quantitative Analysi*s, ELBS. 1986
5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,*Universities Pres
7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann,

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-II, Theory Ppaer-1**.**

Suggested equivalent online courses:

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Further Suggestions:

………………………………………………………………………………………………….

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
		Diploma in Chemical Dynamics and Analytical Techniques			
2	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4
		B020302P	Physical Analysis	Practical	2
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4
		B020402P	Instrumental Analysis	Practical	2

Programme**:** Diploma in Chemical Dynamics and Analytical Techniques	**Year: Two**	**Semester: III**
Paper-1 Theory		Subject: **Chemistry**
Course Code:B020301T	**Course Title: Chemical Dynamics & Coordination Chemistry**	

Course outcomes: Upon successful completion of this course students should be able to describe the characteristic of the three states of matter and describe the different physical properties of each state of matter. kinetic theory of gases, laws of crystallography , liquid state and   liquid crystals, conductometric, potentiometric, optical methods, polarimetry and spectrophotometer technique to study Chemical kinetics and chemical equilibrium. After the completion of the course, Students will be able to understand .metal- ligand bonding in transition metal complexes, thermodynamic and kinetic aspects of metal complexes.

Credits: 4	**Elective**
Max. Marks: 25+75	Min. Passing Marks:…………

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Chemical Kinetics:** Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).	10
II	**Chemical Equilibrium :** Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. reaction isotherm and reaction isochore – Clapeyron-Clausius equation and its applications.	5
III	**Phase Equilibrium** : Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system– water, CO_2 and systems. Phase equilibria of two component systems – Solid - liquid equilibria , simple eutectic – Bi-Cd, Pb-Ag systems.	05

IV	**Kinetic theories of gases** **Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. **Critical phenomena**: PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state. **Molecular Velocities**: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter.	10
V	**Liquid State** **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. **Liquids in solids (gels**): Classification, preparation and properties, inhibition, general application	5
VI	**Coordination Chemistry** Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.	5
VII	**Theories of Coordination Chemistry** **I** Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, John teller effect, factors affecting the crystal-field parameters. II. Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes	10
VIII	**Inorganic Spectroscopy and Magnetism** I)Electronic spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion. II)Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ s and μ eff	10

values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

Suggested Readings:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Douglas,B, McDaniel ,D and Alexander,J ,Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition , 1994
7. Shriver,D.E Atkins,P.W and Langford,C .H , Inorganic Chemistry ,Oxford University Press, 1994.
8. Porterfield ,W.W, Inorganic Chemistry ,Addison Wesley 1984.
9. Sharpe,A .G, Inorganic Chemistry, ELBS,3RD edition ,1993
10. Miessler,G.L,Tarr,D.A, Inorganic Chemistry, 2nd edition , Prentice Hall,2001

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links-

Suggestive digital platforms web links:

11. https://swayam.gov.in/
12. https://www.coursera.org/learn/physical-chemistry
13. https://www.mooc-list.com/tags/physical-chemistry
14. https://www.openlearning.com/courses/introduction-to-physical-chemistry/
15. https://www.my-mooc.com/en/categorie/chemistry
16. https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
17. https://swayam.gov.in/
18. **https://www.coursera.org/browse/physical-science-and-engineering/chemistry**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12th , Physics in Class 12th

Suggested equivalent online courses:
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Further Suggestions:
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Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: Two	Semester: III
Practical paper-2		Subject: Chemistry
Course Code: B020302P	**Course Title: Physical Analysis**	

Course Outcomes: Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.

Credits: 4	Elective
Max. Marks: 25 +75	Min. Passing Marks:

Practical	**60 h**

Unit	Topics	No of Lectures
I	**Strengths of Solution** Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution – 0.1 M to 0.001 M solutions. Mole Concept and Concentration Units :Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles	20
II	**Surface Tension and Viscosity** 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution	06
III	**Boiling point and Transition Temperature** 1. Boiling point of common organic liquid compounds **ANY FIVE**]$n$butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180^0C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric /dialometric method (e.g. $MnCl_2.4H_2O$/$SrBr_2.2H_2O$)	14
IV	**Phase Equilibrium**	20

	1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenolwater system) and to determine the concentration of that solute in the given phenol-water system	
	2. To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.	

Suggested Readings:
1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-III, Theory Ppaer-1

Suggested equivalent online courses:

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Further Suggestions:

……………………………………………………………………………………………..

Semester IV Paper-1 (Theory)
Course Title: Quantum Mechanics and Analytical Techniques

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: **Two**	Semester: **IV**
Paper-1	Elective	Subject: **Chemistry**
Course Code: BO20401T	**Course Title:** Quantum Mechanics and Analytical Techniques	

Course Outcomes:: Upon successful completion of this course students should be able to describe atomic structure, elementary quantum mechanics ,wave function and its significance ;Schrodinger wave equation and its applications; Molecular orbital theory, basic ideas – Criteria for forming molecular orbital from atomic orbitals , Molecular Spectroscopy, Rotational Spectrum ,vibrational Electronic Spectrum: photo chemistry and kinetics of photo chemical reaction

Analytical chemistry plays an enormous role in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of great importance in different research areas. Analytical chemistry is a science that is directed towards creating new knowledge so that chemical analysis can be improved to respond to increasing or new demands.

- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- Students will be able to function as a member of an interdisciplinary problem solving team.
- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems
- Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques
- To develop basic skills required for purification, solvent extraction, TLC and column chromatography

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:……………

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Atomic Structure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of Ψ and Ψ^2 , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule.	5
II	**Elementary Quantum Mechanics** : Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. de-Broglie hypothesis. Heisenberg uncertainty principle . Hamiltonian Operator.	10

	Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO – H_2 + ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics.	
III	**Molecular Spectroscopy**: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom **Rotational Spectrum**:Diatomic molecules . Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect . **Vibrational Spectrum:** Infrared spectrum : Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. **Raman spectrum:** Concept of polarizability , pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules.	10
IV	**UV-Visible Spectroscopy :** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λmax for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers (Cis and trans stilbene) .	5
V	**Infrared Spectroscopy:** **IR Spectroscopy**: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitile) , Effect of H-bonding, conjugation, resonance and ring size of cyclic ketones and lactones on IR absorptions; Fingerprint region and its significance; application in functional group analysis and and interpretation of I.R. spectra of simple organic compounds.	5

VI	**^{1}H-NMR Spectroscopy (PMR)** NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules such as Ethanol, Ethyl acetate, acetone, acetaldehyde, dimethylformamide, Cis and trans 1,2-dimethyl cycloprpanone, propene , vinyl chloride, acetophenone, benzaldehyde, phenol, Toluene and ethyl benzene.	10
VII	**Introduction to Mass Spectrometry:** Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, fragmentation process, McLafferty rearrangement.	3
VIII	**Separation Techniques: Solvent** extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.	07

Suggested Readings:

1. Alberty,R A, Physical Chemistry,4 th editionWiley Eastern Ltd ,2001.
2. Atkins,P W,the elements of physical chemistry,Oxford ,1991
3. Barrow,G .M,International student Edition .McGraw Hill, McGraw-Hill,1973.
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press 2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
8. Pavia, D. L. *et al. Introduction to Spectroscopy,* 5th Ed. Cengage Learning India Ed.
9. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
10. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
11. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
12. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

Suggestive digital platforms web links

1. https://www.coursera.org/courses?query=chemistry&languages=en
2. https://www.mooc-list.com/tags/physical-chemistry
3. https://www.coursera.org/learn/physical-chemistry
4. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
5. http://heecontent.upsdc.gov.in/Home.aspx
6. https://nptel.ac.in/courses/104/108/104108078/
7. https://nptel.ac.in/courses/104/108/104108124/
8. https://nptel.ac.in/courses/104/106/104106122/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in   a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12th

Suggested equivalent online courses:
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Further Suggestions:
……………………………………………………………………………………………..

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: Two	Semester: V
Practical paper-3		Subject: Chemistry
Course Code: B020402P	**Course Title: Instrumental Analysis**	

Course outcomes: Upon completion of this course, chemistry majors are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.

- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

- Students will be able to function as a member of an interdisciplinary problem solving team.

- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems

- Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques

- To develop basic skills required for purification, solvent extraction, TLC and column chromatography

Credits: 2	Elective
Max. Marks: 25 + 75	Min. Passing Marks:
Practical	**60 h**

Unit	Topics	No of Lectures
I	**Molecular Weight Determination** 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy	10
II	**Spectrophotometry** 1. To verify Beer – Lambert Law for $KMnO_4$/$K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand (COD).	20

	4. Determination of Biological oxygen demand (BOD).	
III	**Spectroscopy** 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). 2. Assignment of labelled peaks in the ^{1}H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern. **3.** Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).	**10**
IV	**Chromatographic Separations** 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II) 2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography (TLC) 3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values **4.** TLC separation of a mixture of dyes (fluorescein and methylene blue)	**20**

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & AlliedMethods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.
Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University
Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the chemistry in class
Suggested equivalent online courses:
……………………………………………………………………………………………..
Further Suggestions:
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Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
			Degree in Bachelor of Science		
3	V	B020501T	Organic Synthesis-A	Theory	4
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4
		B020503P	Qualitative Analysis	Practical	2
		B020504R	Research Project	Project	3
	VI	B020601T	Organic Synthesis-B	Theory	4
		B020602T	Chemical Energetics and Radiochemistry	Theory	4
		B020603P	Analytical Methods	Practical	2
		B020604R	Research Project	Project	3

Semester V, Paper-1 (Theory)
Course Title: Organic Synthesis A

Programme**:** Degree in Bachelor of Science	Year: Three	Semester: **V**
Paper-2 Theory	**Compulsory**	Subject: Chemistry
Course Code: B020501T		Course Title: **Organic Synthesis A**

Course outcomes: Hydrocarbons are the principal constituents of petroleum and natural gas. They serve as fuels and lubricants as well as raw materials for the production of plastics, fibers, rubbers, solvents and industrial chemicals. This course will provide a broad foundation in for the synthesis of hydrocarbons. Hydroxy and carbonyl compounds are industrially important compounds The industries of plastics, fibers, petroleum and rubbers will specially recognize this course. Students will gain an understanding of which are used as solvents and raw material for synthesis of drug and other pharmaceutically important compounds.

- Synthesis and chemical properties of aliphatic and aromatic hydrocarbons
- Synthesis and chemical properties of alcohols, halides carbonyl compounds, carboxylic acids and esters
- How to design and synthesize aliphatic and aromatic hydrocarbons.
- How to convert aliphatic and aromatic hydrocarbons to other industrially important compounds
- Functional group interconversion.

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Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

| Total No. of Lectures- = 60 |||

Unit	Topics	No. of Lectures
I	**Chemistry of Alkanes and Cycloalkanes** **A) Alkanes** :Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity **B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.	8
II	**Chemistry of Alkenes** Methods of formation of alkenes, Addition to **C=C:** mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic	12

	addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of *E*- and *Z*- alkenes.	
III	**Chemistry of Alkynes** Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non-terminal alkynes.	06
IV	**Aromaticity and Chemistry of Arenes** Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.	10
V	**Chemistry of Alcohols** Classification and nomenclature, Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol pinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.	8
VI	**Chemistry of Phenols** : Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman syntheis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction	06
VII	**Chemistry of Ethers and Epoxides**: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.	05
VIII	**Chemistry of Organic Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN^2 and SN^1 reactions with energy profile	05

diagrams; Polyhalogen compounds : Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.

Suggested Readings:
1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley. \
9. Bariyar and Goyal , Organic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University
Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://nptel.ac.in/courses/104/106/104106096/

This course is compulsory for the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:
Students can be evaluated on the basis of score obtained in   a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper

Suggested equivalent online courses:
………………………………………………………………………………………………..
Further Suggestions:
………………………………………………………………………………………………..

Semester-V   Paper-2
Course Title: **Rearrangements and Chemistry of Group Elements**

Programme**:** Degree in Bachelor of Science	Year: Three	Semester: V
Paper-2 Theory	**Elective**	Subject: Chemistry
Course Code: B020502T		**Course Title: Rearrangements and Chemistry of Group Elements**

Course outcomes: This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.

- This paper also provides a detailed knowledge on the elements present in our surroundings, their occurrence in nature. Their position in periodic table, their physical and chemical properties as well as their extraction. This paper also gives detailed understanding of the s, p, d and f block elements and their characteristics.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Rearrangements** A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, BenzilBensilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement	6
II	**Catalysis** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.	8
III	**Chemistry of Main Group Elements**	10

	s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements**: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gasses**: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.	
IV	**Chemistry of Transition Elements** **Chemistry of Elements of First Transition Series** -Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series-** General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.	06
V	**Chemistry of Lanthanides** Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.	4
VI	**Chemistry of Actinides** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.	4
VII	**Metal Carbonyls** Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclea carbonyls.	6
VIII	**Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with special reference to heamoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} . Nitrogen fixation.	6

Suggested Readings:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.

7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
10. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006
11. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
12. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
13. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
14. Francis**, P. G.** Mathematics for Chemists, Springer, 1984
15. Prakash Satya,Tuli G.D.,Basu S.K.Madan R.D.,Advanced inorganic Chemistry,S.Chand publishing.
16. Bariyar and Goyal , Inorganic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:
Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper

Suggested equivalent online courses:
……………………………………………………………………………………………..

Further Suggestions:
……………………………………………………………………………………………..

Semester V, Paper-3 (Practical)
Course Title: Qualitative Analysis

Programme: Degree in Bachelor of Science	Year: Three	Semester: V
Practical paper-3		Subject: Chemistry
Course Code: B020503P	**Course Title: Qualitative Analysis**	

Course outcomes:

Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixtures and organic compounds.

- Identification of acidic and basic radicals in inorganic mixtures
- Separation of organic compounds from mixture
- Elemental analysis in organic compounds
- Identification of functional group in organic compounds
- Identification of organic compound

Credits: 2	Elective
Max. Marks: 25+75	Min. Passing Marks:

Practical		**60 h**

Unit	Topics	No of lectures
I	**Inorganic Qualitative Analysis** Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3	16
II	**Elemental analysis and identification of functional groups** Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.	14
III	**Separation of Organic Mixture** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives	18
IV	**Identification of organic compounds** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.	12

Suggested Readings:
1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris, D.C.*Exploring Chemical Analysis*, 9$_{th}$Ed. New York, W.H. Freeman, 2016.
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

4. https://www.labster.com/chemistry-virtual-labs/
5. https://www.vlab.co.in/broad-area-chemical-sciences
1. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-V Theory Ppaer-1 &2

Suggested equivalent online courses:
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Further Suggestions:
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Semester-VI Paper-1
Course Title: Organic Synthesis B

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Paper-1 Theory	**Compulsory**	Subject: Chemistry
Course Code:B020601T	**Course Title: Organic Synthesis B**	

Course outcomes: This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

The study of natural products and heterocyclic compounds offers an excellent strategy toward identifying novel biological probes for a number of diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a number of diseases including cancer and infection.

- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- Learn the different types of alkaloids, & terpenes etc and their chemistry and medicinal importance.
- Explain the importance of natural compounds as lead molecules for new drug discovery.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Reagents in Organic Synthesis** A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO_2, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with $NaBH_4$, $LiAlH_4$, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H	6

II	**Organometallic Compounds-**Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.	4
III	**Chemistry of Aldehydes and ketones:** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones An introduction to α, β unsaturated aldehydes and Ketones.	10
IV	**Carboxylic acids and their Functional Derivatives** Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.	8
V	**Organic Synthesis via Enolates** Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.	5
VI	**Organic Compounds of Nitrogen-** Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic	10

	substituton in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling	
VII	**Heterocyclic Chemistry** Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophilc substitution reactions of indole, quinoline and isoquinoline	10
VIII	**Natural Products** **Alkaloids & Terpenes:** Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification;. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.	7

Suggested Readings:
17. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
19. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
20. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
21. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
22. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
23. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
24. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
25. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly& Sons (1976).
26. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
27. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural
28. Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
29. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).
30. Organic Chemistry III, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University
Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/103/104103111/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course compulsory for the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:
Students can be evaluated on the basis of score obtained in   a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-V Theory paper-1

Suggested equivalent online courses:
…………………………………………………………………………………………..

Further Suggestions:
…………………………………………………………………………………………..

Semester-VI Paper-2
Course Title: Chemical Energetics and Radio Chemistry

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Paper-2 Theory	**Elective**	Subject: Chemistry
Course Code: B020602T	**Course Title: Chemical Energetics and Radio Chemistry**	

Course outcomes: Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electro chemistry ,ionic equilibrium applications of conductivity and potentiometric measurements

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Thermodynamics-1 :** **First Law of Thermodynamics** : Statement , definition of internal energy and enthalpy. Heat capacity ,heat capacities at constant volume and pressure and their relationship. Joule's law – Joule-Thomson coefficient and inversion temperature . Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. **Thermochemistry:** Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume . Enthalpy of neutralization . Bond dissociation energy and its calculation from thermo-chemical data , temperature dependence of enthalpy. Kirchhoff's equation.	8
II	**Thermodynamics II**	10

	Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality , entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmhotz function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T. Third Law of Thermodynamics ; Nernst heat theorem , statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications .	
III	**Electrochemistry**: Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law , Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations . Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only) . Transport number, definition and determination by Hittorf method and moving boundary method.	8
IV	**Ionic Equilibrium**: Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definition of pH and pKa , determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hazel equation, application of buffer solution. Hydrolysis of salts	10
V	**Photo Chemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes . Laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.	04

VI	**Colligative Properties-**Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.	6
VI I	**Surface Chemistry** **Adsorption**: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); **Colloids**:Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids,Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation	07
VI II	**Radiochemistry** Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutrom emission, positrom emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-99mTc radiopharmaceuticals	07

Suggested Readings:
1. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B..I. Waverly Pvt. Ltd. New Delhi.
2. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
3. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
4. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
7. Allen Bard ,J Larry . Faulkner R ,Fundamentals of Electrochemical methods –fundamentals and applications ,new York   John ,Wiley &sons , 2001
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th ed., New Age International, New Delhi, 1995.
9. Bariyar,and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University
Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://swayam.gov.in/
https://www.coursera.org/learn/physical-chemistry
https://www.mooc-list.com/tags/physical-chemistry
https://www.openlearning.com/courses/introduction-to-physical-chemistry/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class	
Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others . **Or**	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have had the chemistry in class 12th , Physics in 12th	
Suggested equivalent online courses: …………………………………………………………………………………………..	
Further Suggestions: …………………………………………………………………………………………..	

Semester VI, Paper-3 (Practical)
Course Title: Analytical Methods

Programme: Degree in Bachelor of Science	Year: Three	Semester: IV
Practical paper-3		Subject: Chemistry
Course Code: B020603P	**Course Title: Analytical Methods**	

Course Outcomes: Upon successful completion of this course students should be able to quantify the product obtained through gravimetric method; determination of R_f values and identification of organic compounds through paper and thin layer chromatography laboratory techniques: perform thermo chemical reactions

Credits: 2	Elective
Max. Marks: 25+75	Min. Passing Marks:

Practical		**60 h**

Unit	Topics	No of Lectures
I	**Gravimetric Analysis** 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni (dimethylgloxime) 3. Analysis of Ba as BaSO$_4$.	30
II	**Paper Chromatography** Ascending and Circular. Determination of Rf values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L – alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent	8

	– ninhydrin. Separation of monosaccharaides – a mixture of D- galactose and D -fructose using n- butanol: acetone: water (4:5:1). Spray reagent – aniline hydrogen phthalate	
III	**Thin Layer Chromatography** Determination of Rf values and identification of organic compounds:Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)	8
IV	**Thermochemistry** 1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process 2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base 3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle	14

Suggested Readings:
1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University
Suggestive digital platforms web links

4. https://www.labster.com/chemistry-virtual-labs/
5. https://www.vlab.co.in/broad-area-chemical-sciences
6. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the chemistry in 12th class

Suggested equivalent online courses:
……………………………………………………………………………………………………..
Further Suggestions:
……………………………………………………………………………………………………..