SACRED HEART COLLEGE (AUTONOMOUS)

THEVARA, KOCHI – 682013

KERALA

CURRICULUM AND SYLLABUS

FOR

B. Sc. CHEMISTRY

CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS)

INTRODUCED FROM 2023-2024 ADMISSION ONWARDS

Prepared By

Board of Studies in Chemistry

Sacred Heart College (Autonomous)

Thevara, Kochi

BOARD OF STUDIES IN CHEMISTRY
Sacred Heart College (Autonomous)
Thevara, Kochi, Kerala

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CONTENTS

1. INTRODUCTION

Science is a study dealing with a body of facts or truths systematically and the base of all developments in the world is because of practical application of science, *i.e*. technology. When one uses the scientific methods to study or investigate nature or the universe, one is practicing scientific thinking. The creation of a scientific thinking in society necessitates proper education and guidance. In order to achieve this, one must update the developments in every field of science. An effective science education can be imparted at the undergraduate level only by revamping the present curriculum. To achieve this goal, the curriculum of every programme in science should be revised frequently to incorporate the recent advances in science.

The Board of Studies in Chemistry revised the curriculum in tune with the parent University and the University Gants Commission's model for Under Graduate Curriculum. In this process care has been taken to give emphasis to various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, the skills essential for handling equipment and instruments in laboratories and industries, employability and entrepreneur development. Later, consequent of the Hon'ble Supreme Court of India order and the subsequent UGC circular, the Academic Council of the college decided to incorporate Environmental Studies and Human Rights in the UG curriculum, as an additional core course.

The BoS in Chemistry resolved to revise the syllabus and introduce the new syllabus from the academic year 2023-2024. The OBE based syllabus has been drafted and submitted to Academic Council.

1.1 Outcome Based Education (OBE)

B.Sc. Chemistry programme follows the Outcome-based Education (OBE) framework. OBE is a system where all the parts and aspects of education are focused on the outcomes of the course. The students take up courses with a certain goal of developing skills or gaining knowledge and they have to complete the goal by end of the course. Outcome-based education affirms teachers as facilitators, rather than lecturers. In this model, teachers guide the students and encourage them to develop their knowledge and skills. The under graduate programme at the Department of Chemistry, Sacred Heart College (Autonomous), Thevara provides a learning approach in which students develop analytical ability and critical thinking and research acumen over various economic and social issues.

1.2 Programme Outcome (PO)

The syllabus is framed in the Outcome Based Education (OBE) framework and the Programme Outcomes (POs) are given in the table below:

PO1 - Critical Thinking and deep domain knowledge

PO2 - Effective Communication

PO3 - Contributes to nation building

PO4 - Care for environment

PO5 - Ethical values

PO6 - Global Perspective

1.3 Eligibility for Admission:

The candidate must have passed the Class-XII or Plus 2 from a recognized board. Academic eligibility should be satisfied as on the last date of submission of academic data. In the case of candidates who have passed examinations of other Boards/Institutes/Governments, except CBSE/ICSE, they shall be admitted only if these examinations have been declared equivalent to the qualifying examinations of Mahatma Gandhi University.

2. REGULATIONS FOR CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS) FOR UNDERGRADUATE PROGRAMMES - 2023

Preamble

Sacred Heart College, Thevara became an autonomous college under Mahatma University Kottayam in 2014. Since then, academic programmes of the college are being conducted as per the curriculum and syllabus approved by the various Boards of studies and the academic council of the college. The college revised the syllabi of the undergraduate (UG) programmes in 2015-16 and 2019-20. The curriculum and syllabus under the choice-based credit and semester system (CBCSS) for the undergraduate programmes effective from 2019-20 admissions offer Outcome Based Education (OBE). The new 'REGULATIONS FOR CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS) FOR UNDERGRADUATE PROGRAMMES-2023' is a continuation of the effort of the college for providing best education to the UG students of the college.

2.1 Title

These regulations shall be called "SACRED HEART COLLEGE THEVARA REGULATIONS FOR CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS) FOR UNDERGRADUATE PROGRAMMES -2023.

2.2 Scope

Applicable to all undergraduate (UG) programmes of the college with effect from 2023 admissions onwards, except otherwise approved by the Academic Council of the College.

2.3. Definitions

i) '**Programme**' means the entire course of study and examinations.

ii) '**Duration of Programme**' means the period of time required for the conduct of the programme. The duration of under graduate programmes shall be 6 semesters, post-graduate programme shall be of 4 semesters and M Phil programmes shall be 2 semesters.

iii) '**Semester**' means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days, each with 5 contact hours of one hour duration.

iv) '**Course**' means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork / study tour /seminar / project / practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

v) '**Common Course I**' means a course that comes under the category of courses for English and 'Common Course II' means additional language, a selection of both is compulsory for all students undergoing undergraduate programmes (Model I).

vi) '**Core Course**' means a course in the subject of specialization within a degree programme.

vii) '**Complementary Course**' means a course which would enrich the study of core courses.

viii) '**Open Course**' means a course outside the field of his/her specialization, which can be opted by a student.

ix) '**Additional core course**' means a compulsory course for all undergraduate students (as per the UGC directive) to enrich their general awareness.

x) The U.G. programmes shall include (a) Common courses (b) Core courses (c) Complementary Courses (d) Open Course (e) Study tour and (f) Internship for selected programmes.

xi) '**Additional Course**' is a course registered by a student over and above the minimum required courses.

xii) '**Credit**' (Cr) of a course is the numerical value assigned to a course according to the relative importance of the content of the syllabus of the programme.

xiii) '**Extra credits**' are additional credits awarded to a student over and above the minimum credits required for a programme for achievements in co-curricular activities carried out outside the regular class hours OR curricular activities/courses completed for value addition, as directed by the College/ department. It is the numerical value assigned to Club activities, Social service, Internship, add on courses etc. which is not added with the total academic credits of the students. Additional credit components

(a) Talent & career club activity (optional)
(b) Social service (mandatory)
(c) Internship for Commerce, Communication and Computer applications (mandatory).
(d) Internship (desirable for other programmes)
(e) Add on courses (optional)

xiv) '**Programme Credit**' means the total credits of the UG Programme.

xv) '**Programme Elective Cours**e' means a course, which can be chosen from a list of electives and a minimum number of courses is required to complete the programme.

xvi) '**Programme Project**' means a regular project work with stated credits on which the student undergoes a project under the supervision of a teacher in the parent department / any appropriate Institute in order to submit a dissertation on the project work as specified.

xvii) '**Internship**' is on-the-job training for professional careers.

xviii) '**Plagiarism**' is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

xix) '**Tutorial**' means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

xx) '**Seminar**' means a lecture by a student expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

xxi) '**Evaluation**' means every course shall be evaluated by 25% continuous (internal) assessment and 75% end course/end semester (external) assessment.

xxii) '**Repeat Course**' is a course that is repeated by a student for having failed in that course in an earlier registration.

xxiii) '**Audit Course**' is a course for which no credits are awarded.

xxiv) '**Department**' means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.

xxv) '**Parent Department**' means the Department which offers a particular UG/PG programme.

xxvi) '**Department Council**' means the body of all teachers of a Department in a College.

xxvii) '**Faculty Advisor**' is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.

xxviii) '**College Co-ordinator**' means a teacher from the college nominated by the College Council to look into the matters relating to CBCSS.

xxix) '**Letter Grade**' or simply '**Grade**' in a course is a letter symbol (O, A, B, C, D, etc.) which indicates the broad level of performance of a student in a course.

xxx) Each letter grade is assigned a '**Grade Point**' (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

xxxi) '**Credit Point**' (CP) of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course CP=GP x Cr.

xxxii) '**Semester Grade Point Average**' (SGPA) is the value obtained by dividing the sum of credit points (CP) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester . The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxxiii) '**Cumulative Grade Point Average**' (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places.

xxxiv) '**Grace Marks**' means marks awarded to course/s, as per the orders issued by the college from time to time, in recognition of meritorious achievements in NCC/NSS/Sports/Arts and cultural activities.

2.4 ATTENDANCE

Being a regular college, physical presence in the regular activities, especially, classes and exams, is mandatory for the students. However, if a student secures 75% of attendance he/she is eligible to appear for the exams, provided there are no other impediments like disciplinary proceedings, malpractice record etc.

i. A maximum of 5 marks (5%) for a course is given for attendance.

ii. **Absence**: A student found absent for one hour in the forenoon or afternoon session is deprived of the attendance for the entire session as far as eligibility for final exam is concerned.

iii. The hour related calculation in a course is meant for awarding marks for the course concerned.

iv. **Late entry**: A student is supposed to be in time in the class. Late arrival related treatment is left to the discretion of the individual teacher. However, as a norm, a late arriving student may be permitted to the class, if it is not inconvenient or distraction to the class as such; though attendance MAY NOT BE GIVEN. Late arrival beyond 5 minutes is treated as ABSENCE; though the teacher may consider permitting the student to sit in the class.

v. **Leave**: A student has to formally report his/her absence with reasons either in advance, or immediately after the absence for obtaining an approved leave. This applies to all sorts of leave – medical, on duty or other.

vi. The student is supposed to report in prescribed format on the very next day of the absence; however, upto a week's time is permitted. Afterwards, the leave applications will not be considered.

vii. The student has to retain a copy/section of the approved leave form and produce the same as proof, in case there is any confusion regarding the leave sanctioning. In the absence of such proof, the claims will not be entertained.

viii. **Duty Leave**: A student representing the college in sports, arts, social service or academic matters, has to get sanction from the class teacher concerned and submit the leave application form duly endorsed by teacher concerned & the class teacher, and submit it to the faculty Dean (or Vice Principal). The same will be forwarded by the Dean/Vice Principal for attendance entry. SPORTS: The approval of the Department of Physical Education and the class teacher is required. The time limit for submission mentioned above is applicable in the case of duty leave as well.

ix. **CONDONATION**: A student may have the privilege of condonation of attendance shortage (upto a maximum of 10 days) on the basis of genuineness of the grounds of absence (medical reasons or college duty), duly recommended by the department. This is not a matter of right. It is a matter of privilege based on Principal's discretion and the good conduct of the student on the campus. A student of UG programme may have a maximum of two such opportunities.

x. **RE-ADMISSION** – a student whose attendance is inadequate will have to discontinue the studies. Such students, whose conduct is good, may be re-admitted with the approval of Governing Body, on the basis of recommendation from the department, and assurance from the student and the guardian regarding good conduct and compliance in academic and discipline matters. For this the prescribed re-admission fee has to be paid.

As a condition for re-admission, the student should have cleared all academic arrears, or should have appeared for the exams in which he/she is having an arrear (if the results are not out), and should have fulfilled all academic assignments prescribed by the department for compensating for his lack of attendance.

xi. **UNAUTHORISED ABSENCE & REMOVAL FROM ROLLS**: A student absent from the classes continuously for 10 consequent days without intimation or permission, shall be

removed from the rolls, and the matter intimated to the student concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

2.5 PROGRAMME REGISTRATION

i. A student shall be permitted to register for the programme at the time of admission.
ii. A UG student who registered for the programme shall complete the same within a period of 12 continuous semesters from the date of commencement of the programme.

2.6 PROMOTION: A student who registers for the end semester examination shall be promoted to the next semester. However, in extreme circumstances, a student having sufficient attendance who could not register for the end semester examination may be allowed to register notionally by the Principal with the recommendation of the Head of the department concerned and, by paying the prescribed fee.

2.7 UNDERGRADUATE PROGRAMME STRUCTURE

Model I B.Sc. Chemistry

Programme Duration	6 Semesters
Total Credits required for the successful completion of the programme	120 Credits
Credits required from Common Course I (*English*)	22 Credits
Credits required from Common Course II (*Second Language*)	16 Credits
Credits required from Core Course, Complementary Courses and Project	79 Credits
Open Course	3 Credits
Minimum attendance required	75 %

The B. Sc. Chemistry programme consists of common courses with 38 credits, core course, Choice based course and complementary courses with 79 credits and open course with 3 credits. The number and credits of different types of courses of the programme are listed below.

Type of the Course	No. of Courses	No. of Credits
Common Course I (*English*)	6	22
Common Course II (*Second Language*)	4	16
Total	**10**	**38**
Core Courses – *Theory*	12	34
Core Courses – *Practical*	6	12
Elective Course	1	3
Project & Viva – Voce	1	2

Total	**20**	**51**
Complementary Courses – *Theory*	8	24
Complementary Courses – *Practical*	2	4
Total	**10**	**28**
Open Course	1	3
Grand Total	**41**	**120**

Extra-Credit Courses:

The list of extra-credit courses and their corresponding credits are given below:

Course	No. of Credits
Service-Learning Experience (*Mandatory*)	1
Courses offered by talent clubs	1
Summer Internship Programme.	1
Virtual lab Experiments	1

***Semester-wise Distribution of Credits and Instructional Hours*:**

	Sem I		**Sem II**		**Sem III**		**Sem IV**		**Sem V**		**Sem VI**	
	Credit	Hrs./ Week	Credit	Hrs./ Week	Credit	Hrs./ Week	Credit	Hrs./ Week	Credit	Hrs./ Week	Credit	Hrs./ Week
Common Course I (*English*)	7	9	7	9	4	5	4	5	-	-	-	-
Common Course II (*Second Language*)	4	4	4	4	4	5	4	5	-	-	-	-
Core Course - *Theory*	2	2	2	2	3	3	3	3	12	11	12	12
Core Course - *Practical*	-	2	2	2	-	2	2	2	-	8	8	10
Complementary Course – I *Physics - Theory*	2	2	2	2	3	3	3	3	-	-	-	-
Complementary Course – I *Physics - Practical*	-	2	2	2	-	2	2	2	-	-	-	-
Complementary Course – II *Maths - Theory*	3	4	3	4	4	5	4	5	-	-	-	-
Project	-	-	-	-	-	-	-	-	-	2	2	-
Open Course	-	-	-	-	-	-	-	-	3	4	-	-
Elective Course	-	-	-	-	-	-	-	-	-	-	3	3
Total	**18**	**25**	**22**	**25**	**18**	**25**	**22**	**25**	**15**	**25**	**25**	**25**

SEMESTER	No. of Credits	No. of Instructional Hours/Week
I	**18**	**25**
II	**22**	**25**
III	**18**	**25**
IV	**22**	**25**
V	**15**	**25**
VI	**25**	**25**
Total	**120**	**150**

2.8 EXAMINATIONS

All the End Semester Examinations of the college will be conducted by the Controller of Examination. The Principal will be the Chief Controller of Examinations. An Examination committee consists of the Chief Controller of Examinations, Controller of Examinations, Additional Chief Superintendent, Deans, IQAC Coordinator and other faculty members nominated by the Principal will act as an advisory body of the matters relating to the conduct of examinations.

2.9 EVALUATION AND GRADING

The evaluation of each course shall contain two parts:

(i) CONTINUOUS INTERNAL ASSESSMENT (*CIA*)

(ii) END-SEMESTER EXAMINATION (*ESE*)

The internal to external assessment ratio shall be 1:3, for both courses with or without practical. For courses without practical, there shall be a maximum of 75 marks for external evaluation and maximum of 25 marks for internal evaluation. For courses with practical, generally external evaluation shall be for a maximum of 60 marks and internal evaluation for 20 marks. Both internal and external evaluation shall be carried out in the mark system and the marks are to be rounded to the nearest integer.

2.9.1. Continuous Internal Assessment (CIA) / Continuous Assessment:

The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars/viva/field survey and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The marks assigned to various components for internal evaluation as follows.

Components of Internal Evaluation (for theory without practical):

Components of Theory – *Internal Evaluation*	**Marks**
Attendance	5
Assignment	5
Seminar/ Viva-Voce / Field Survey / Quiz	5
Internal Assessment Tests (*Two*) (*2 × 5 = 10*)	10
Total	**25**

Assignments: Every student shall submit one assignment as an internal component for every course.

Components	**Marks**
Punctuality	1
Content	2
Conclusion	1
Reference / Review	1
Total	**5**

Seminar: The seminar lecture is expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

Components	**Marks**
Content	2
Presentation	2
Reference / Review	1
Total	**5**

Evaluation of Attendance: The attendance of students for each course shall be another component of internal assessment.

Percentage of Attendance	**Marks**
90 % and above	**5**
Between 85 and below 90%	**4**
Between 80 and below 85%	**3**
Between 76 and below 80%	**2**
Between 75% and below 76%	**1**

Components of Internal Evaluation (for theory with practical):

Components of Theory – *Internal Evaluation*	**Marks**
Attendance	5
Assignment / Seminar/ Viva-Voce	5
Internal Assessment Tests (*Two*) (*2 × 5 = 10*)	10
Total	**20**

Components of Practical- Continuous internal assessment:

Components of *Practical – Internal Evaluation*	**Marks**
Attendance	3
Record	5
Lab Involvement	2
Total	**10**

Marks distribution for external and internal assessments and the components for internal evaluation with their marks are shown below:

***Mark Distribution for Theory Papers*:**

a) Marks of End Semester Examination : **60**

b) Marks of Internal Evaluation : **20**

Mark Distribution for Open course and Environment Studies Course (Sem V) and Core Elective Course (Sem VI).

a) Marks of End Semester Examination : **75**

b) Marks of Internal Evaluation : **25**

Decimals are to be rounded to the next whole number

***Mark Distribution for all Practical Papers*:**

The practical end-semester examination is conducted only at the end of even semesters.

Pattern and scheme of evaluation of the examination will be decided by the board of practical examination.

a) Marks of End Semester Examination : **30**

b) Marks of Internal Evaluation : **10**

2.9.2 End Semester Examination (ESE):

The End Semester Examination in theory courses shall be conducted by the college with question papers set by external experts/ question bank. The evaluation of the answer scripts shall be done by the examiners based on a well-defined scheme of evaluation given by the question paper setters/Prepared as per the direction of the Chairman, Board of Examiners. The evaluation of the End Semester Examinations shall be done immediately after the examination preferably through the centralised valuation.

2.9.3 Project

Project work is a part of the syllabus of most of the programmes offered by the college. The guidelines for doing projects are as follows:

i) Project work shall be completed by working outside the regular teaching hours.

ii) Project work shall be carried out under the supervision of a teacher in the concerned department or an external supervisor.

iii) A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization/ Institute on the recommendation of the Supervisor.

iv) There should be an internal assessment and external assessment for the project work in the ratio 1:3

v) The external evaluation of the project work consists of valuation of the dissertation (project report) followed by presentation of the work and viva voce.

vi) The mark and credit with grade awarded for the program project should be entered in the grade card issued by the college.

Mark Distribution for Project and Viva-Voce:

Bonafide reports of the project work and Industrial Visit conducted shall be submitted at the time of examination.

a) Marks of End Semester Examination : **75**

b) Marks of Internal Evaluation : **25**

Different components of Project & Viva-Voce End Semester examination can be decided by Board of Examinations.

2.10 GRADES AND GRADE POINTS:

For all courses (theory & practical), grades are given on a 10-point scale based on the total percentage of marks ***(CIA + ESE)*** as given below:

% of Marks for a course	Grade	Grade Point
95% and above	S - Outstanding	**10**
85 to below 95%	A^+ - Excellent	**9**
75 to below 85%	A - Very Good	**8**
65 to below 75%	B^+ - Good	**7**
55 to below 65%	B - Satisfactory	**6**
45 to below 55%	C - Average	**5**
35 to below 45%	D - Pass	**4**
Below 35	F - Failure	**0**
	Ab – Absent	**0**

Grades for the different semesters and overall programme are given based on the corresponding SGPA/CGPA as shown below:

SGPA/CGPA	Grade
Equal to 9.5 and above	***S Outstanding***
Equal to 8.5 and below 9.5	***A+ Excellent***
Equal to 7.5 and below 8.5	***A Very Good***
Equal to 6.5 and below 7.5	***B+ Good***
Equal to 5.5 and below 6.5	***B Above Average***
Equal to 4.5 and below 5.5	***C Average***
Equal to 4.0 and below 4.5	***D Pass***
Below 4.0	***F Failure***

A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 35% are required for a pass for a course. A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the end semester examination for the same semester, subsequently. A student who fails to secure a minimum marks/grade for a pass in a course can be permitted to write the examination along with the next batch.

After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of semester, a student should pass all courses and score at least the minimum CGPA grade 'D'. However, a student is permitted to move to the next semester irrespective of her/his SGPA.

Computation of SGPA (*Semester Grade Point Average*)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses and the total number of credits of all the courses undergone by a student in a semester.

$$\textbf{SGPA } (S_i) = \frac{\sum (C_i \times G_i)}{\sum C_i}$$

Where, S*i* is the SGPA of the ith semester, C$_i$ is the number of credits of the i^{th} course and G$_i$ is the grade point scored by the student in the i^{th} course.

The SGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration for SGPA:

Course	Credit	Grade Letter	Grade Point	Credit Point (*Credit* × *Grade Point*)
Course 1	3	B	6	3 × 6 = 18
Course 2	4	A	8	4 × 8 = 32
Course 3	3	A^+	9	3 × 9 = 27
Course 4	3	B^+	7	3 × 7 = 21
Course 5	3	C	5	3 × 5 = 15
Course 6	4	S	10	4 × 10 = 40
	Σ C*i* = 20			**Σ (C*i* × G_i) = 153**

$$\textbf{SGPA } (S_i) = \frac{\sum(C_i \times G_i)}{\sum C_i} = \frac{153}{20} = 7.65$$

Computation of CGPA (*Cumulative Grade Point Average*)

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.e.*

$$\textbf{CGPA} = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

Where, S*i* is the SGPA of the i^{th} semester and C_i is the number of credits in that semester.

Note: The CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration for CGPA:

Semester	SGPA (S_i)	Credits (C_i)	$S_i \times C_i$
I	**9.69**	**18**	**174.42**
II	**9.12**	**22**	**200.64**
III	**8.50**	**18**	**153.00**
IV	**8.75**	**22**	**192.50**
V	**9.13**	**15**	**136.95**
VI	**9.50**	**25**	**237.50**
		Σ C*i* = 120	**Σ (S*i* × C_i) = 1095.01**

$$\textbf{CGPA} = \frac{\sum(S_i \times C_i)}{\sum C_i} = \frac{1095.01}{120} = 9.13$$

SGPA/CGPA shall be round off to two decimal places

For a pass in a programme, a separate minimum of Grade **D** is required for all the individual courses. If a candidate secures **F** Grade for any one of the courses offered in a Semester / Programme only **F** grade will be awarded for that Semester/Programme until he/she improves this to **D** grade or above within the permitted period. Candidate secure **D** grade and above will be eligible for higher studies.

To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board/website at least one week before the commencement of external examination. There shall not be any chance for improvement for internal mark.

The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the controller of examinations through the Head of the Department and a copy should be kept in the department for at least two years for verification.

2.11. Registration for the examination

a. All students admitted in a programme with remittance of prescribed fee are eligible for the forthcoming semester examinations.
b. Online application for registration to the various End Semester Examinations shall be forwarded to the CE along with prescribed fee for each course in prescribed format.
c. The eligible candidates who secure the prescribed minimum attendance of the total duration of the course and possess other minimum qualification prescribed in the regulations for each course shall be issued the hall tickets. The hall ticket shall be downloaded by the students from the college website.
d. The mode of fee remittance shall be through the prescribed bank.

2.12. Supplementary Examinations

Candidates who failed in an examination can write the supplementary examination conducted by the College along with regular examinations.

2.13. Improvement of Examination

A candidate can improve his/her marks once by appearing again for the examination with the subsequent batch with the remittance of prescribed fee. In such cases the better of the two marks shall be taken as the marks awarded to him.

Internal assessment marks shall be carried over to the subsequent semester examination.

There shall not be any provision for improving internal assessment marks.

2.14. Promotion to the Next Higher Semester

A candidate shall be eligible for promotion from one semester to the next higher semester if,

i) He / she secures a minimum 75 % attendance and registered for the End Semester Examination of the programme for which he/she is studying.

ii) His / her progress of study and conduct are satisfactory during the semester completed, as per the assessments recorded by the course teachers and the Head of the Department concerned.

2.15 Certificates

i) Degree certificates are issued by the Mahatma Gandhi University, Kottayam as per the act and statues of the University on the submission of the consolidated mark / score cards of the students by the College.

i) A consolidated mark / scored card shall be issued to the candidates after the publication of the results of the final semester examination taken by the candidate.

ii) A Course Completion Certificate with classification shall be issued to students till the provisional certificate is issued by the university.

2.16. Award of Degree

The successful completion of all the courses with 'D' grade shall be the minimum requirement for the award of the degree.

2.17. Monitoring

There shall be a Monitoring Committee constituted by the principal consisting of faculty advisors, HoD, a member from teaching learning evaluation committee (TLE) and the Deans to monitor the internal evaluations conducted by college. The Course teacher, Class teacher and the Deans should keep all the records of the internal evaluation, for at least a period of two years, for verification.

Every Programme conducted under Choice Based Credit System shall be monitored by the College Council under the guidance of IQAC Coordinator, Controller of Exams, academic deans and HoDs.

2.18. Grievance Redressal Mechanism

In order to address the grievance of students regarding Continuous internal assessment (CIA) a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

Level 1: At the level of the concerned course teacher

Level 2: At the level of a department committee consisting of the Head of the Department, a coordinator of internal assessment for each programme nominated by the HoD and the course teacher concerned.

Level 3: A committee with the Principal as Chairman, Dean of the Faculty concerned, HOD of the department concerned and one member of the Academic council nominated by the principal every year as members.

3. SYLLABUS

3.1 Programme Specific Outcomes (PSO) of B.Sc. in Chemistry

At the end of the programme a student should be able to:

PSO1

Explain the basic concepts of chemistry and solve problems in inorganic, organic, theoretical and physical chemistry.

PSO2

Illustrate the applicability of chemistry in solving problems related to industry, agriculture, medicine, environment and day to day life.

PSO3

Experiment, analyse and draw conclusions from qualitative, quantitative and synthetic laboratory exercises in chemistry.

PSO4

Design research projects in inorganic, organic, theoretical and physical chemistry that help develop research aptitude.

3.2 Programme Structure for B.Sc. Chemistry:

Sl. No.	Type of Course	Course Code	Course Title	Credits	Hrs./ Week	Hrs./ Sem.
SEMESTER I						
1.	Common Course (English)	23U1CCENG1	Homo Loquens: Effective Listening And Speaking	4	5	90
2.	Common Course (English)	23U1CCENG2	Pearls From The Deep	3	4	72
3.	Common Course (Additional Language)	23U1CCMAL1A	Kadha, Novel	4	4	72
		23U1CCHIN1A	Prose and Drama			
		23U1CCSAN1A	Drama, Poetry and Alankara			
		23U1CCFRE1A	French Language and Communication Skills - I			
4.	Core	23U1CRCHE1	Theoretical and Inorganic Chemistry - I	2	2	36
5.	Complementary	23U1CPPHY2	Properties of Matter and Thermodynamics	2	2	36
6.	Complementary	23U1CPMAT1	Calculus I	3	4	72
7.	Core - *Practical**	23U2PRCHE2	Volumetric Analysis	-	2	36
8.	Complementary - *Practical**	23U2PCPHY2	Complementary Physics Practical – I	-	2	36
***** *Examination at the end of Sem II*			**Total**	**18**	**25**	**450**

SEMESTER II						
1.	Common Course (English)	23U2CCENG3	Text and Context : A Guide to Effective Reading and Writing	4	5	90
2.	Common Course (English)	23U2CCENG4	Savouring the Classics	3	4	72
3.	Common Course (Additional Language)	23U2CCMAL2A	Kavitha	4	4	72
		23U2CCHIN2A	Translation, Communication Skills and Applied Grammar			
		23U2CCSAN2A	Communication Skills in Sanskrit Language			
		23U2CCFRE2A	French Language and Communication Skills - II			
4.	Core	23U2CRCHE2	Theoretical and Inorganic Chemistry – II	2	2	36
5.	Complementary	23U2CPPHY4	Mechanics and Superconductivity	2	2	36
6.	Complementary	23U2CPMAT2	Calculus II and Numerical Analaysis	3	4	72
7.	Core - *Practical*	23U2PRCHE2	Volumetric Analysis	2	2	36
8.	Complementary - *Practical*	23U2PCPHY2	Complementary Physics Practical – I	2	2	36
			Total	**22**	**25**	**450**
Sl. No.	**Type of Course**	**Course Code**	**Course Title**	**Credits**	**Hrs./ Week**	**Hrs./ Sem.**
SEMESTER III						
1.	Common Course (English)	23U3CCENG5	Scripting the Nation: Reading of Indian Polity, Secularism and Sustainability	4	5	90
2.	Common Course (Additional Language)	23U3CCMAL3A	Arangum Porulum	4	5	90
		23U3CCHIN3A	Poetry and Fiction			
		23U3CCSAN3A	Translation and Communication			
		23U3CCFRE3A	Advanced Course in French – I			
3.	Core	23U3CRCHE3	Organic Chemistry – I	3	3	54
4.	Complementary	23U3CPPHY6	Modern Physics and Magnetism	3	3	54
5.	Complementary	23U3CPMAT3	Differential Equations, Matrices and Trigonometry	4	5	90
6.	Core - *Practical**	23U4PRCHE2	Organic Chemistry Practicals – I	-	2	36
7.	Complementary – *Practical**	23U4PCPHY5	Complementary Physics Practical – II	-	2	36
	***** *Examination at the end of Sem IV*		**Total**	**18**	**25**	**450**
SEMESTER IV						
1.	Common Course (English)	23U4CCENG6	Illuminations	4	5	90
2.	Common Course (Additional Language)	23U4CCMAL4A	Gadhyam, Rachanaparichayam	4	5	90
		23U4CCHIN4A	Culture and Civilization of India			
		23U4CCSAN4A	Historical Survey of Sanskrit Literature and Civilization			
		23U4CCFRE4A	An Advanced Course in French – II			
3.	Core	23U4CRCHE4	Organic Chemistry – II	3	3	54

4.	Complementary	23U4CPPHY8	Optics and Solid State Physics	3	3	54
5.	Complementary	23U4CPMAT4	Fourier Series, Laplace Transforms, Fourier Transforms and Groups.	4	5	90
6.	Core - *Practical*	23U4PRCHE2	Organic Chemistry Practicals – I	2	2	36
7.	Complementary - *Practical*	23U4PCPHY5	Complementary Physics Practical – II	2	2	36
			Total	**22**	**25**	**450**

Sl. No.	Type of Course	Course Code	Course Title	Credits	Hrs./ Week	Hrs./ Sem.
SEMESTER V						
1.	Core	23U5CRCHE5	Environmental Studies	4	4	72
2.	Core	23U5CRCHE6	Organic Chemistry - III	3	3	54
3.	Core	23U5CRCHE7	Physical Chemistry – I	3	2	36
4.	Core	23U5CRCHE8	Physical Chemistry – II	2	2	36
5.	Open Course		*Any one Course offered by other departments*	3	4	72
6.	Core - *Practical**	23U6PRCHE3	Qualitative Inorganic Analysis	-	3	54
7.	Core - *Practical**	23U6PRCHE4	Organic Chemistry Practicals – I	-	2	36
8.	Core - *Practical**	23U6PRCHE5	Physical Chemistry Practicals	-	3	54
9.	Core - *Project**	23U6PJCHE1	Project	-	2	36
	***** *Examination at the end of Sem VI*		**Total**	**15**	**25**	**450**
SEMESTER VI						
1.	Core	23U6CRCHE9	Inorganic Chemistry	3	3	54
2.	Core	23U6CRCHE10	Organic Chemistry – IV	3	3	54
3.	Core	23U6CRCHE11	Physical Chemistry - III	3	3	54
4.	Core	23U6CRCHE12	Physical Chemistry - IV	3	3	54
5.	Choice Based Core Elective Course	23U6CRCHE13 EL1	Applied Inorganic Chemistry	3	3	54
		23U6CRCHE13 EL2	Advances in Chemistry			
		23U6CRCHE13 EL3	Medicinal and Pharmaceutical Chemistry			
6.	Core - *Practical*	23U6PRCHE3	Qualitative Inorganic Analysis	2	3	54
7.	Core - *Practical*	23U6PRCHE4	Organic Chemistry Practicals – II	2	2	36
8.	Core - *Practical*	23U6PRCHE5	Physical Chemistry Practicals	2	3	54
9.	Core - *Practical*	23U6PRCHE6	Gravimetric Analysis	2	2	36
10.	Core - *Project*	23U6PJCHE1	Project	2	-	-
			Total	**25**	**25**	**450**

3.3 PROGRAMME STRUCTURE OF CHEMISTRY COMPLEMENTARY COURSES (*Semester-wise Distribution*)

Course Code	Course Title	Credits	Hours / Week	Hour / Sem.	Examination		
					ESE *Duration*	ESE *Max. Marks*	CIA *Max. Marks*
SEMESTER I *(Common for students who have opted for Physics, Botany OR Zoology as Core)*							
23U1CPCHE1	General Chemistry	2	2	36	3 Hrs.	60	20
23U2PCCHE1	Volumetric Analysis	-	2	36	*Examination at the end of Sem II*		
SEMESTER II *(Common for students who have opted for Physics, Botany OR Zoology as Core)*							
23U2CPCHE2	Basic Organic Chemistry	2	2	36	3 Hrs.	60	20
23U2PCCHE1	Volumetric Analysis	2	2	36	3 Hrs.	30	10
SEMESTER III *(for students who have opted for Physics as Core)*							
23U3CPCHE3.1	Fundamentals of Physical Chemistry	3	3	54	3 Hrs.	60	20
23U4PCCHE2.1	Physical Chemistry Practicals	-	2	36	*Examination at the end of Sem IV*		
(for students who have opted for Botany OR Zoology as Core)							
23U3CPCHE3.2	Bio-inorganic and Heterocyclic Chemistry	3	3	54	3 Hrs.	60	20
23U4PCCHE2.2	Organic Chemistry Practicals	2	2	36	*Examination at the end of Sem IV*		
SEMESTER IV *(for students who have opted for Physics as Core)*							
23U4CPCHE4.1	Advanced Physical Chemistry	4	4	72	3 Hrs.	60	20
23U4PCCHE2.1	Physical Chemistry Practicals	-	2	36	3 Hrs.	30	10
(for students who have opted for Botany OR Zoology as Core)							
23U4CPCHE4.2	Advanced Bio-Organic Chemistry	3	3	54	3 Hrs.	60	20
23U4PCCHE2.2	Organic Chemistry Practicals	3	3	54	3 Hrs.	30	10

SYLLABUS FOR
CHEMISTRY CORE COURSES

SEMESTER I

COURSE CODE	**23U1CRCHE1**
COURSE TITLE	**THEORETICAL AND INORGANIC CHEMISTRY-I**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcome	POs / PSOs	CL	Class Sessions
CO1	*Recall the evolution of chemistry as a discipline of science.*	**PO 1, PO 5 PSO 1, PSO 4**	R	3
CO2	*Explain the basics concepts of chemistry and fundamental principles of analytical chemistry.*	**PO 1 PSO 1**	U	3
CO3	*Illustrate the methods in analytical chemistry and deduce errors in chemical analysis.*	**PO 1 PSO 3**	A	9
CO4	*Differentiate the features of various atomic models.*	**PO 1 PSO 1**	U	9
CO5	*Interpret the quantum mechanical model of atom.*	**PO 1 PSO 1**	A	12

Unit 1: ***Chemistry as a Discipline of Science*** **(3 Hrs.)**

What is Science? - Scientific statements - Scientific methods – Observation - Posing a question - Formulation of hypothesis – Experiment – Theory – Law - Revision of scientific theories and laws. Evolution of chemistry - Alchemy - Branches of chemistry.
Components of a research project -Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

Unit 2: ***Basic Concepts in Chemistry*** **(3 Hrs.)**

Atomic mass and Molecular mass. Mole concept – Molar volume. Oxidation and reduction – Oxidation number and valency - Variable valency - Equivalent mass. Methods of expressing concentration: Weight percentage, molality, molarity, normality, formality, mole fraction, ppm and millimoles. *Numerical Problems related to basic concepts*.

Unit 3: ***Analytical Chemistry - I*** **(9 Hrs.)**

Quantitative Analysis: Primary standard-secondary standard, quantitative dilution – problems. Calibration of volumetric apparatus. Acid base titrations- titration curves – pH indicators. Redox titrations – Titration curve, Titrations involving $KMnO_4$ and $K_2Cr_2O_7$, Redox indicators. Complexometric titrations – EDTA titrations, titration curves, metal ion indicators and characteristics.

*Errors in Chemical Analysis***.** Accuracy, precision, Types of error-absolute and relative error, methods of eliminating or minimizing errors. Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation. Significant figures and its application.

Unit 4: ***Atomic Structure*** **(9 Hrs.)**

Introduction to atomic structure based on historical development – Rutherford's atom model and its limitations - Failure of classical physics – Black body radiation – Compton Effect - Planck's quantum hypothesis - Photoelectric effect – Generalization of quantum theory -Atomic spectra of hydrogen and hydrogen like atoms – Ritz-combination principle – Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - Explanation of atomic spectra – Rydberg equation – Limitations of Bohr theory – Sommerfeld's modification - Louis de Broglie's matter waves – Wave-particle duality - Electron diffraction – Davisson and Germer experiment, Heisenberg's uncertainty principle.

Unit 5: ***Quantum Mechanical Model of Atom*** **(12 Hrs.)**

Operator algebra – Linear and Hermitian operators - Laplacian and Hamiltonian operators – Eigen functions and Eigen values of an operator - Well behaved functions, Normalization of wave function, Postulates of quantum mechanics, Time-independent Schrödinger wave equation, Application to particle in a one dimensional box, Particle in a three-dimensional box - Degeneracy. Application of Schrödinger wave equation to hydrogen atom – Conversion of Cartesian coordinates to polar coordinates - The wave equation in spherical polar coordinates (*derivation not required*) - Radial and Angular functions (*derivation not required*) – Orbitals and concept of Quantum numbers (*n, l, m*). Radial functions - Radial distribution functions and their plots – Shapes of orbitals (*s, p* and *d*). Electron spin – Spin quantum number. Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle, Electronic configuration of atoms.
Schrödinger equation for multi-electron atoms: Need for approximation methods.

Text Books

1. Jeffrey A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, Pearson Education, 1999.
2. C.N.R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. Robert H. Hill and David Finster, *Laboratory Safety for Chemistry Students*, 1st Edition, Wiley, Hoboken, NJ, 2010.
4. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
5. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1,* 5th Edition, S. Chand and Sons, New Delhi, 2012.

7. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
8. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 1994.
9. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.
10. B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.

References

1. T.F Gieryn, *Cultural Boundaries of Science,* University of Chicago Press, Chicago, 1999.
2. H. Collins and T. Pinch, *The Golem: What Everyone Should Know about Science,* Cambridge University Press, Cambridge, 1993.
3. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd Revised Edition, New Age International Publishers, New Delhi, 2004.
4. *Guidance in a Nutshell - Compilation of Safety Data Sheets*, European Chemicals Agency, Finland, Version 1.0, December 2013.
5. J. D. Lee, *Concise Inorganic Chemistry*, 5th edn., Blackwell Science, London (Chapter 1).
6. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 3rd edn., Oxford University Press (Chapter 1)
7. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models in Inorganic Chemistry* (Chapter 1)
8. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
9. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
10. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
11. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition, Oxford University Press, New York, 1997.
12. N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.

SEMESTER II

COURSE CODE	**23U2CRCHE2**
COURSE TITLE	**THEORETICAL AND INORGANIC CHEMISTRY-II**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs/PSOs	CL	Class Sessions
CO 1	*Describe the periodic properties of elements.*	**PO 1, PSO 1**	U	6
CO 2	*Explain theories of chemical bonding and different types of bonds.*	**PO 1, PSO 1**	U	18
CO 3	*Analyze the properties of acids, bases and non-aqueous solvents.*	**PO 1, PSO 1**	An	9
CO 4	*Illustrate gravimetry and different separation and purification techniques.*	**PO 1, PSO 3**	A	3

Unit 1: ***Elements and Periodic Properties*** **(6 Hrs.)**

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii – Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity. Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications.

Unit 2: ***Chemical Bonding – I*** **(9 Hrs.)**

Introduction – Type of bonds – Octet rule and its limitations.

Ionic Bond: Factors favoring the formation of ionic bonds - Lattice energy and hydration energy of ionic compounds - Born-Lande equation (*derivation not expected*) – Solvation enthalpy and solubility of ionic compounds –Born-Haber cycle and its applications –Properties of ionic compounds - Polarisation of ions – Fajan's rules and its applications.

Covalent Bond: Lewis theory. Valence Bond Theory. Coordinate bond. Hybridization: Definition and characteristics, VSEPR theory: Postulates, Applications – Shapes of molecules - sp ($BeCl_2$, C_2H_2), sp^2 (BF_3, C_2H_4), sp^3 (CH_4, CCl_4, NH_3, H_2O, NH_4^+, H_3O^+ and SO_4^{2-}), sp^3d (PCl_5, SF_4, ClF_3, XeF_2), sp^3d^2 (SF_6, IF_5, XeF_4) and sp^3d^3 (IF_7, XeF_6). Limitations of VBT. Properties of covalent compounds. Polarity of covalent bond – Percentage of ionic character – Dipole moment and molecular structure.

Unit 3: *Chemical Bonding – II* (9 Hrs.)

Covalent Bond: Molecular Orbital Theory – LCAO - Bonding and anti-bonding molecular orbitals –Bond order and its significance. MO diagrams of homo-nuclear and hetero-nuclear diatomic molecules. H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO – Comparison of bond length, magnetic behavior and bond energy of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}. Resonance structures of borate, carbonate and nitrate ions – Comparison of bond energy. Comparison of VB and MO theories.

Metallic Bond: Free electron theory and band theory (*qualitative treatment only*) – Explanation of metallic properties based on these theories.

Intermolecular Forces: Induction forces and dispersion forces: Van der Waals forces, ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions.

Hydrogen bond: Intra and inter molecular hydrogen bonds – Effect on physical properties.

Unit 4: *Acids and Bases* (5 Hrs.)

Definition- Bronsted-Lowry, Lux-Flood, Solvent system, Usanovich and Lewis definitions, Strength of Lewis acids and bases: Factors affecting strength of acids and bases: Solvent effect, Leveling and differentiating solvents. Effect of substituent - steric factor, charge on the species, Electronegativity, hydration, oxidation number of the central atom, resonance effect, Hard and Soft acids and bases. HSAB Theory, basis of HSAB theory.

Unit 5: *Non-Aqueous Solvents* (4 Hrs.)

Classification of solvents, characteristics of solvents, reactions in liquid ammonia, Alkali metal solution in liquid ammonia, their important properties.

Liquid sulphur dioxide and liquid HF (acid base, amphoteric, solvation, oxidation – reduction, complex formation).

Unit 6: *Analytical Chemistry - II* (3 Hrs.)

Gravimetric analysis: Systematic steps in gravimetric analysis. Illustrations using iron and barium estimation.

Separation and purification techniques – Filtration, Crystallization and precipitation – concept of solubility product as applied in group separation of cations – problems. Fractional distillation, Solvent extraction.

Text Books

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
2. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1,* 5th Edition, S. Chand and Sons, New Delhi, 2012.
3. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
4. Vogel's *Textbook of Quantitative Chemical Analysis*, 6th edn, Pearsons Education Ltd.
5. R. D. Day, A. L. Underwood, *Quantitative analysis*,6th Edn., Prentice Hall of India Pvt. Ltd.

References

1. J. D. Lee, *Concise Inorganic Chemistry*, 5th edn., Blackwell Science, London(Chapter 2-5)
2. C. N. R. Rao, *University General Chemistry*, Macmillan India (Chapter 3)
3. F. A. Cotton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry*, 3rd edn., John Wiley
4. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 3rd edn., Oxford University Press.
5. J. E. Huheey, E. A. Keiter, R. L. Keiter, *Inorganic Chemistry*, 4th edn., Harper Collins, 1993.
6. G. Wulfsberg, *Inorganic Chemistry*, Viva Books.
7. W. L Jolly, *Inorganic Chemistry*, Tata McGraw Hill .
8. M. N. Greenwood and A. Earnshaw, *Chemistry of the elements*, 2nd edn, Butterworth
9. H. J. Emeleus, A. G. Sharpe, *Modern Aspects of Inorganic Chemistry*, Universal Book Stall
10. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 1994.
11. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.
12. I.N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.
13. J David Brown, *The Chemical Bond in Inorganic Chemistry*, Oxford Science Publication
14. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
15. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition, Oxford University Press, New York, 1997.
16. J.B. Rajam and L.D. Broglie, *Atomic Physics*, 7th Edition, S. Chand and Co. Pvt. Ltd., New Delhi, 1999.
17. S. Glasstone, *Source Book on Atomic Energy*, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 1967.
18. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry, 8th edn, Brooks/Cole Nelson (Chapters 12-17).
19. G. D. Christian, Analytical Chemistry, John Wiley and Sons.

SEMESTER I & II

PRACTICAL 1

COURSE CODE	**23U2PRCHE1**
COURSE TITLE	**VOLUMETRIC ANALYSIS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs/PSOs	CL	Class Sessions
CO 1	*Estimate the amount of substance in a given solution by volumetric analysis*	**PO 1, PO 4, PSO 3**	An	72

A. *Acidimetry and Alkalimetry*

1. Strong acid – Weak base
2. Strong base – Weak acid
3. Estimation of Na_2CO_3 and $NaHCO_3$ in a mixture
4. Estimation of NaOH and Na_2CO_3 in a mixture

B. *Complexometry*

1. Estimation of Zn using EDTA
2. Estimation of Mg using EDTA
3. Estimation of Mg and Ca in a mixture
4. Determination of hardness of water

C. *Permanganometry*

1. Estimation of Ferrous iron
2. Estimation of Oxalic acid
3. Estimation of Calcium

D. Dichrometry

1. Estimation of Ferrous iron using internal indicator
2. Estimation of Ferrous iron using external indicator
3. Estimation of Ferric iron – reduction with $SnCl_2$

E. Iodometry and Iodimetry

1. Standardisation of thiosulphate using KI, electrolytic copper and potassium dichromate.
2. Estimation of As_2O_3 and arsenite.
3. Estimation of Cu in a copper salt.

References

1. Vogel's, *Textbook of Quantitative Chemical Analysis*, 6th edn, Pearsons Education Ltd.
2. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th edn, Brooks/Cole Nelson.
3. G. D. Christian, *Analytical Chemistry*, John Wiley and Sons.

SEMESTER III

COURSE CODE	**23U3CRCHE3**
COURSE TITLE	**ORGANIC CHEMISTRY-I**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Classify and predict the name of organic compounds.*	**PO 1, PSO 1**	U	3
CO 2	*Illustrate the fundamentals of organic reaction mechanisms.*	**PO 1, PSO 1**	A	15
CO 3	*Interpret the stereochemistry of organic compounds.*	**PO 1, PSO 1**	A	12
CO 4	*Explain aromaticity of organic compounds.*	**PO 1, PSO 1**	A	18
CO 5	*Categorize various organic polymers and its applications.*	**PO 1, PO 4 PSO 1, PSO 2**	An	6

Unit 1: *Classification and Nomenclature of Organic Compounds* (3 Hrs.)

1.1 Classification of organic compounds.

1.2 Rules of IUPAC system of nomenclature of organic compounds such as alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, alkyl halides, alcohols, phenols, aldehydes, ketones, carboxylic acids and its derivatives, amines, nitro compounds. (*Both aliphatic and aromatic*).

Unit 2: *Organic Reaction Mechanisms* (15 Hrs.)

2.1 *Meaning of reaction mechanism* - Drawing electron movements with arrows – curved arrow notation. Half headed and double headed arrows. Nature of bond fission – homolytic and heterolytic.

2.2 *Types of reagents* – Electrophiles and Nucleophiles- Types and sub-types of following organic reactions with definition and at least one example of each - Substitution, Addition reactions, Elimination and Rearrangement.

2.3 *Reactive Intermediates* with examples – carbocations, carbanions, carbenes, nitrenes and free radicals.

2.4 *Electron displacement effects* - Inductive, electrometric, mesomeric, resonance, hyper conjugation and steric effects- steric inhibition of resonance.

2.5 *Aliphatic nucleophilic substitutions*, mechanism of S_N1, S_N2- effects of structure, substrate, solvent, nucleophile and leaving groups - Stereochemistry- Walden inversion

2.6 *Elimination Reactions*:-Hoffmann and Saytzeff rules- *cis* and *trans* eliminations – mechanisms of E1 and E2 reactions. Elimination *versus* substitution.

2.7 *Addition Reactions*- mechanisms of addition of Bromine – inductomeric effect, mechanisms of addition of hydrogen halides to double bonds - Markonikoff's rule and peroxide effect.

Unit 3: *Stereochemistry of Organic Compounds* (12 Hrs.)

3.1 *Stereoisomerism* - definition - classification - optical and geometrical isomerism

3.2 *Projection formulae* - Fischer, flying wedge, Sawhorse and Newman projection formulae - notation of optical isomers, D–L notation- Cahn-Ingold-Prelog rules - R-S notations for optical isomers with one and two asymmetric carbon atoms - erythro and threo representations.

3.3 *Optical isomerism* - optical activity - optical and specific rotations - conditions for optical activity - asymmetric centre, chirality - achiral molecules - meaning of (+) and (-), Elements of symmetry. Prochirality- Racemization - methods of racemization (by substitution and tautomerism) - Resolution - methods of resolution -mechanical, seeding, biochemical and conversion to diastereoisomers - Asymmetric synthesis (*partial and absolute synthesis*). Optical activity in compounds does not containing asymmetric carbon atoms-Biphenyls and allenes.

3.4 *Geometrical isomerism* - *cis-trans, syn-anti* and E-Z notations - geometrical isomerism in maleic and fumaric acids and unsymmetrical ketoximes - methods of distinguishing geometrical isomers using melting point, dipole moment, dehydration and cyclisation.

Unit 4: *Aromaticity* (18 Hrs.)

4.1 *Concept of Resonance*- resonance energy in benzene. Heat of hydrogenation and heat of combustion of Benzene, mention of C-C bond lengths and orbital picture of Benzene. Structure of naphthalene and anthracene (*Molecular Orbital picture and resonance*)

4.2 *Concept of Aromaticity* – aromaticity (definition), Huckel's rule – application to Benzenoids – Benzene, Naphthalene, Anthracene, Phenanthrene and Non–Benzenoid compounds – cyclopropenylcation, cyclopentadienyl anion and tropylium cation.

4.3 *General mechanism of electrophilic substitution*- mechanism of halogenation, nitration, Friedal Craft's alkylation and acylation, sulphonation. Orientation of aromatic substitution – Definition of *ortho, para* and *meta*- directing groups. Ring activating and deactivating groups with examples -Electronic interpretation of various groups like $–NO_2$ and –OH. Orientation of (i). Amino, methoxy and methyl groups (ii). Carboxy, nitro, nitrile, carbonyl and sulfonic acid groups. (iii). Halogens. (*Explanation by taking minimum of one example from each type is required*).

4.4 Reactions of Naphthalene, Anthracene, Phenanthrene, Biphenyl; Reactivity of naphthalene towards electrophilic substitution. Nitration and sulphonation. Elementary Idea of Naphthyl amines, naphthols, napthaquinones.

4.5 *Aromatic Nucleophilic substitutions* - bimolecular displacement mechanism- Elimination – Addition mechanism - Benzyne intermediate, Reactivity and orientation in Aromatic Nucleophilic substitutions.

Unit 5: *Organic Polymers* (6 Hrs.)

5.1 Polymerisation reactions-Types of polymerization - free radical, cationic and anionic – polymerisations –including mechanism.

5.2 Synthesis and applications of the following polymers - Polyesters - terephthalates, polyamides - Nylon-6 and Nylon-6,6, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes, PVC and Teflon.

5.3. Synthetic rubbers – SBR and Nitrile rubber- structure and applications.

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2. M.K. Jain and S.C. Sharma, '*Modern Organic Chemistry*' 3rd Edn, Vishal Publishing Company Co.
3. K.S. Tewari and N. K. Vishnoi, '*Organic Chemistry*', 3rd Edition, Vikas Publishing House.
4. S. C. Pal, '*Nomenclature of Organic Compounds*,, Narosa Publishing Company.
5. J Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*: 6th Edition, Pearson Education.
6. P. S. Kalsi' '*Organic Reactions and their Mechanisms*' New Age International Publishers.
7. R. T. Morrison and R. N. Boyd, '*Organic Chemistry*', 6th Edition - Prentice Hall of India,

Further Reading

1. P. Y. Bruice, '*Organic Chemistry*' - 3rd Edn. Pearson Education.
2. C. N. Pillai '*Organic Chemistry*' Universities Press.
3. J. March, '*Advanced Organic Chemistry*', IV Edn, John Wiley & Sons, NY.
4. S. M. Mukherjee and S.P. Singh '*Reaction Mechanism In Organic Chemistry*', Macmillan.
5. Reinhard Bruckner, '*Advanced Organic Chemistry*' Elsevier.
6. J. Clayden, N. Greeves, S. Warren and P. Wothers, *Organic Chemistry*, Oxford University Press.
7. V. K. Ahluwalia, *Green Chemistry*, Ane *Books* India.

SEMESTER IV

COURSE CODE	**23U4CRCHE4**
COURSE TITLE	**ORGANIC CHEMISTRY - II**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Explain the chemistry of alcohols, phenols, ethers and epoxides.*	**PO 1, PSO 1**	An	11
CO 2	*Differentiate between aldehyde and ketones.*	**PO 1, PSO 1**	An	12
CO 3	*Illustrate the structure and chemical properties of carboxylic acids and sulphonic acids.*	**PO 1, PSO 1**	A	18
CO 4	*Identify active methylene compounds and explain their reactions.*	**PO 1, PSO 1**	U	5
CO 5	*Describe the chemistry of dyes, soaps and detergents*	**PO 1, PO 4 PSO 1, PSO 2**	U	8

Unit 1: ***Hydroxy Compounds*** **(8 Hrs.)**

1.1 Monohydric alcohols: Classification, physical properties–hydrogen bonding-distinction between primary, secondary and tertiary alcohols- Ascent and descent in alcohol series dihydric alcohols:

1.2 Oxidative cleavage – Lead tetra acetate, Periodic acid- Pinacol - Pinacolone rearrangement – mechanism.

1.3 Phenols – Acidity of phenols- effects of substituents – comparison of acidity with alcohols.

1.4 Preparation and uses of nitrophenol, picric acid, catechol, resorcinol and quinol.

1.5 Mechanisms of Reimer –Tiemann reaction, Lederer- Mannase reaction, Fries rearrangement.

Unit 2: ***Ethers and Epoxides*** **(3 Hrs.)**

2.1 Synthesis and reactions of epoxides - Cleavage of ether linkages by HI- Ziesels method of estimation of alkoxy groups - Claisen rearrangement –mechanism.

2.2 Elementary idea of anisole and phenetol.

Unit 3: ***Aldehydes and Ketones*** **(12 Hrs.)**

3.1 Structure and reactivity of the carbonyl group - acidity of alpha hydrogen.

3.2 Comparative studies of - aldehydes and ketones - aliphatic and aromatic aldehydes - formaldehyde and acetaldehyde-

3.3 Mechanism of nucleophilic additions to carbonyl groups with special emphasis on Claisen, Claisen-Schmidt, Benzoin, Aldol, Perkin and Knoevenagel condensations.

3.4 Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Oxidation and reduction of aldehydes and ketones - Baeyer-Villiger oxidation-Cannizzaro's reaction, Meerwein-Pondorof-Verley, Clemmensen, Wolff-Kishner reductions (*mechanisms expected*).

3.5 Use of acetal as protecting group.

Unit 4: *Carboxylic and Sulphonic Acids* (18 Hrs.)

4.1 Structure of carboxylate ion- effects of substituents on acid strength of aliphatic and aromatic carboxylic acids.

4.2 Ascent and descent in fatty acid series- Hell-Volhard- Zelinsky reaction - Mechanism of decarboxylation.

4.3 Preparation of functional derivatives of carboxylic acids- acid chlorides, esters anhydrides and amides – their importance

4.4 Methods of preparation and chemical reactions of anthranilic acid, cinnamic acid, acrylic acid, oxalic acid, malonic acid, citric acid, adipic acid, maleic acid, fumaric acid and coumarin.

4.5 Preparation and reactions of benzene sulphonic acid, benzene sulphonyl chloride and *otho*- and *para*- toluene sulphonyl chlorides- uses

Unit 5: *Compounds Containing Active Methylene Groups* (5 Hrs.)

5.1. Keto-enol tautomerism

5.2. Synthetic uses of malonic ester, acetoacetic ester and cyanoacetic ester.

5.3. Alkylation of carbonyl compounds *via* enamines and enolates.

Unit 6: *Dyes* (5 Hrs.)

6.1 Theory of colour and constitution. Classification - according to structure and method of application.

6.2 Preparation and uses of 1) Azo dye-methyl orange and Bismark brown 2) Triphenylmethane dye - Malachite green 3) Phthalein dye - phenolphthalein and fluroescein 4) Vat dye – indigo, 5) Anthraquinone dye - alizarin.

Unit 7: *Soaps and Detergents* (3 Hrs.)

7.1 Composition of soaps - detergent action of soap.

7.2 Synthetic detergents - their functions – comparison between soaps and detergents.

7.3 Environmental aspects. LAS and ABS detergents.

References

1. R. T. Morrison and R. N. Boyd, '*Organic Chemistry*', 6th Edition - Prentice Hall of India,
2. I. L. Finar, '*Organic Chemistry*', 6th Edition, Vol- I, Pearson.
3. M. K. Jain and S.C. Sharma, '*Modern Organic Chemistry*', 3rd Edition, Vishal Publishing Company Co.

4. K.S. Tewari and N K Vishnoi, 'Organic *Chemistry*', 3rd Edition, Vikas Publishing House.
5. P. S. Kalsi' '*Organic Reactions and their Mechanisms*' New Age International Publishers.

Further reading

1. B. S. Bahl, '*Advanced organic Chemistry*', S. Chand.
2. John McMurry, '*Organic Chemistry*' - Vth Edition -Thompson Asia Pvt. Ltd.
3. C. N. Pillai, '*Organic Chemistry*', Universities Press.
4. S. H. Pine, 'Organic Chemistry', McGraw Hill.
5. A. K. Bansal, "A Textbook of Organic Chemistry', New Age International Publishers.

SEMESTER III & IV
PRACTICAL 2

COURSE CODE	**23U4PRCHE2**
COURSE TITLE	***Organic Chemistry Practical – I*** **QUALITATIVE ORGANIC ANALYSIS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Analyze an organic compound and prepare its derivative.*	**PO 1, PSO 3**	An	72

1. Tests for elements: Nitrogen, Halogens and Sulphur
2. Tests for unsaturation.
3. Tests for aromatic character.
4. Determination of Physical constants of solids and liquids.
5. Study of the reactions and systematic analysis of the following organic compounds containing one functional group and characterization with a derivative - alcohol, aldehyde, ketone, carboxylic acid, 1,2-dicarboxylic acid, ester, primary, secondary amines and tertiary amines, nitro compounds, amides, diamide, anilide reducing and non-reducing sugars, phenols, and halogen compounds, polynuclear hydrocarbons.

   (Minimum Nine mono functional and three bifunctional compounds to be analysed)

References

1. Vogel's '*Textbook of Practical Organic Chemistry*' Pearson Education.
2. F. G. Mann and B. C. Saunders, '*Practical Organic Chemistry*' *Fourth Edition,* Pearson Education.
3. V. K. Ahluwalia and S. Dhingra, '*Comprehensive Practical Organic Chemistry*', Universities Press.

SEMESTER V

COURSE CODE	**23U5CRCHE5**
COURSE TITLE	**ENVIRONMENTAL STUDIES**
NO. OF CREDITS	**4**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Express the multidisciplinary nature of environmental studies.*	PO 4, PSO 2	U	12
CO 2	*Explain the structure and function of ecosystem.*	PO 4, PSO 2	A	8
CO 3	*Assess social issues related to the environment and environmental pollution.*	PO 4, PO 5, PSO 2	E	26
CO 4	*Illustrate the basic principles of green chemistry.*	PO 4, PSO 2	A	8
CO 5	*Explain the environmental aspects of nuclear chemistry and nano chemistry.*	PO 4, PO 5, PSO 2	A	18

Unit 1: ***Multidisciplinary Nature of Environmental Studies*** **(12 Hrs.)**

Definition, scope and importance. Need for public awareness. Natural resources: Renewable and non-renewable resources, forest resources - use and over-exploitation, deforestation. Water resources - use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources - use and exploitation, environmental effects of extracting and using mineral resources. Food resources - World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems. Energy resources -growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources - land as a resource, land degradation, man induced landslides, soil erosion and desertification

Unit 2: ***Ecosystems*** **(8 Hrs.)**

Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the given ecosystem:- Forest ecosystem.

Unit 3: ***Social Issues and the Environment*** (**8 Hrs.**)

Urban problems related to energy. Water conservation, rain water harvesting, water shed management. Resettlement and rehabilitation of people: its problems and concerns. Environmental ethics: Issues and possible solutions. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Unit 4: ***Air, Water and Soil Pollution*** **(18 Hrs.)**

Air pollution: Primary and secondary air pollutants; Causes, effects and control measures. Acid rain, smog, green house effect, Global warming, ozone depletion – causes and consequences. Introduction to noise pollution, hazards of noise pollution.

Water pollution: Causes- organic, inorganic and macroscopic contaminants, effects of pesticides, insecticides and detergents on water pollution. Marine pollution, eutrophication, biomagnification, water quality parameters- Total hardness (Ca and Mg), DO, BOD, COD.

Sewage water Treatment – Primary, Secondary, Tertiary treatment process – Trickling filter, UASB, Reverse osmosis, Activated sludge process, Disinfection methods by chlorination and UV, Water reuse and recycling, zero liquid disposal.

Soil pollution: Causes and effects: Agrochemicals, industrial wastes, petroleum wastes, electronic wastes, landfill and dumping. Genetically modified plants.

Unit 5: ***Introduction to Green Chemistry*** **(8 Hrs.)**

Introduction to green chemistry, twelve principles of green chemistry illustrated by examples (*Mechanism not expected*), atom economy calculation, examples. Green solvents – organic reactions with water as solvent, Ultrasound assisted Ullmann reaction, Green alternative Claisen rearrangement (*Mechanism not expected*). Ionic liquids and their applications.

Unit 6: ***Environmental Aspects of Nuclear Chemistry*** **(8 Hrs.)**

Nuclear particles, size of the nucleus - nuclear forces - nuclear stability – N/P ratio – packing fraction – mass defect – binding energy - magic numbers. Nuclear models – shell model and liquid drop model.

Natural radioactivity. Modes of decay- group displacement law — rate of decay – decay constant – half-life period – Gieger-Nuttall rule – disintegration series – transmutation reactions using protons, deutrons, particles and neutrons. Artificial radioactivity – positron emission and K electron capture – trans-uranic elements, spallation reactions.

Applications of radioactivity: Radio carbon dating – rock dating – isotopes as tracers – study of reaction mechanism (ester hydrolysis). Application of radioactive isotopes in medicine. Nuclear fission - atom bomb - nuclear reactors – fast breeder reactors. Nuclear fusion and hydrogen bomb. Nuclear waste and its impact on environment – nuclear waste management

Unit 7: ***Environmental Aspects of Nano Chemistry*** **(10 Hrs.)**

Nanomaterials – properties, synthesis – Green synthesis of nanosilver and nanogold, surface plasmon resonance, arc discharge, laser ablation, mechano-chemical method, micro emulsion method, reduction method, precipitation method, chemical vapour deposition and sol-gel method (brief study). Properties and applications of fullerenes, quantum dots and carbon nanotubes. Applications of nano materials – green nanocomposites, bioplastics, nanocoating, nano medicines, gas sensors, water treatment, solar cell.

References

1. Bharucha Erach, *Text Book of Environmental Studies for undergraduate Courses*. University Press, IInd Edition 2013 (TB).
2. Clark R. S., *Marine Pollution*, Clanderson Press Oxford (Ref).
3. Cunningham, W. P. Cooper, T. H. Gorhani, E & Hepworth, M.T.2001, *Environmental Encyclopedia*, Jaico Publ. House. Mumbai. 1196p .(Ref)
4. De A.K., *Environmental Chemistry*, Wiley Eastern Ltd.(Ref)
5. *Down to Earth*, Centre for Science and Environment (Ref)
6. Heywood, V.H & Watson, R.T. 1995. *Global Biodiversity Assessment*, Cambridge University Press 1140pb (Ref)
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8. Mekinney, M.L & Schock.R.M. 1996. *Environmental Science Systems & Solutions*. Web enhanced edition 639p (Ref)
9. Miller T.G. Jr., *Environmental Science*, Wadsworth Publishing Co. (TB)
10. Odum E. P., 1971. *Fundamentals of Ecology*. W.B. Saunders Co. USA 574p (Ref)
11. Rao M. N. & Datta. A. K., 1987 Waste Water treatment Oxford & IBII Publication Co.Pvt.Ltd.345p (Ref)
12. Rajagopalan. R, *Environmental Studies from crisis and cure*, Oxford University Press, Published: 2016 (TB)
13. Sharma B.K., 2001. *Environmental Chemistry*. Geol Publ. House, Meerut (Ref)
14. Townsend C., Harper J, and Michael Begon, *Essentials of Ecology*, Blackwell Science (Ref)
15. Trivedi R.K., *Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards*, Vol I and II, Enviro Media (Ref)
16. Trivedi R. K. and P.K. Goel, *Introduction to air pollution*, Techno-Science Publication (Ref)
17. K. D. Wanger, 1998 *Environmental Management*. W.B. Saunders Co. Philadelphia, USA 499p (Ref)
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19. S. Glasstone, *Source Book on Atomic Energy*, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 1967.
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21. V. S. Muraleedharan and A. Subramanian, *Nano science and Nanotechnology*, Ane Books Pvt. Ltd. New Delhi, 2009.
22. T. Pradeep, *Nano; The Essentials*, Mc Graw-Hill education, New Delhi, 2006.

SEMESTER V

COURSE CODE	**23U5CRCHE6**
COURSE TITLE	**ORGANIC CHEMISTRY - III**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Illustrate the chemistry of organic compounds containing nitrogen.*	PO 1, PSO 1	A	20
CO 2	*Explain the basics of organic photochemical and pericyclic reactions.*	PO 1, PSO 1	U	6
CO 3	*Explain the conformational analysis of aliphatic compounds.*	PO 1, PSO 1	A	6
CO 4	*Point out the applications of synthetic and organometallic reagents.*	PO 1, PSO 2	An	9
CO 5	*Cite the importance of chemotherapy.*	PO 4, PSO 2	U	5
CO 6	*Predict the structure of an organic compound using spectroscopic techniques.*	PO 4, PSO 3	E	8

Unit 1: *Organic Compounds Containing Nitrogen* (20 Hrs.)

1.1 *Nitro compounds* – nitromethane – tautomerism - reduction products of nitrobenzene in acidic, neutral and alkaline media - electrolytic reduction and selective reduction of poly nitro compounds- formation of charge transfer complexes.

1.2 *Amines* - isomerism- stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines - Structural features affecting basicity of aliphatic and aromatic amines. Quaternary amine salts as phase-transfer catalysts. Comparative study of aliphatic and aromatic amines.

1.3 Preparation of alkyl and arylamines (reduction of nitro compounds, nitriles), reductive amination of aldehydes and ketones, Gabriel-Phthalimide reaction, Hoffmann bromamide reaction.

1.4 *Diazonium salts* - preparation, synthetic transformations of aryldiazonium salts, azo coupling - Mechanisms of Sandmeyer's and Gatterman reactions – Schiemann and Gomberg reactions.

1.5 Preparation and uses of Phenyl hydrazine.

1.6 *Diazomethane and diazoacetic ester* - preparation, structure and synthetic uses. Arndt-Eistert synthesis- mechanism –Wolff rearrangement –mechanism.

1.7 Curtius rearrangement and its mechanism.

Unit 2: *Organic Photochemical and Pericyclic Reactions* (6 Hrs.)

2.1 Introduction - Photochemical *versus* Thermal reactions. Reactions.

2.2 Norrish reactions of acyclic Ketones. Patterno-Buchi, Photo-Fries reactions.

2.3 *Pericyclic Reactions*: Classification- electrocyclic, sigmatropic, cycloaddition reactions (*Examples for each type*.)

2.4 Diels- Alder reaction- Stereochemical aspects - Effect of substituents.

Unit 3: *Conformational Analysis* (**6 Hrs**.)

3.1 *Conformational analysis* - introduction of terms - conformers, configuration, dihedral angle, torsional strain - Conformational analysis of ethane and n-butane using energy profile diagrams - conformers of cyclohexane (chair, boat and skew boat forms) - axial and equatorial- bonds-ring flipping showing axial equatorial interconversion, conformation of methyl cyclohexane.

3.2 Relative stabilities of Cycloalkanes – Bayer's Strain theory.

Unit 4: *Chemotherapy* (**5 Hrs.**)

4.1. Drugs- introduction –classification –mode of action

4.2. Elementary idea of the structure and mode of action of the following drugs: Sulphanilamides, Ampicillin and Chloramphenicol.

4.3. Elementary idea of the structure and application of Chloroquine, Paracetamol, Analgin and, Aspirin.

4.4. Drugs in cancer therapy- Chlorambucil.

Unit 5: *Chemistry of Organic Reagents* (**6 Hrs.**)

5.1. Analytical reagents – Tollen's reagent, Fehling solution, Schiff's reagents, Borsche's reagent, Benedict solution. (*Procedure not required*)

5.2. Applications of Synthetic reagents –NBS, Lead tetra acetate, Periodic acid, OsO_4, Ozone, LDA, Selenium dioxide, Perbenzoic acid, DDQ, DCC, Raney Nickel, $LiAlH_4$, $NaBH_4$, DIBAL-H, Diborane, $NaBH_3CN$.

Unit 6: *Organometallic Compounds* **(3 Hrs.)**

6.1. Grignard reagents-formation, structure and synthetic applications.

6.2. Reformatsky reaction, alkyl lithium and organo copper reagents-Gilman reagent

Unit 7: *Structure Elucidation* (**8 Hrs.**)

7.1 Introduction to UV, IR and NMR spectroscopy.

7.2 UV, IR and NMR spectral characteristics of simple molecules such as ethylene, butadiene, benzene, acetaldehyde, acetone, acetophenone, crotonaldehyde, ethanol, ethyl acetate, acetic acid, aniline, acetamide.

7.3 Problems pertaining to the structure elucidation of simple organic compounds using IR and PMR spectroscopic techniques.

7.4 Mass spectrometry- Introduction-EI ionization - Determination Molecular mass by MS (*Elementary idea- fragmentation study not required*)

References

1. I. L. Finar, '*Organic Chemistry*', 6th Edition, Vol. I, Pearson.
2. R. T. Morrison and R. N. Boyd, '*Organic Chemistry*', 6th Edition - Prentice Hall of India.
3. M. K. Jain and S. C. Sharma '*Modern Organic Chemistry*', 3rd Edition, Vishal Publishing Company Co.
4. K. S. Tewari and N. K. Vishnoi, '*Organic Chemistry*', 3rd Edition, Vikas Publishing House
5. B. S. Bahl, '*Advanced Organic Chemistry*', S. Chand.
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7. V. R. Gowariker, N. V. Viswanathan and Jayader Sreedhar, '*Polymer Science*', Wiley Eastern Ltd., New Delhi.
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9. F. G. Mann and B.C. Saunders, '*Practical Organic Chemistry*', 4th edn. Pearson Education.
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2. John McMurry, '*Organic Chemistry*', Vth Edition -Thompson Asia Pvt. Ltd.
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6. W. Kemp, '*Organic Spectroscopy*', Longman, 1995.
7. D. L. Pavia, G. M. Lampman and G. S. Kriz, '*Introduction to Spectroscopy*', Thomson Brooks Cole.

SEMESTER V

COURSE CODE	**23U5CRCHE7**
COURSE TITLE	**PHYSICAL CHEMISTRY - I**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Apply the principles of chemical thermodynamics to various physical and chemical processes.*	PO 1, PSO 1, PSO 2	A	24
CO 2	*Construct and explain the phase diagrams of one- and two-component systems.*	PO 1, PSO 1	A	6
CO 3	*Discuss the theories of chemical kinetics and catalysis.*	PO 1, PSO 1	U	6

Unit 1: *Chemical Thermodynamics* (24 Hrs.)

1.1 *Introduction to Thermodynamics:* Definition of thermodynamic terms, intensive and extensive properties, path and state functions, exact and inexact differentials, reversible and irreversible processes, spontaneous and non-spontaneous processes, internal energy, work and heat, zeroth law of thermodynamics.

1.2 *First law of thermodynamics:* Statement and mathematical expression, enthalpy, heat capacity, C*p* and C*v* relation in ideal gas systems, change in thermodynamic properties of an ideal gas during reversible isothermal and adiabatic reversible processes. Joule-Thomson experiment, Joule-Thomson coefficient μ_{JT}, inversion temperature.

1.3 *Thermochemistry***:** Enthalpies of formation, combustion, neutralization, solution and hydration; Integral and differential enthalpies of solution. Variation of heats of reaction with temperature – Kirchoff's equation.

1.4 *Second and Third laws of Thermodynamics***:** Limitations of first law – statements of second law, Carnot's cycle – efficiency of heat engines, Carnot theorem. Entropy – entropy change for various reversible/irreversible processes, Change in entropy of an ideal gas with pressure, volume and temperature. Third law of thermodynamics (*statement only*).

1.5 *Free Energy Functions:* Helmholtz energy and Gibbs energy – variation of Gibbs energy with T and P. Criteria for reversible and irreversible processes. Gibbs-Helmholtz equation. Clausius - Clapeyron equation, applications.

1.6 *Partial molar properties*: chemical potential, Gibbs-Duhem equation, chemical potential in a system of ideal gases, concept of fugacity and activity.

1.7 *Chemical equilibrium:* Conditions for chemical equilibrium, relation between K_c and K_x, K_p, van't Hoff reaction isotherm. Temperature dependence of K_p – van't Hoff equation. Le-Chateliers Principle.

Unit 2: *Phase Equilibria* (6 Hrs.)

2.1 The phase rule, equilibrium between phases – conditions.

2.2 *One component system*: water system, sulphur system.

2.3 *Two component systems* – solid-liquid equilibrium – simple eutectic, lead- silver system, formation of compounds with congruent melting point ferric chloride- water system, formation of compounds with incongruent melting point sodium sulphate - water system.

Unit 3: *Chemical Kinetics* (6 Hrs.)

3.1 Rate of reaction, rate equation, order and molecularity of reactions, integrated rate expressions for first and second order reactions. Zero order reactions, pseudo-order reactions, half-life.

3.2 *Theories of chemical kinetics***:** effect of temperature on the rate of reaction, Arrhenius equation, concept of activation energy Collision theory, transition state theory. Thermodynamic parameters for activation – Eyring equation (no derivation needed), enthalpy and entropy of activation. Theory of unimolecular reactions – Lindemann theory.

3.3 *Kinetics of complex (composite) reactions*: Opposing reactions, consecutive reactions, and parallel (simultaneous) reactions. Chain reactions – steady state treatment, hydrogen bromine reaction.

3.4 *Catalysis:* Homogeneous catalysis, enzyme catalysis – Michaelis-Menten equation (*no derivation needed*). Heterogeneous catalysis – surface catalysis, uni- and bi-molecular reactions on surface. Elementary idea about autocatalysis.

References

1. R. P. Rastogi, R. R. Misra, '*An Introduction to Chemical Thermodynamics*', 6th edn., Vikas Pub. Pvt. Ltd. (2003).
2. P. Atkins and J Paula, '*The Elements of Physical Chemistry*', 7th edn, Oxford University Press.
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4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, Vishal Pub. Co. Jalandhar.
5. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd.
6. K. L. Kapoor, '*A Textbook of Physical Chemistry'*, Volumes 4, Macmillan India Ltd.

Further reading

1. J. Rajaram and J. C. Kuriakose, *Thermodynamics*, Shoban Lal Nagin Chand & Co (1986).
2. H. Kuhn and H. D. Fosterling, *Principles of Physical chemistry*, John Wiley.
3. W. J. Moore, *Basic Physical Chemistry*, Orient Longman.
4. D.A. McQuarrie, J.D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd.
5. F. A. Alberty and R. J .Silby, *Physical Chemistry*, John Wiley.
6. G. M. Barrow, *Physical Chemistry*, 5th edn., Tata McGraw Hill.
7. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd. (1997).

8. G. W. Castellan, *Physical Chemistry*, 3rd edn, Narosa Publishing House, New Delhi, (2004).
9. K. J. Laidler, *Chemical kinetics* 3rd edn, Pearson education 2004.
10. J Rajaram and J. C. Kuriakose, *Kinetics and mechanisms of chemical transformations*, Macmillan, 2006.
11. S. H. Marron and J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan Ltd. (1996).
12. F. A. Alberty and R. J. Silby, *Physical Chemistry*, John Wiley.

SEMESTER V

COURSE CODE	**23U5CRCHE8**
COURSE TITLE	**PHYSICAL CHEMISTRY - II**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Describe the fundamentals of spectroscopic techniques.*	PO 1, PSO 1	U	30
CO 2	*Explain the fundamentals of photochemistry and its application in everyday life.*	PO 1, PSO 1	A	6

Unit 1: ***Introduction to Spectroscopy*** **(2 Hrs.)**

Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with molecules, various types of molecular spectroscopic techniques, Born-Oppenheimer approximation.

Unit 2: ***Rotational Spectroscopy*** **(4 Hrs.)**

Rotational spectrum: diatomic molecules, energy levels of a rigid rotator, selection rules, determination of bond length.

Unit 3: ***Vibrational Spectroscopy*** **(6 Hrs.)**

Vibrational spectrum: the simple harmonic oscillator – energy levels, force constant, selection rules. Anharmonic oscillator – pure vibrational spectra of diatomic molecules, selection rules, fundamental frequencies, overtones, hot bands. Degrees of freedom for polyatomic molecules, concept of group frequencies – frequencies of common functional groups in organic compounds.

Unit 4: ***Raman Spectroscopy*** **(4 Hrs.)**

Raman spectrum: quantum theory of Raman Effect (elementary idea), concept of polarizability, qualitative treatment of pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, rule of mutual exclusion.

Unit 5: ***Electronic Spectroscopy*** **(5 Hrs.)**

Electronic spectrum: concept of potential energy curves for bonding and anti-bonding molecular orbitals, electronic transition, the Frank-Condon principle, dissociation energy. Polyatomic molecules – qualitative description of σ, π and n- molecular orbitals, their energy levels and the respective transitions.

Unit 6: ***NMR Spectroscopy*** **(6 Hrs.)**

NMR spectroscopy: basic principles of NMR spectroscopy – nuclear spin, Larmor precession. Proton magnetic resonance (^{1}H NMR or PMR) – nuclear shielding and deshielding, chemical shift and molecular structure. Spin-spin splitting and coupling constant. First order spectra – interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, ethyl acetate, toluene, acetophenone.

Unit 7: ***Mass Spectroscopy*** **(3 Hrs.)**

Mass spectrometry: Basic principle-ionization, fragmentation, separation of ions and representation of the spectrum, application in molecular mass determination.

Unit 8: ***Photochemistry*** **(6 Hrs.)**

Interaction of radiation with matter: Laws of photochemistry – Grothus-Draper law, Stark-Einstein law, examples of photochemical reactions. Beer law and Beer-Lambert's law. Jablonsky diagram, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Stern-Volmer equation, quenching, Quantum yield, primary and secondary processes. Basic concepts of photosensitized reactions – photosynthesis, dissociation of hydrogen molecule, isomerization of 2-butene, and chemiluminescence.
Optical properties - optical activity, molar refraction.

References

1. Mc Quarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd,
2. C. N. Banwell and E M Mc Cash, *Fundamentals of Molecular Spectroscopy*, 4th edn, Tata Mc Graw Hill.
3. K. L. Kapoor, *A Textbook of Physical chemistry*, Volumes 4, Macmillan India Ltd.
4. I. N. Levine, *Physical Chemistry*, Tata Mc Graw Hill, Chapter 21.
5. R. Puri, L. R. Sharma, M. S. Pathania, '*Elements of Physical Chemistry*', Vishal Pub. Co.,
6. K. J. Laidler, John H. Meiser, '*Physical Chemistry'*, 2nd edn..
7. K. K. Sharma, L R Sharma, '*A Text Book of Physical Chemistry'*, Vikas Publishing house.
8. A. S. Negi, S. C. Anand, '*A Textbook of Physical Chemistry*', Second Edition, New Age International (P) limited, publishers.

SEMESTER V
(OPEN COURSE)

COURSE CODE	**23U5OCCHE1**
COURSE TITLE	**CHEMISTRY IN EVERYDAY LIFE**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Appreciate the role of chemistry in everyday life.*	PO 1, PO 4, PO 5 PSO 2	U	72

Unit 1: ***Food additives and Flavours*** **(12 Hrs.)**

Functional food additives, adulteration, food laws. Food colours - permitted and non – permitted- Toxicology. Flavours – natural and synthetic- Toxicology .Other functional additives- Soft drinks- formulation Health drinks.

Unit 2: ***Soaps*** **(7 Hrs.)**

Soaps – Introduction, detergent action of soap. Toilet soap, bathing bars, washing soaps, liquid soap manufacture- additives, fillers and flavours. Significance of acidity and alkalinity.

Unit 3: ***Synthetic Detergents*** **(9 Hrs.)**

Detergents- Introduction, detergent action, types of detergents-cationic, anionic, amphiphilic detergents. Common detergent chemicals. Additives, excipients colours and flavours. Enzymes used in commercial detergents. Environmental hazards.

Unit 4: ***Cosmetics*** **(12 Hrs.)**

Cosmetics- Introduction, classification – bathing oils, face creams, toilet powder, skin products, dental cosmetics, hair dyes, shaving cream, shampoo, general formulation of each type. Toxicology of cosmetics.

Unit 5: ***Plastics, Paper and Dyes*** **(14 Hrs.)**

Plastics in everyday life. Brief idea of polymerization-Thermoplastic and thermosetting polymers. Use of PET, HDPE, PVC, LDPE, PP, ABS. Recycling of plastics. Biodegradable plastics. Environmental hazards of plastics. News print paper, writing paper, paper boards, cardboards. Organic materials, wood, cotton, jute and coir. International recycling codes, and symbols for identification. Natural and synthetic dyes (*basic idea only*).

Unit 6: ***Drugs*** **(6 Hrs.)**

Chemotherapy- types of drugs- analgesics, antipyretics, antihistamines, antacids tranquilizers, sedatives, antibiotics, antifertility drugs.

Unit 7: *Chemistry and Agriculture* (12 Hrs.)

Fertilizers- natural, synthetic, mixed, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers. Plant growth hormones.

Pesticides- Classification-insecticides, herbicides, fungicides. Excessive use of pesticides – environmental hazards. Bio pesticides. Antiseptics and Disinfectants-Oils - vegetable oils, mineral oil, essential oil-Sugars, artificial sugars

References:

1. T.P. Coultate, *Food- The Chemistry of its components*. Royal Society of Chemistry, London.
2. Shashi Chowls, *Engineering Chemistry*, Danpat Rai Publication.
3. B.K. Sharma. *Industrial Chemistry*.
4. CNR Rao, *Understanding chemistry*, Universities Press.
5. Puri and Sharma. *Advanced Organic Chemistry*.
6. Brown, *Insect control by chemicals*
7. A. K. De, *Environmental Chemistry*, New age International Ltd.
8. S. S. Dara, *A Textbook of Environmental chemistry and pollution con*trol, S. Chand & Company Ltd.
9. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. *Soil Fertility and Fertilizers*, Macmillian Publishing Company, New York, 1990.
10. Buchel, K.H., *Chemistry of Pesticides*, John Wiley & Sons, New York, 1983
11. P.C Pall, K. Goel, R.K Gupta, *Insecticides, pesticides and agrobased industries*.
12. Gowariker V.R., Viswanathan N.V. and Jayader Sreedhar, *Polymer Science*, Wiley Eastern Ltd., New Delhi.
13. I.I Singh, V.K Kapoor, *Organic Pharmaceutical Chemistry*.

SEMESTER VI

COURSE CODE	**23U6CRCHE9**
COURSE TITLE	**INORGANIC CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Explain the chemistry of s, p, d and f block elements.*	**PO 1, PSO 1**	A	22
CO 2	*Interpret the properties and applications of coordination compounds.*	**PO 1, PSO 1**	A	22
CO 3	*Illustrate the structure and properties of inorganic solids.*	**PO 1, PSO 1**	A	10

Unit 1: ***Compounds of s and p Block Elements*** **(10 Hrs.)**

Macrocyclic ligands: crown ethers and cryptands, Macrocyclic effect, Alkali metal complexes with crown ethers and cryptands, their applications.

Boron hydrides: Boranes: Definition, preparation & types (Closo, Nido, Arachno), Wade's rule, STYX number, diborane (*preparation, properties and bonding*), B5H9, B4H10 (*structure only*). Closo carboranes, boron nitride, borazine, boric acid. Peroxy acids of sulphur. Oxides and oxy acids of halogens (*structure only*), superacids, interhalogen compounds, pseudohalogens, electropositive iodine, fluorocarbons. Fluorides, oxides and oxy fluorides of xenon (*structure only*).

Unit 2: ***Chemistry of d and f Block Elements*** **(12 Hrs.)**

General characteristics of d-block elements with special reference to electronic configuration, oxidation states, variable valency, metallic character, colour, magnetic properties, catalytic properties and ability to form complexes. Comparison of the properties of second and third transition series with first transition series.

Chemistry of lanthanides – electronic structure, oxidation states, lanthanide contraction, consequences of lanthanide contraction, magnetic properties, spectral properties and separation of lanthanides by ion exchange and solvent extraction methods (*Brief study*).

Chemistry of actinides – electronic configuration, oxidation states, actinide contraction, position of actinides in the periodic table, comparison with lanthanides in terms of magnetic properties and spectral properties (*Brief study*).

Unit 3: ***Coordination Chemistry*** **(22 Hrs.)**

Ligands, classification based on the number of donor atoms, chelating ligands, bridging ligands, isomerism in complexes-Structural isomerism only:

IUPAC nomenclature, coordination number and possible geometries of complexes from C. N. 3 to 12, Stereo isomerism- geometrical and optical isomerism of complexes with 4 and 6 coordination

numbers. Stability of complexes - stepwise stability constant and overall stability constant, factors affecting the stability of metal complexes. EAN, Chelates and chelate effect.

Magnetic behavior of complexes- Diamagnetic and paramagnetic complexes, explanation, effective magnetic moment, spins only magnetic moments, calculation of spin only magnetic moment. Quenching of magnetic moment.

Theories of bonding in coordination compounds – Werner's theory of coordination, primary and secondary valences of metal ions.

Valence bond theory- of octahedral, tetrahedral and square planar complexes, high spin and low spin complexes- inner and outer orbital complexes, explanation of magnetic properties, limitations of valence bond theory.

Crystal filed theory- splitting of d-orbitals in octahedral, tetrahedral, tetragonal and square planar complexes, strong and weak field ligands, pairing energy, explanation of colour and magnetic properties of complexes, limitation of CF theory.

Jahn-Teller distortion - Cu (II) complexes.

MO theory- evidence for metal ligand covalency, MOE diagram of complexes of octahedral symmetry (*sigma bonding only*). Explanation of Δ in the Octahedral complexes using MOE diagram.

Substitution reactions in metal complexes- Labile and inert complexes, ligand substitution reactions in octahedral complexes, S_N1 and S_N2 substitution reactions.

Substitution reactions of square planar complexes – Trans effect and applications of *trans* effect.

Symbiosis, Applications of HSAB Concept. Stability of complexes, mode of coordination, predicting feasibility of reactions.

Unit 4: *Structure of Inorganic Solids* (10 Hrs.)

Close packing of spheres, ccp and hcp arrangements. Interstitial sites in close packing, Tetrahedral, Octahedral sites. Radius ratio, Limiting radius ratio for trigonal, tetrahedral and octahedral sites.(*only values*). Use of limiting radius ratio in the structural determination of ionic crystals. Structure of ionic crystals of NaCl, CsCl, ZnS. Defects in crystals – stoichiometric and non-stoichiometric defects, Consequences of defects. extrinsic and intrinsic defects. Impurity defects. Semi-conductors, *n*-type, *p*-type, Superconductivity – *an introduction*.

References

1. J. D. Lee, '*Concise Inorganic Chemistry*' 5th edn., Wiley India Pvt. Ltd. 2008.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, '*Principles of Inorganic Chemistry'*, Milestone Publishers, New Delhi 2010.
3. G. L. Meissler, D.A Tarr, '*Inorganic Chemistry*',3rd Edn. Pearson Education, 2004.
4. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, *Inorganic Chemistry*, Pearson 2006
5. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry* 6th edn., John Wiley, New York 1991.
6. M. Clyde Day and J. Selbin, '*Theoretical Inorganic Chemistry*' 2nd Edn. Reinhold Book Corp. 2008.
7. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*, 3rd edn., John Wiley. 2006.
8. D. F. Shriver and P.W. Atkins, *Inorganic Chemistry*, 3rd edn., Oxford University Press.

9. G.L. Meissler, D.A Tarr, *Inorganic Chemistry*, Pearson Education.
10. A. R. West, *Solid State Chemistry and its applications*, John Wiley.

Further Reading

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, Pearson 2006.
2. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry* 6th edn., John Wiley, New
3. York. 1999.
4. D. F. Shriver and P.W. Atkins, *Inorganic Chemistry* 3rd edn., Oxford University Press. 2009
5. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*, 3rd edn., John Wiley, 2006.
6. M. N. Greenwood and A. Earnshaw, *Chemistry of the elements* 2nd edn, Butterworth. 1997.

SEMESTER VI

COURSE CODE	**23U6CRCHE10**
COURSE TITLE	**ORGANIC CHEMISTRY - IV**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Categorize and explain the structure and properties of various biomolecules.*	**PO 1, PSO 1**	An	44
CO 2	*Point out the synthetic methods and chemical properties of five and six membered heterocyclic compounds.*	**PO 1, PSO 1**	An	10

Unit 1: ***Natural Products*** **(12 Hrs.)**

1.1. Natural Products: *Terpenoids* - isoprene rule. Structure elucidation of citral and geraniol.
1.2. *Alkaloids* - general methods of isolation –classification – structure elucidation and synthesis of conine, piperine and nicotine.
1.3. *Vitamins* – classification- structure (*elementary idea*) of vitamin A, C and B_1, B_2, B_6
1.4. *Lipids* – biological functions – oils and fats – common fatty acids- extraction and refining- hydrogenation – rancidity- identification of oils and fats – saponification value, acid value, iodine value and RM value.

Unit 2: ***Carbohydrates*** **(14 Hrs.)**

2.1. Classification - constitution of glucose and fructose.
2.2. Reactions of glucose and fructose - osazone formation. Mutarotation and its mechanism. Epimerisation.
2.3. Configuration of monosaccharides
2.4. Cyclic structure. Pyranose and furanose forms. Determination of ring size. Haworth projection formula.
2.5. Chain lengthening and chain shortening of aldoses. Inter conversion of aldoses and ketoses.
2.6. Disaccharides - reactions and structure of sucrose and maltose. Ring structure
2.7. Structure and properties of starch and cellulose (*elementary idea).* Industrial applications of cellulose.

Unit 3: ***Heterocyclic Compounds*** **(10 Hrs.)**

3.1 Aromaticity of heterocyclic compounds.
3.2 Preparation, properties and uses of furan, pyrrole and thiophene.
3.3 Synthesis and reactions of pyridine and piperidine - comparative study of basicity of pyrrole, pyridine and piperidine with amines.

3.3 Synthesis and reactions of quinoline, isoquinoline and indole with special reference to Skraup, Bischler, Napieralskii and Fisher indole synthesis.

Unit 4: ***Amino acids and Proteins*** **(12 Hrs.)**

4.1 Amino acids- classification, Zwitter ion. Peptide- solution phase peptide synthesis.
4.2 Classification of proteins based on physical and chemical properties and on physiological functions.
4.3 Primary secondary tertiary and quaternary structure of proteins, helical and sheet structures (*elementary treatment only*). Denaturation of proteins.
4.4 Nucleic acids. Types of nucleic acids - RNA and DNA, polynucleotide chain components - biological functions.
4.5 Supramolecular interactions – Significance in nucleic acids and proteins.
4.6 Green Fluorescent Proteins (*elementary idea*)

Unit 5: ***Enzymes*** **(3 Hrs.)**

5.1 Nomenclature and classification of enzymes (*based on substrate*). Chemical nature of enzymes.
5.2 Mechanism of enzyme action. Substrate specificity of enzymes. Enzyme inhibition.

Unit 6: ***Steroids*** **(3 Hrs.)**

6.1 Introduction – Diels hydrocarbon- Structure and functions of cholesterol.
6.2 Elementary idea of HDL, LDL, Vitamin D.

References

1. I. L. Finar, *Organic Chemistry* - Volume I & II - Pearson Education.
2. M. K. Jain and S. C. Sharma '*Modern Organic Chemistry'*, 3rd Edition, Vishal Publishing Company Co.
3. K.S. Tewari and N.K. Vishnoi, 'Organic *Chemistry'*, 3rd Edition, Vikas Publishing House.
4. R. T. Morrison and R.N. Boyd, '*Organic Chemistry'*, 6th Edition - Prentice Hall of India.
5. *en.wikipedia.org/wiki/Green_fluorescent_protein*
6. *www.scholarpedia.org/article/fluorescent_protein*

Further reading

1. S. P. Bhutani, *Chemistry of Biomolecules,* Ane Books Pvt Ltd
2. O.P. Agarwal, *Chemistry of Natural Products* - Goel Publications
3. J. F. Robyt, *Essentials of Carbohydrate C*hemistry, Springer.
4. John McMurry, '*Organic Chemistry*' - Vth Edition -Thompson Asia Pvt Ltd
5. C. N. Pillai '*Organic Chemistry*' Universities Press.

SEMESTER VI

COURSE CODE	**23U6CRCHE11**
COURSE TITLE	**PHYSICAL CHEMSITRY - III**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Illustrate the properties of solid, liquid and gaseous states.*	**PO 1, PSO 1**	A	39
CO 2	*Explain the fundamentals of group theory and interpret the point groups of simple molecules.*	**PO 1, PSO 1**	A	6
CO 3	*Describe the theories and applications of adsorption.*	**PO 1, PSO 1**	U	9

Unit 1: *Gaseous State* (18 Hrs.)

Kinetic molecular model of gases: pressure of an ideal gas, derivation of gas laws, Maxwell's distribution of velocities – molecular velocities (average, root mean square and most probable velocities).

Collision parameters: Collision diameter, Collision cross-section, Collision number, collision frequency, mean free path, viscosity of gases – temperature and pressure dependence. Relation between mean free path and coefficient of viscosity.

Law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Barometric distribution law.

Real gases: compressibility factor z, van der Waal s equation of state – derivation and application in explaining real gas behavior. Virial equation of state, van der Waals equation expressed in virial form – calculation of Boyle temperature.

Critical phenomena: Critical state and critical constants, Isotherms of real gases, Principle of continuity of states. Relationship between van der Waal's constants and critical constants.

Liquefaction of gases - Joule-Thomson effect, Linde's process and Claude's process.

Unit 2: *Liquid State* (3 Hrs.)

Intermolecular forces in liquids (*qualitative idea only*), Unusual behavior of water. Surface tension of liquids, surface tension and temperature, interfacial tension, surface active agents. Viscosity of liquids, experimental determination of viscosity coefficient, its variation with temperature.

Unit 3: *Symmetry* (6 Hrs.)

Symmetry of molecules-symmetry elements and symmetry operations – centre of symmetry, plane of symmetry, proper and improper axes of symmetry, combination of symmetry elements,

molecular point groups, Schoenflies symbols, Point groups, C_nV and D_nh. Determination of point groups of simple molecules like H_2O, NH_3, BF_3, C_2H_4, C_2H_2, C_6H_6, CO_2, N_2, HCl, CH_3Cl.

Unit 4: ***Solid State*** **(18 Hrs.)**

The nature of the solid state- anisotropy- Structural distinction between liquid and solid, crystalline state, space lattice, crystal lattices, unit cell, crystal systems, the law of constancy of interfacial angles, the law of rational indices, Miller indices, equation, law of rational indices - Miller indices. Seven crystal systems and law of symmetry, fourteen Bravais lattices. X-ray diffraction, Bragg's law, detailed study of simple, face centered and body centered cubic systems – Bragg's X-ray diffractometer method and powder method. Analysis of powder diffraction patterns of NaCl and KCl, density of cubic crystals – calculation of Avogadro number, identification of cubic crystal from crystallographic data.

Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX_2 (CaF_2, Na_2O).

Liquid crystals thermographic behaviour. Classification, structure of nematic and cholesteric phases. Applications of liquid crystals.

Unit 5: ***Surface Chemistry*** **(9 Hrs.)**

Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm – Langmuir adsorption isotherm (*derivation*). The BET theory (*no derivation*) – use of BET equation for the determination of surface area. Applications of adsorption. Types of solutions – true, colloid and suspensions, Purification of colloids – Ultra filtration and electrodialysis, optical and electrical properties of colloids. Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule. Micelles and critical micelle concentration, sedimentation, and streaming potential

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical Chemistry*, Vishal Pub. Co. Jalandhar.
2. K. L. Kapoor, *A Textbook of Physical Chemistry*, Volumes 1, Macmillan India Ltd.
3. P. Atkins and J Paula, *The Elements of Physical Chemistry*, 7th edn., Oxford University Press.
4. F. A. Alberty and R. J. Silby, *Physical Chemistry*, 3rd Edn, John Wiley.
5. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd.
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8. V. Ramakrishnan and M S Gopinathan, *"Group Theory in Chemistry"*, Vishal Publishing.
9. R. P. Rastogi, R. R. Misra, *An Introduction to Chemical Thermodynamics*, 6th edn., Vikas Pub. Pvt. Ltd. (2003).

SEMESTER VI

COURSE CODE	**23U6CRCHE12**
COURSE TITLE	**PHYSICAL CHEMSITRY - IV**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Summarize the physical and chemical properties of acids and bases.*	**PO 1, PSO 1**	U	8
CO 2	*Explain the properties of solutions.*	**PO 1, PSO 1**	U	12
CO 3	*Describe the theory of electrical conductance and its applications.*	**PO 1, PSO 1**	U	16
CO 4	*Explain electromotive force, different electrochemical cells and its applications.*	**PO 1, PSO 1**	U	18

Unit 1: ***Ionic Equilibrium*** **(8 Hrs.)**

Dissociation constants – acids, bases, and polyprotic acids. Ostwald's dilution law. Degree of ionization, factors affecting degree of ionization, ionization constant and Ionic product of water – pH. Effects of solvents on ionic strength.

Buffer solutions – mechanism of buffer action, Henderson equation. Hydrolysis of salts – hydrolysis constant, degree of hydrolysis, pH of salt solutions.
Acid-base indicators, theories, determination of pH by indicators, solubility product principle – applications.

Unit 2: ***Solutions*** **(12 Hrs.)**

Introduction - Binary liquid solutions – Raoult's law- ideal and non-ideal solutions- Gmix, V_{mix}, and S_{mix} for ideal solutions. Vapour pressure-composition and boiling point-composition curves of ideal and non-ideal binary liquid solutions. Fractional distillation of binary liquid-liquid solutions – distillation of immiscible liquids, partially miscible liquid-liquid systems.

Critical solution temperature (CST) – the lever rule, introduction to ternary liquid solutions.

Solubility of gases in liquids – Henry's law. Distribution of a solute between two solvents – Nernst distribution law.

Colligative properties of dilute solutions – vapour pressure lowering, Boiling point elevation and freezing point depression (*thermodynamic derivation*). Molar mass determination-related problems- Osmotic pressure –laws of osmotic pressure - Reverse osmosis – purification of sea water. Abnormal molecular masses – van't Hoff factor – degree of association and degree of dissociation.

Unit 3: *Electrical Conductance* (16 Hrs.)

Introduction - Faraday's laws of electrolysis, electrochemical equivalent, and chemical equivalent- electrolytic conductivity, molar conductivity - Variation of molar conductivity with concentration. Kohlrausch's law – applications.

Ionic mobility – relation with ion conductivity, influence of temperature on ion conductivity, ion conductivity and viscosity – Walden's rule, influence of dielectric constant of solvent on ion conductivity. Abnormal ion conductivity of hydrogen and hydroxyl ions.

Discharge of ions during electrolysis – Hittorf's theoretical device. Transport Numbers – determination by Hittorf's method and moving boundary method.

Debye-Hückel theory of strong electrolytes – the concept of ionic atmosphere, Asymmetry and electrophoretic effect, Debye-Hückel-Onsager equation (*no derivation*). Activity, mean ionic activity and mean ionic activity coefficients of electrolytes. Ionic strength of a solution, Debye-Hückel limiting law (*no derivation*). Applications of conductance measurements – Determinations of degree of dissociation of weak electrolytes, ionic product of water, and solubility of sparingly soluble salts, conductometric titrations.

Unit 4: *Electromotive Force* (18 Hrs.)

Introduction – Electrochemical Cells and Electrolytic cells, Galvanic cells, characteristics of reversible cells. Reversible electrodes – different types, Reference electrodes – Standard Hydrogen Electrode, Calomel electrode, electrode potential – electrochemical series. Representation of cells – e.m.f of cell, electrode reactions and cell reactions.

Thermodynamics of reversible cells and reversible electrodes – Determination of ΔG, ΔH and ΔS of cell reaction. E.M.F and equilibrium constant of cell reaction, effect of electrolyte concentration on electrode potential and e.m.f - Derivation of Nernst equation.

Concentration cells – electrode concentration cell and electrolyte concentration cells. Types of electrolyte concentration cells – with transference and without transference, liquid junction potential. Fuel cells – the hydrogen-oxygen fuel cell.

Applications of e.m.f measurements – determination of solubility product, determination of pH using hydrogen electrode, quinhydrone electrode and glass electrode. Potentiometric titrations - Redox indicators. Irreversible electrode processes – overvoltage.

Corrosion of metals – forms of corrosion, corrosion monitoring and prevention methods.

References

1. K. L. Kapoor, '*A Textbook of Physical Chemistry*', Volumes 1, Macmillan India Ltd.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, '*Elements of Physical Chemistry*', Vishal Pub. Co. Jalandhar.
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5. Barrow, G.M. *Physical Chemistry*, Tata McGraw-Hill (2007).
6. Castellan, G.W. *Physical Chemistry*, 4th Ed. Narosa (2004).

7. Kotz, J.C., Treichel, P.M. & Townsend, J.R., *General Chemistry*, Cengage Learning India Pvt. Ltd. New Delhi (2009).
8. Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
9. Glasstone S, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. (2006).
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12. P. W. Atkins, *The elements of Physical chemistry*, 8thedn, Oxford University Press.
13. S. H. Marron and J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan Ltd.

SEMESTER VI
(CORE ELECTIVE COURSE - 1)

COURSE CODE	**23U6CRCHE13EL1**
COURSE TITLE	**APPLIED INORGANIC CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Describe the process of metallurgy.*	**PO 1, PSO 1**	A	9
CO 2	*Explain the structure and properties of organometallic compounds, metal carbonyls metal clusters and inorganic polymers.*	**PO 1, PSO 1**	U	24
CO 3	*Articulate the fundamentals of modern analytical techniques.*	**PO 1, PSO 1**	A	9
CO 4	*Explain the importance of bioinorganic chemistry.*	**PO 1, PSO 1**	U	12

Unit 1: ***Metallurgy*** **(9 Hrs.)**

Methods of concentration of ores - Gravity, magnetic and electrostatic separations, Froth flotation and leaching. Calcination and Roasting. Reduction to free metal- smelting and electrometallurgy, hydrometallurgy. Goldschmidt Thermite Process. Refining of metals- electrolytic, ion exchange, zone refining, vapour phase refining and oxidative refining. Thermodynamics of the oxidation of metals to metal oxides - Ellingham diagrams. Extractive metallurgy of U, Ti, Th and Ni.

Unit 2: ***Organometallic Compounds*** **(9 Hrs.)**

Definition, classification of organometallic compounds, Ylides, classification on the basis of hapticity, naming of organometallic compounds, 18 electron rule, metal-alkene complexes, metal-alkyne complexes, carbene and carbyne complexes. Metallocenes – ferrocene (preparation and structure only). Zeise's salt – preparation, properties and structure.

Catalytic properties of organometallic compounds - alkene hydrogenation, synthesis of water gas – shift reaction, Zeigler-Natta polymerization

Unit 3: ***Metal Carbonyls and Metal Clusters*** **(9 Hrs.)**

Preparation and properties of mononuclear carbonyls. Structures of $Mo(CO)_6$, $Fe(CO)_5$ and $Ni(CO)_4$. Polynuclear carbonyls, bridged carbonyls and bonding in carbonyls. Metal clusters - carbonyl and halide clusters, low nuclearity carbonyl clusters and high nuclearity carbonyl clusters, electron counting schemes for $Rh_6(CO)_{16}$ and $[Os_6(CO)_{18}]^{2-}$, metal only clusters (Zintl ions). Quadruple bond – structure of $Re_2Cl_8^{2-}$.

Unit 4: ***Inorganic Polymers*** **(6 Hrs.)**

Inorganic polymers – general properties, comparison with organic polymers, glass transition temperature. Sulphur based polymers – polymeric sulphur nitride and chalcogenic glasses

(*preparation, properties and uses*). Phosphorus based polymers – polyphosphazenes and polyphosphates. Silicon based polymers – silicones and silicone rubber (*preparation, properties and uses*).

Unit 5: *Modern Analytical Techniques* (9 Hrs.)

Thermo analytical methods: Principle of thermo gravimetry, TG and DTG curves, TGA of calcium oxalate monohydrate, differential thermal analysis, differential scanning calorimetry. Applications.
Colorimetry: Principle, Beer's law, Lambert's law, absorption coefficient, transmittance, opacity, Absorbance, optical density, molar absorption coefficient. Principle of estimation of iron, chromium and ammonia.

Chromatography - Classification of methods elementary study of adsorption, paper, thin layer, column, ion exchange and gas chromatographic methods. HPLC.

Unit 6: *Bioinorganic Chemistry* (12 Hrs.)

Essential and trace elements in biological systems, Myoglobin and Hemoglobin, role of myoglobin and hemoglobin in biological systems, mechanism of oxygen transport, cooperativity, Bohr effect, Phosphate effect.

Cytochromes- Structure and function. Metalloenzymes: Inhibition and poisoning of enzymes. A brief study of the following metalloenzymes and their functions. Carbonic anhydrase, Carbonic peptidase, cytochrome oxidase, cytochrome P450, Peroxidase, catalases, superoxide dismutase and Nitrogenase (*Structure is not expected*). Role of alkali and alkaline earth metals in biological systems, Na/K pump.

Metal deficiency: Deficiency of Iron, Copper and Zinc. Metal toxicity. Toxicity of Copper, Iron, Calcium, Plutonium, Mercury and Cadmium. Metals as carcinogens. Treatment of metal toxicity. Chelation therapy. Anti-cancer drugs – cisplatin and carboplatin (*An outline study*).

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, '*Principles of Inorganic Chemistry*', 31st Ed. Milestone Publishers, New Delhi 2010.
2. S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, '*Advanced Inorganic Chemistry*', 5th edn., 2012, Volume I, S Chand.
3. Cottrel, *An Introduction to Metallurgy*, 2nd edn., University press. 1990.
4. G. L. Meissler, D. A Tarr, *Inorganic Chemistry*, 3rd Edn. Pearson Education, 2004.
5. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, *Inorganic Chemistry*, Pearson 2006
6. R. C. Mehrothra and A. Singh, *Organometallic Chemistry*, New age publishers.
7. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 3rd edn., John Wiley, New York.1995.
8. G. Sharpe, *Inorganic Chemistry*, 3rd Edn. Pearson.
9. D. F. Shriver and P.W. Atkins, *Inorganic Chemistry*, 3rd edn., Oxford University Press, 2009.
10. G. S. Sodhi, *Organometallic Chemistry*, Ane books Ltd, New Delhi, 2009.
11. H.H Willard, L.L. Merritt, J.A. Dean, F.A Settle, *Instrumental methods of Analysis*, CBS Publishers And Distributors, Delhi, 1996.
12. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*, 3rd edn., John Wiley.
13. Ivano Bertini, Harry B Gray, Stephen J. Lippard, Joan Selvertone Valentine, *Bioinorganic Chemistry*. Viva Books Pvt Ltd. 2007.

SEMESTER VI
(CORE ELECTIVE COURSE - 2)

COURSE CODE	**23U6CRCHE13EL2**
COURSE TITLE	**ADVANCES IN CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Cite the advanced applications of inorganic chemistry.*	**PO 1, PSO 2**	A	18
CO 2	*Illustrate the advances in retrosynthesis, supramolecular chemistry and green chemistry.*	**PO 1, PSO 2**	A	18
CO 3	*Explain the principles of physical and computational chemistry*	**PO 1, PSO 2**	U	18

Unit 1: ***Advanced Topics in Inorganic Chemistry*** **(18 Hrs.)**

1.1 *Nanomaterials*:

Nanomaterials – synthesis – chemical precipitation, mechano-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (*brief study*). Properties and applications of fullerenes, quantum dots and carbon nanotubes. Applications of nano materials - nano composites – nano medicines.

1.2. *Industrially important materials***:**

Refractory materials - carbides, nitrides, borides. Graphite and graphite oxide, intercalation compounds of alkali metals, carbon monofluoride, intercalation compounds of graphite with metal halides, glass, silicates, zeolites, ultramarines and ceramics.

1.3 *Modern Analytical Techniques:*

Thermo analytical methods - Principle of thermo gravimetry, differential thermal analysis, differential scanning calorimetry.

Colorimetry – Principle and applications.

Unit 2: ***Advanced Topics in Organic Chemistry*** **(18 Hrs.)**

2.1 *Supramolecular Chemistry*:

Introduction-Molecular recognition-Host-guest interactions- types of non-covalent interactions - Importance of molecular recognition in DNA and protein structure.

2.2 *Retrosynthetic Analysis:*

Retrosynthetic analysis and disconnection approach. Basic principles and terminology. Retrosynthetic analysis of simple cyclic and acyclic alkenes, alcohols, and carbonyl compounds. Simple problems of reterosynthesis of the above compounds.

2.3 *Green Chemistry:*

Green Chemistry- introduction- need for green chemistry –Twelve principles of green chemistry with examples- polylactic acid (PLA) as a green polymer.

2.4 *Advances in Polymer Chemistry:*

Biopolymers - biomaterials. Polymers in medical field. High temperature and fire-resistant polymers. Silicones, Conducting polymers- carbon fibers (*basic idea only*).

Unit 3: *Advanced Topics in Physical Chemistry* (18 Hrs.)

3.1 *Biophysical Chemistry*:

Protein structure; Amino acids. Primary, secondary and tertiary structure; Protein folding. Significance of Van der Waals force, hydrogen bond and hydrophobic interactions.

Acid-Base equilibrium: Protonation and deprotonation reactions. Biological significance of pH.

Thermodynamics and Kinetics. Standard free energy change in biochemical reactions, exergonic, hydrolysis of ATP. Chemical potential. Oxidation/reduction reactions and bioenergetics.

3.2 *Introduction to Computational Chemistry:*

Scope of computational chemistry. Building of 3D molecular structures using computer softwares. Coordinate formats. Brief introduction to Hartree Fock, ab initio, semi empirical, DFT and molecular mechanics methods. Basis sets, STO & GTO basis sets. Potential energy surface. Local and Global minima. Single point energy calculations and Geometry optimizations. Format of input and output files in Computational Chemistry Calculations. (Single point and Optimization Calculations in simple molecules such as molecules H_2O, CO_2 & NH_3 using suitable software package.

References

1. V. S. Muraleedharan and A. Subramanian, *Nano science and Nanotechnology*, Ane Books Pvt. Ltd. New Delhi, 2009.
2. T. Pradeep, *Nano; The Essentials*, Mc Graw-Hill education, New Delhi, 2006.
3. H.H Willard, L.L. Merritt, J.A. Dean, F.A Settle, *Instrumental methods of Analysis*, CBS Publishers And Distributors, Delhi, 1996.
4. Helena Dodzuik, *Introduction to Supramolecular Chemistry*, Springer.
5. J. M. Lehn, *Supramolecular Chemistry*, VCH
6. Paula Yurkanis Bruice, *Organic Chemistry*, 2002, (3rd Edition).
7. S. Warren, Organic Synthesis, *The disconnection Approach*, John Wiley & Sons, 2004.
8. E. J. Corey, X-M. Cheng (1995). *The Logic of Chemical Synthesis*. New York: Wiley.
9. V. K. Ahluwalia, *Green Chemistry*, *Ane Books* India.

10. Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press: New York, 1998, p.30. By permission of Oxford University Press.
11. Albert L. Lehninger, *Principles of Biochemistry*, CBS Publishers & Distributors.
12. Narayanan, P (2000), *Essentials of Biophysics*, New Age Int. Pub. New Delhi.
13. Roy R.N. (1999), *A Text Book of Biophysics*, New Central Book Agency.
14. T Clark, *Hand book of Computational Chemistry*, Wiley, New York.
15. F. Jensen, '*Introduction to Computational Chemistry*', John Wiley.
16. Christopher J. Cramer, '*Essentials of Computational Chemistry*' John Wiley,

SEMESTER VI
(CORE ELECTIVE COURSE - 3)

COURSE CODE	**23U6CRCHE13EL3**
COURSE TITLE	**MEDICINAL AND PHARMACEUTICAL CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Describe the importance of drug discovery, design, development and metabolism.*	**PO 1, PSO 2**	A	18
CO 2	*Generalize the drug-receptor interactions.*	**PO 1, PSO 2**	U	9
CO 3	*Explain the synthesis and SAR of different classes of drugs.*	**PO 1, PSO 2**	A	27

Unit 1: ***Drug Discovery, Design and Development*** **(9 Hrs.)**

Drug discovery without a lead, Lead Discovery, Random Screening Non-random Screening, Lead Modification, Identification of active part: The pharmacophore, Functional group modification, Structure activity relationship.

Unit 2: ***Drug Metabolism*** **(9 Hrs.)**

Phase-transformations: Oxidative reactions, Reductive reactions, Carboxylation reactions and Hydrolytic reactions. & Phase-II Metabolic Reactions Conjugation reactions, Introduction to Drug Designing on the Basis of Metabolic Pathways. Prodrugs- Bioprecursor & Carrier Linked Prodrugs, Hard and Soft Drugs.

Unit 3: ***Drug Receptor Interactions*** **(9 Hrs.)**

Drug Receptor Interactions: General considerations, Interactions involved in drug receptor complexes, Covalent bonds, Ionic interactions, Ion dipole and dipole- dipole interactions, Hydrogen bonds, Charge transfer complexes, Hydrophobic interactions, Theories of Drug Receptor Interactions.

Unit 4: ***Classification, Synthesis and SAR of Some Important Drugs*** **(27 Hrs.)**

4.1 General Anaesthetics: General Discussion, classification and synthesis of nitrous oxide, chloroform, halothane and thiopental sodium.

4.2 Local Anaesthetics: General Discussion, classification and synthesis of Procaine Hydrochloride, Benzocaine, Lignocaine Hydrochloride.

4.3 Hypnotics and Sedatives: Classification, Structural Activity Relationship (SAR) and synthesis of Barbiturates, Allobarbitol, hexobarbitol.

4.4 Tranquilizers: Classification, Mode of action and synthesis of Reserpine, chloropromazine Hydrochloride, and Diazepam.

4.5 Anticonvulsants: Classification and Synthesis of Phenobarbitol, Phenytoin Sodium

4.6 Analgesics and Antipyretics: General Discussion and classification of Analgesics & Antipyretics, Mode of action and SAR of Morphine & its analogues, mefenemic acid, ibuprofen, paracetomol and aspirin.

4.7 Antihistamines: General Discussion, mode of action, SAR of ethanol amine derivatives and synthesis of Diphenhydramine hydrochloride, mepyramine, Promethazine Hydrochloride.

References:

1. Smith HJ, Williams H, eds, "*Introduction to the principles of Drug D*esign" Wright Boston.
2. Silverman R.B. "The Organic Chemistry of Drug Design and Drug Action" Academic Press New York.
3. Robert GCK,ed., " Drug Action at the Molecular Level" University Prak Press Baltimore.
4. Martin YC. "Quantitative Drug Design" Dekker, New York.
5. Lien EJ. SAR " Side effects and Drug Design" Dekker, New York.
6. William H, Malick JB "Drug Discovery and Development" Humana Press Clifton.
7. Foye W O "Principles of Medicinal Chemistry" Lea & Febiger
8. Medicinal Chemistry – Ashutosh Kar, New Age Publication.
9. Medicinal Chemistry – D. Sriram and P. Yogeeswari, Pearson Publication.

SEMESTER V & VI

PRACTICAL 3

COURSE CODE	**23U6PRCHE3**
COURSE TITLE	**QUALITATIVE INORGANIC ANALYSIS**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**108**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Analyse the given inorganic salt mixtures.*	**PO 1, PSO 3**	An	108

1. Study of the reactions of the following radicals with a view to their identification and confirmation.
   Ag^{+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}.
   CO_3^{2-}, S^{2-}, SO_4^{2-}, NO^{3-}, F^{-}, Cl^{-}, Br^{-}, BO_2^{-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

2. Elimination of interfering anions such as F^{-}, BO^{2-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

3. Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the following with one interfering radical by semi-micro method only
   Ag^{+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}.
   CO_3^{2-}, S^{2-}, SO_4^{2-}, NO^{3-}, F^{-}, Cl^{-}, Br^{-}, BO^{2-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

   (*Minimum of seven mixtures to be analyzed*)

References

1. Vogel '*A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis*': (Third Ed.) (ELBS)
2. G. Svehla, *Text Book of Vogel's Macro and Semi-micro Inorganic Analysis*, revised, Orient Longman.
3. V. V. Ramanujam, *'Inorganic Semi micro Qualitative Analysis'*, The National Publishing Co., Chennai.
4. W. G. Palmer '*Experimental Inorganic Chemistry*', Cambridge.

SEMESTER V & VI

PRACTICAL 4

COURSE CODE	**23U6PRCHE4**
COURSE TITLE	***Organic Chemistry Practicals - II*** **PREPARATION AND BASIC LABORATORY SKILLS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Synthesize and purify an organic compound.*	**PO 1, PSO 3**	C	72

A. Basic Laboratory Skills

a. *Solvent extraction*:
o-toludine from water, phenol from water, methyl benzoate from water using ether. Record the yield recovery (*Any two experiments shall be done*).

b. *Crystallisation*:
Any four compounds using ethyl acetate, ethanol, and water. Record the yield recovery.

c. *Distillation:*
Purification of water and ethyl acetate. Record the yield recovery.

d. *Thin Layer Chromatography*:
Separation and identification- Determination of R_f value of *o*-and *p*- nitroanilines, benzil and *o*-nitroaniline or any two amino acids.

B. Organic Preparations

1. Oxidation (benzaldehyde or benzyl alcohol to benzoic acid).
2. Hydrolysis (methyl salicylate or ethyl benzoate to the acid).
3. Nitration (nitrobenzene to *m*-dinitrobenzene).
4. Halogenation (*p*-bromoacetanilide from acetanilide).
5. Diazocoupling (methyl orange or benzene azo –β-naphthol).

(*Minimum five preparations expected*)

References

1. F. G Mann and B.C. Saunders, '*Practical Organic Chemistry*' Fourth Edition, Pearson Education.
2. A. I. Vogel, 'Vogel's *Textbook of Practical Organic Chemistry*' Pearson Education
3. Brauer '*Handbook of Preparative Inorganic chemistry*', Vol - I & II, Academic Press.

SEMESTER V & VI

PRACTICAL 5

COURSE CODE	**23U6PRCHE5**
COURSE TITLE	**PHYSICAL CHEMISTRY PRACTICALS**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**108**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Demonstrate various physical chemistry experiments.*	**PO 1, PSO 3**	An	108

Physical Chemistry Experiments

1. Viscosity – percentage composition of a mixture.
2. Heat of solution – KNO_3, NH_4Cl
3. Heat of neutralization
4. Determination of equivalent conductance of an electrolyte.
5. Conductometric titration – strong acid *vs.* strong base, weak acid-strong base.
6. Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate)
8. Critical solution temperature. Phenol-water system
9. Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)
10. Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.
11. Potentiometric titration – Fe^{2+} *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO_4^-, strong acid - strong base, weak acid-strong base.
12. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)
13. Determination of equivalence point of potentiometric and conductometric titrations using spreadsheet program.

References

1. W. G. Palmer, '*Experimental physical chemistry*', Cambridge University Press.
2. J. B. Yadav, '*Advanced Practical Physical Chemistry*', Goel Publishing House.
3. R.C. Das and B. Behra, '*Experiments in Physical Chemistry*', Tata McGraw hill.
4. K. K. Sharma, '*An Introduction of Practical Chemistry*': Vikas Publishing House, New Delhi.

SEMESTER VI
PRACTICAL 6

COURSE CODE	**23U6PRCHE06**
COURSE TITLE	**GRAVIMETRIC ANALYSIS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Estimate the amount of a substance by gravimetric analysis.*	**PO 1, PSO 3**	An	36

1. Estimation of Barium as $BaSO_4$
2. Estimation of sulphate as $BaSO_4$
3. Estimation of magnesium as oxinate
4. Estimation of iron as Fe_2O_3
5. Estimation of Nickel as dimethyl glyoxime complex
6. Estimation of copper as CuCNS

References

1. A.I. Vogel '*A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis*': (Third Ed.) (ELBS)
2. J. Bassett, R.C. Denney, G. H. Heffery and J Mendham, '*Vogel's Textbook of quantitative Inorganic Analysis*' (revised), ELBS

SYLLABUS FOR COMPLEMENTARY CHEMISTRY COURSES - FOR STUDENTS WHO HAVE OPTED PHYSICS AS CORE

SEMESTER I

COURSE CODE	**23U1CPCHE1**
COURSE TITLE	**GENERAL CHEMISTRY**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Differentiate the features of various atomic models.*	**PO 1, PSO 1**	A	9
CO 2	*Define acids and bases and explain the concept of equilibrium.*	**PO 1, PSO 1**	U	8
CO 3	*Explain the fundamentals of nuclear chemistry.*	**PO 1, PSO 1**	A	6
CO 4	*Illustrate the methods in analytical chemistry and deduce errors in chemical analysis.*	**PO 1, PSO 3**	A	5
CO 5	*Apply the principles of chemical thermodynamics to various physical processes.*	**PO 1, PSO 1**	A	8

Unit 1: ***Atomic Structure*** **(9 Hrs.)**

Introduction: Atoms, Planck's quantum Theory, Photoelectric effect, Postulates of bohr's theory, Energy levels in atom and origin of hydrogen spectrum (*qualitative treatment only*). Sommerfeld's extension of Bohr's Theory, Shortcomings of Bohr Theory, Dual nature of matter and radiation. Derivation of de Broglie equation, Wave nature of electron and quantisation of angular momentum, Heisenberg's uncertainty principle, Concept of orbital, Quantum numbers, shapes of orbitals (*s, p, d*), Electronic configuration of atoms - Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle.

Unit 2: ***Concept of Equilibrium*** **(8 Hrs.)**

Acids and bases – Arrhenius, Lowry-Bronsted and Lewis Concepts, ionic product of water, introductory idea of pH, pOH. Strengths of acids and bases, Ka and Kb, pKa and pKb, buffer solution Henderson equation (*elementary idea only*), hydrolysis of salt, solubility, solubility product, application. Common ion effect, application.

Unit 3: ***Nuclear Chemistry*** **(6 Hrs.)**

Stability of Nucleus:- binding energy, magic number, packing fraction, n/p ratio.

Radioactivity: natural radioactivity, induced radioactivity, fertile and fissile isotopes, units of radioactivity.

Nuclear Reactions: fission and fusion, chain reactions, disposal of nuclear wastes.

Applications: Reactors – conventional and breeder, energy generation, radiocarbon dating, medical, agricultural and industrial applications.

Unit 4: ***Analytical Chemistry- Basic principles*** **(5 Hrs.)**

Concentration terms- molality, molarity, normality, weight percentage, ppm, and millimoles. Titrimetric method of analysis: General principle, types of titrations, requirements for titrimeric analysis. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions.

Evaluation of analytical data: Accuracy, precision, absolute error, relative error, types of error. Methods of elimination or minimization of errors.

Unit 5: ***Laws of Thermodynamics*** **(8 Hrs.)**

System and Surrounding. First law of Thermodynamics: Internal energy, Significance of internal energy change, enthalpy, Second law of Thermodynamics: free energy, Entropy and Spontaneity, Statement of second law based on entropy, Entropy change in Phase transitions (*No derivation required*) - entropy of fusion, entropy of vaporization, entropy of sublimation.

The concept of Gibbs's free energy- Physical significance of free energy, conditions for equilibrium & spontaneity based on ΔG values. Effect of temperature on spontaneity of Reaction. Third law of thermodynamics.

References:

1. B. R. Puri, L. R. Sharma, Kalia, *Principles of Inorganic Chemistry*, 31st edn. Milstone (2010).
2. Manas Chanda, *Atomic Structure and Molecular Spectroscopy*.
3. P. L. Soni, *Inorganic Chemistry*.
4. C. N. R. Rao, *University General Chemistry*, Macmillan.
5. R. A. Day Junior, A.L. Underwood, *Quantitative Analysis*, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988.
6. Vogel's *Text Book of Quantitative Chemical Analysis*, J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, 6th edn. Pearson Education (2003).
7. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi.
8. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd edn. Vishal Pub. CO., 2008.

SEMESTER II

COURSE CODE	**23U2CPCHE2**
COURSE TITLE	**BASIC ORGANIC CHEMISTRY**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Demonstrate simple methods of purifying an organic compound.*	**PO 1, PSO 1**	A	3
CO 2	*Interpret the stereochemistry of organic compounds.*	**PO 1, PSO 1**	A	11
CO 3	*Explain the basics of organic reaction mechanism.*	**PO 1, PSO 1**	U	15
CO 4	*Categorize various organic polymers and its applications.*	***PO 1, PO 4 PSO 1, PSO 2***	An	7

Unit 1: ***Purification of Organic Compounds*** **(3 Hrs.)**

Purification techniques: Recrystallisation, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

Unit 2: ***Stereochemistry of Organic Compounds*** **(11 Hrs.)**

Geometrical isomerism- *cis* and *trans* configuration, 2-butene, maleic and fumaric acid, determination of configuration of cis-trans isomers, E and Z configuration.

Optical isomerism- D and L configuration. Optical activity, Chirality, Stereogenic Centre, Enantiomers and diastereomers – optical isomerism in lactic acid and tartaric acid, Racemisation.

Conformation- Newman projection, Saw-horse projection, Conformations of Ethane, n - butane and Cyclohexane.

Unit 3: ***Mechanisms of Organic Reactions*** **(15 Hrs)**

Hybridization and shape of molecules - sp^3, sp^2 and sp, (ethane, ethene, ethyne).Types of reagents - electrophiles, nucleophiles.

Types of electron displacement in organic molecules- Inductive, electromeric, mesomeric, and hyper conjugative effects. Explanation of the strength of carboxylic and halogen substituted acids, base strength of primary, secondary and tertiary amines.

Types of bond fission- homolytic and heterolytic fission.

Reactive intermediates- carbocations, carbanions and free radicals. Their formation and stability.

Types of organic reactions – Substitution reactions: Nucleophilic substitution of alkyl halides- S_N1 and S_N2 mechanisms. Factors affecting rate of Substitution reaction of alkyl halide. Nature of alkyl halide, Effect of solvent. Stereochemistry of S_N1 and S_N2 reactions.

Electrophilic substitution in benzene-reaction mechanism. Halogenation, Nitration and Sulphonation.

Addition reactions: electrophilic addition. Addition of Bromine and Hydrogen halides to ethane, propene and ethyne-the Markwonikoff's rule, Peroxide effect.

Elimination reactions: E1 and E2 mechanisms. Saytzeff and Hofmann elimination.(Detailed mechanism is not expected.)

Unit 4: ***Natural and Synthetic Polymers*** **(7 Hrs.)**

Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions, Addition Polymerization, Condensation polymerization, typical examples- polyethene, polypropylene, PVC, phenol-formaldehyde resins, polyamides (nylons) and polyester. Natural rubber: structure, vulcanization. Synthetic rubbers- SBR, nitrile rubber, neoprene. Biodegradable polymers, environmental hazards caused by polymers, Health problem due to burning of plastics.

References

1. I. L. Finar, *Organic Chemistry*, Vol. I, 6th edn. Pearson.
2. S. M. Mukherji, S. P Singh, R. P Kapoor, *Organic Chemistry*, Vol.1, New Age International (P) Ltd, 2006.
3. P.S Kalsi, *Stereochemistry Conformation and Mechanism*, New Age International Publishers, 2004.
4. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th edn. Orient Longman, 1988.
5. S. M. Mukherji, *S.P Singh*, *Reaction Mechanism in Organic Chemistry*, Macmillan, 3rd Edn., 2003.
6. V. R. Gowariker, *Polymer Science*, Wiley Eastern.
7. K.S Tewari,N K Vishnoi, *Text book of Organic Chemistry*, Vikas Publishing House Pvt. Ltd.2007.

SEMESTER I AND II

PRACTICAL I

COURSE CODE	**23U2PCCHE1**
COURSE TITLE	**VOLUMETRIC ANALYSIS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Estimate the amount of substance in a given solution by volumetric analysis*	**PO 1, PO 4, PSO 3**	An	72

Standard solution must be prepared by the student.

Laboratory operations (*Non-evaluative*): Use of different glass wares like pipette, burette, standard measuring flask, distillation apparatus; heating methods, filtration techniques, weighing principle in chemical balance, weighing in electronic balance-general idea.

***Micro-scale Chemistry*:** The volumetric analysis may be done by two-burette titration procedure.

I. *Acidimetry and Alkalimetry*

1. Standardization of HCl with standard Na_2CO_3 solution
2. Standardization of NaOH with standard oxalic acid solution
3. Estimation of any acid using standard NaOH
4. Estimation of any alkali using standard HCl.

II. *Permanganometry*

1. Standardization of $KMnO_4$ using (i) oxalic acid (ii) Mohr's salt
2. Estimation of Fe^{2+} in Mohr's salt and crystalline Ferrous Sulphate using standard $KMnO_4$.
3. Estimation of oxalic acid using standard $KMnO_4$.

III. *Dichrometry*

1. Estimation of Ferrous ions (external indicator)
2. Estimation of Ferrous ions (internal indicator)

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th edn, Brooks/Cole Nelson.
2. Vogel's *Textbook of Quantitative Chemical Analysis* 6th edn, Pearsons Education Ltd.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons.

SEMESTER III

COURSE CODE	**23U3CPCHE3.1**
COURSE TITLE	**FUNDAMENTALS OF PHYSICAL CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Illustrate the properties of solid, liquid and gaseous states.*	**PO 1, PSO 1**	**A**	24
CO 2	*Explain the fundamentals of group theory and interpret the point groups of simple molecules.*	**PO 1, PSO 1**	U	6
CO 3	*Construct and explain the phase diagrams of one- and two-component systems.*	**PO 1, PSO 1**	A	9
CO 4	*Describe the basics of surface chemistry and chemical kinetics.*	**PO 1, PSO 1**	U	15

Unit 1: ***Gaseous State*** **(6 Hrs.)**

Kinetic molecular model of gases: Maxwell's distribution of velocities – molecular velocities (average, root mean square and most probable velocities). Collision parameters: Collision diameter, Collision number, collision frequency, mean free path, viscosity of gases – temperature and pressure dependence. Real gases: compressibility factor z, van der Waal s equation of state (*no derivation*)

Unit 2: ***Symmetry and Molecular Structure*** **(6 Hrs.)**

Symmetry elements and symmetry operation – Centre of symmetry, plane of symmetry, proper and improper axes of symmetry, identity, molecular point groups, Schoenflies symbol (determination of point groups of simple molecules like H_2O, NH_3, BF_3, C_2H_2, CO_2, CO, HCl, Benzene, NO_3^-, PCl_5).

Unit 3: ***Solid State*** **(15 Hrs.)**

Classification: amorphous, crystalline – differences. Lattice, lattice energy (general idea), unit cell, examples of simple cubic, bcc and fcc lattices, calculation of number of molecules in a unit cell, calculation of lattice parameters of cubic unit cell.

Weiss and Miller indices, crystal systems, Bravais lattices, X-ray diffraction – Bragg's equation, structure determination of NaCl by X-ray diffraction.

Theories of Solid: metallic bond, band theory, conductors, semiconductors and insulators, mention of super conductors.

Liquid crystals – the intermediate phase between solid and normal liquid phases, thermographic behavior, classification, structure of nematic and cholesteric phases.

Unit 4: ***Liquid State*** **(3 Hrs.)**

Intermolecular forces in liquids (*qualitative idea only*), viscosity, surface tension (*method of determination not expected*).

Unit 5: ***Surface Chemistry and Colloids*** **(6 Hrs.)**

Adsorption – types of adsorption of gases by solids, factors influencing adsorption, Freundlich adsorption isotherm – Langmuir adsorption isotherm (derivation not required). Colloids: preparation, properties – optical and electrical, electric double layer, coagulation, electrophoresis, electro osmosis, surfactants, micelle, applications of colloids.

Unit 6: ***Phase Equilibrium*** **(9 Hrs.)**

The phase rule, definition, equilibrium between phases, one component system – water system, Sulphur system. Two component systems: simple eutectic, lead-silver system, Distribution law, partition coefficient, applications- Study of association or dissociation, Principle of extraction. Distribution indicators.

Unit 7: ***Chemical Kinetics*** **(9 Hrs.)**

Rate of reaction, rate law, order of reaction, molecularity of reaction. Integrated rate expression for first order reaction, half life, determination of order of reactions. Influence of temperature on reaction rate – Arrhenius equation, concept of activation energy, importance of activated complex, catalysis – Homogeneous and Heterogenous Catalysis, examples. Kinetics of Enzyme Catalysis-Michelis-Menten equation.

References:

1. V. S. Muraleedharan and A. Subramanian, *Nanoscience and Nanotechnology*, Ane Books Pvt. Ltd. New Delhi, 2009
2. T. Pradeep, *Nano; The Essentials*, McGraw-Hill education, New Delhi, 2006.
3. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical Chemistry*, 40th edn. Vishal Pub. Co. Jalandhar (2003)
4. Ashcroft / Mermin, *Solid State Physics*, Thomson Publishers
5. J. Tareen and T. Kutty, *A basic course in Crystallography*, University Press.

SEMESTER IV

COURSE CODE	**23U4CPCHE4.1**
COURSE TITLE	**ADVANCED PHYSICAL CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Describe the fundamentals of basic spectroscopic techniques.*	**PO 1, PSO 1**	U	12
CO 2	*Explain the principles of photochemistry, electrochemistry and redox reactions.*	**PO 1, PSO 1**	U	34
CO 3	*Illustrate the synthesis and application of nanomaterials.*	**PO 1, PSO 1, PSO 2**	A	8

Unit 1: ***Introduction to Spectroscopy*** **(12 Hrs.)**

Interaction of electromagnetic radiation with matter, electromagnetic spectrum, quantization of energy, electronic, vibrational and rotational energy levels, Boltzmann distribution of energy (*formula only*), population of levels.

UV- Visible Spectroscopy: Beer Lambert's law, molar extinction coefficient and its importance, UV spectrum, max, chromophore, auxochrome, red shift, blue shift, types of transition.

Infra-red spectroscopy: vibrational degrees of freedom, types of vibrations – symmetric and asymmetric stretching and bending. Concept of group frequencies-frequencies of common functional groups in organic compounds.

Rotational Spectroscopy: diatomic molecules, determination of bond length.

Unit 2: ***Photochemistry*** **(5 Hrs.)**

Laws of Photochemistry, photochemical process – primary and secondary, quantum yield. Basic Concepts of Photosensitized reactions, flash photolysis and chemiluminescence. Frank-Condon principle – fluorescence and phosphorescence.

Unit 3: ***Electrochemistry*** **(12 Hrs.)**

Conductance of electrolytic solution, electrolytic conductivity (K), and molar conductivity of solutions of electrolytes. Variation of conductivity and molar conductivity with concentration. Kohlrausch's law – application. Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent, transport number-determination by Hittorf's method.

Applications of conductance measurements – Kw, Ksp, conductometric titrations, strong and weak electrolytes. Ostwald's dilution law, hydrolysis of salts.

Unit 4: ***Electromotive Force*** **(11 Hrs.)**

Galvanic cells, characteristics of reversible cells. Reversible electrodes – different types, electrode potential – effect of electrolyte concentration on electrode potential and emf (*Nernst equation*). Electrochemical series, representation of cell, EMF of cell. EMF and equilibrium constant of cell reaction, concentration cells – general discussion of electrode – concentration cell and electrolyte concentration cells. Liquid junction potential, fuel cells – the hydrogen – oxygen fuel cell.

Application of emf measurement – determination of pH using hydrogen electrode, quinhydrone electrode, glass electrode- potentiometric titrations.

Unit 5: ***Redox Reactions*** **(6 Hrs.)**

Oxidation Reduction reactions: explanation with examples, oxidation states, rules to assign oxidation states in polyatomic molecules, determination of oxidation states.
Oxidation reduction titrations: Experimental method, example.

Unit 6: ***Nanomaterials and Nanotechnology*** **(8 Hrs.)**

Introduction to nanoscience-Moore's law-properties of nanomaterials–Synthesis of nanomaterials-reduction method-precipitation method-sol gel method - Green synthesis of nanosilver and nanogold-surface plasmon resonance (SPR)-SEM and TEM (*principle only*)-Elementary idea about carbon nanotubes, fullerenes and quantum dots- Properties and applications of nanomaterials - nanocomposites-nanomedicine.

References:

1. C. N. Banwell, E.M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th edn. Tata McGraw – Hill Pub. C. Ltd. New Delhi.
2. Bruce H. Mahan, *University Chemistry*, 3rd edn.
3. P. Atkins. J. Paula, *Physical Chemistry*, 8th edn.Oxford University Press, 2006.
4. B. R. Puri, L.R. Sharma, M. S. Pathania, *Elements of Physical Chemistry*, 40th edn. Vishal Pub. Co. Jalandhar (2003).

SEMESTER III &IV

PRACTICAL 2

COURSE CODE	**23U4PCCHE2.1**
COURSE TITLE	**PHYSICAL CHEMISTRY PRACTICALS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

(*For students who have opted Physics as main*)

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Explain the principles of physical chemistry through experiments.*	**PO 1, PSO 2**	A	72

Experiments:

1. Molecular Weight by Victor Meyer's method
2. Determination of Partition coefficient of a non volatile solute
3. Transition temperature of salt hydrates, eg. Sodium thiosulphate Sodium acetate etc.
4. Critical solution temperature of phenol water system
5. Phase diagram of two component systems
6. Heat of Solution KNO_3, NH_4Cl
7. Heat of neutralization
8. Determination of equivalent conductance of an electrolyte
9. Conductometric titration of strong acid Vs. strong base
10. Potentiometric titrations : Fe^{2+} Vs. $Cr_2O_7^{2-}$ and Fe^{2+} Vs. $KMnO_4$
11. Determination of molecular weight by Rast's method. (using Napththalene, camphor or biphenyl as solvent and acetanilide, p–dichlorobenzene etc.as solute)
12. Kinetics of simple reactions, eg. Acid hydrolysis of methyl acetate

References

1. W. G. Palmer, '*Experimental Physical Chemistry*', Cambridge University Press.
2. J. B. Yadav, *Advanced Practical Physical Chemistry*, Goel Publishing House.
3. R. C. Das and B. Behra, '*Experiments in Physical Chemistry*', Tata McGraw hill.
4. K. K. Sharma, '*An Introduction of Practical Chemistry'*: Vikas Publishing House, New Delhi

SYLLABUS FOR COMPLEMENTARY CHEMISTRY COURSES – FOR STUDENTS WHO HAVE OPTED BOTANY OR ZOOLOGY AS CORE

SEMESTER I

COURSE CODE	**23U1CPCHE1**
COURSE TITLE	**GENERAL CHEMISTRY**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Differentiate the features of various atomic models.*	**PO 1, PSO 1**	A	9
CO 2	*Define acids and bases and explain the concept of equilibrium.*	**PO 1, PSO 1**	U	8
CO 3	*Explain the fundamentals of nuclear chemistry.*	**PO 1, PSO 1**	A	6
CO 4	*Illustrate the methods in analytical chemistry and deduce errors in chemical analysis.*	**PO 1, PSO 3**	A	5
CO 5	*Apply the principles of chemical thermodynamics to various physical processes.*	**PO 1, PSO 1**	A	8

Unit 1: ***Atomic Structure*** **(9 Hrs.)**

Introduction: Atoms, Planck's quantum Theory, Photoelectric effect, Postulates of bohr's theory, Energy levels in atom and origin of hydrogen spectrum (*qualitative treatment only*). Sommerfeld's extension of Bohr's Theory, Shortcomings of Bohr Theory, Dual nature of matter and radiation. Derivation of de Broglie equation, Wave nature of electron and quantisation of angular momentum, Heisenberg's uncertainty principle, Concept of orbital, Quantum numbers, shapes of orbitals (*s, p, d*), Electronic configuration of atoms - Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle.

Unit 2: ***Concept of Equilibrium*** **(8 Hrs.)**

Acids and bases – Arrhenius, Lowry-Bronsted and Lewis Concepts, ionic product of water, introductory idea of pH, pOH. Strengths of acids and bases, Ka and Kb, pKa and pKb, buffer solution Henderson equation (*elementary idea only*), hydrolysis of salt, solubility, solubility product, application. Common ion effect, application.

Unit 3: ***Nuclear Chemistry*** **(6 Hrs.)**

Stability of Nucleus:- binding energy, magic number, packing fraction, n/p ratio.

Radioactivity: natural radioactivity, induced radioactivity, fertile and fissile isotopes, units of radioactivity.

Nuclear Reactions: fission and fusion, chain reactions, disposal of nuclear wastes.

Applications: Reactors – conventional and breeder, energy generation, radiocarbon dating, medical, agricultural and industrial applications.

Unit 4: ***Analytical Chemistry- Basic principles*** **(5 Hrs.)**

Concentration terms- molality, molarity, normality, weight percentage, ppm, and millimoles. Titrimetric method of analysis: General principle, types of titrations, requirements for titrimeric analysis. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions.

Evaluation of analytical data: Accuracy, precision, absolute error, relative error, types of error. Methods of elimination or minimization of errors.

Unit 5: ***Laws of Thermodynamics*** **(8 Hrs.)**

System and Surrounding. First law of Thermodynamics: Internal energy, Significance of internal energy change, enthalpy, Second law of Thermodynamics: free energy, Entropy and Spontaneity, Statement of second law based on entropy, Entropy change in Phase transitions (*No derivation required*) - entropy of fusion, entropy of vaporization, entropy of sublimation.

The concept of Gibbs's free energy- Physical significance of free energy, conditions for equilibrium & spontaneity based on ΔG values. Effect of temperature on spontaneity of Reaction. Third law of thermodynamics.

References:

1. B. R. Puri, L. R. Sharma, Kalia, *Principles of Inorganic Chemistry*, 31st edn. Milstone (2010).
2. Manas Chanda, *Atomic Structure and Molecular Spectroscopy*.
3. P. L. Soni, *Inorganic Chemistry*.
4. C. N. R. Rao, *University General Chemistry*, Macmillan.
5. R. A. Day Junior, A.L. Underwood, *Quantitative Analysis*, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988.
6. Vogel's *Text Book of Quantitative Chemical Analysis*, J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, 6th edn. Pearson Education (2003).
7. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi.
8. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd edn. Vishal Pub. CO., 2008.

SEMESTER II

COURSE CODE	**23U2CPCHE2**
COURSE TITLE	**BASIC ORGANIC CHEMISTRY**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**36**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Demonstrate simple methods of purifying an organic compound.*	**PO 1, PSO 1**	A	3
CO 2	*Interpret the stereochemistry of organic compounds.*	**PO 1, PSO 1**	A	11
CO 3	*Explain the basics of organic reaction mechanism.*	**PO 1, PSO 1**	U	15
CO 4	*Categorize various organic polymers and its applications.*	***PO 1, PO 4 PSO 1, PSO 2***	An	7

Unit 1: ***Purification of Organic Compounds*** **(3 Hrs.)**

Purification techniques: Recrystallisation, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

Unit 2: ***Stereochemistry of Organic Compounds*** **(11 Hrs.)**

Geometrical isomerism- *cis* and *trans* configuration, 2-butene, maleic and fumaric acid, determination of configuration of cis-trans isomers, E and Z configuration.

Optical isomerism- D and L configuration. Optical activity, Chirality, Stereogenic Centre, Enantiomers and diastereomers – optical isomerism in lactic acid and tartaric acid, Racemisation.

Conformation- Newman projection, Saw-horse projection, Conformations of Ethane, n - butane and Cyclohexane.

Unit 3: ***Mechanisms of Organic Reactions*** **(15 Hrs)**

Hybridization and shape of molecules - sp^3, sp^2 and sp, (ethane, ethene, ethyne).Types of reagents - electrophiles, nucleophiles.

Types of electron displacement in organic molecules- Inductive, electromeric, mesomeric, and hyper conjugative effects. Explanation of the strength of carboxylic and halogen substituted acids, base strength of primary, secondary and tertiary amines.

Types of bond fission- homolytic and heterolytic fission.

Reactive intermediates- carbocations, carbanions and free radicals. Their formation and stability.

Types of organic reactions – Substitution reactions: Nucleophilic substitution of alkyl halides- S_N1 and S_N2 mechanisms. Factors affecting rate of Substitution reaction of alkyl halide. Nature of alkyl halide, Effect of solvent. Stereochemistry of S_N1 and S_N2 reactions.

Electrophilic substitution in benzene-reaction mechanism. Halogenation, Nitration and Sulphonation.

Addition reactions: electrophilic addition. Addition of Bromine and Hydrogen halides to ethane, propene and ethyne-the Markwonikoff's rule, Peroxide effect.

Elimination reactions: E1 and E2 mechanisms. Saytzeff and Hofmann elimination.(Detailed mechanism is not expected.)

Unit 4: ***Natural and Synthetic Polymers*** **(7 Hrs.)**

Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions, Addition Polymerization, Condensation polymerization, typical examples- polyethene, polypropylene, PVC, phenol-formaldehyde resins, polyamides (nylons) and polyester. Natural rubber: structure, vulcanization. Synthetic rubbers- SBR, nitrile rubber, neoprene. Biodegradable polymers, environmental hazards caused by polymers, Health problem due to burning of plastics.

References

1. I. L. Finar, *Organic Chemistry*, Vol. I, 6th edn. Pearson.
2. S. M. Mukherji, S. P Singh, R. P Kapoor, *Organic Chemistry*, Vol.1, New Age International (P) Ltd, 2006.
3. P.S Kalsi, *Stereochemistry Conformation and Mechanism*, New Age International Publishers, 2004.
4. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th edn. Orient Longman, 1988.
5. S. M. Mukherji, *S.P Singh*, *Reaction Mechanism in Organic Chemistry*, Macmillan, 3rd Edn., 2003.
6. V. R. Gowariker, *Polymer Science*, Wiley Eastern.
7. K.S Tewari,N K Vishnoi, *Text book of Organic Chemistry*, Vikas Publishing House Pvt. Ltd.2007.

SEMESTER I AND II

PRACTICAL I

COURSE CODE	**23U2PCCHE1**
COURSE TITLE	**VOLUMETRIC ANALYSIS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Estimate the amount of substance in a given solution by volumetric analysis*	**PO 1, PO 4, PSO 3**	An	72

Standard solution must be prepared by the student.

Laboratory operations (*Non-evaluative*): Use of different glass wares like pipette, burette, standard measuring flask, distillation apparatus; heating methods, filtration techniques, weighing principle in chemical balance, weighing in electronic balance-general idea.

***Micro-scale Chemistry*:** The volumetric analysis may be done by two-burette titration procedure.

I. *Acidimetry and Alkalimetry*

1. Standardization of HCl with standard Na_2CO_3 solution
2. Standardization of NaOH with standard oxalic acid solution
3. Estimation of any acid using standard NaOH
4. Estimation of any alkali using standard HCl.

II. *Permanganometry*

1. Standardization of $KMnO_4$ using (i) oxalic acid (ii) Mohr's salt
2. Estimation of Fe^{2+} in Mohr's salt and crystalline Ferrous Sulphate using standard $KMnO_4$.
3. Estimation of oxalic acid using standard $KMnO_4$.

III. *Dichrometry*

1. Estimation of Ferrous ions (external indicator)
2. Estimation of Ferrous ions (internal indicator)

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th edn, Brooks/Cole Nelson.
2. Vogel's *Textbook of Quantitative Chemical Analysis* 6th edn, Pearsons Education Ltd.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons.

SEMESTER III

COURSE CODE	**23U3CPCHE3.2**
COURSE TITLE	**BIO-INORGANIC AND HETEROCYCLIC CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

(*For students who have opted Botany and Zoology as main*)

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Point out the synthetic methods and chemical properties of five and six membered heterocyclic compounds.*	**PO 1, PSO 1**	U	10
CO 2	*Explain the role bioinorganic molecules in various biological processes.*	**PO 1, PSO 1**	A	16
CO 2	*Illustrate the structure and properties of enzymes and nucleic acids.*	**PO 1, PSO 1**	A	16
CO 3	*Cite the role of chemistry in agriculture.*	**PO 1, PSO 1**	A	12

Unit 1: ***Heterocyclic Compounds*** **(10 Hrs.)**

Aromaticity – Huckel rule, preparation (*any one method*), properties, structure and aromaticity of furan, pyrrole, pyridine, indole. Pyrimidines and purines.

Unit 2: ***Bioinorganic Chemistry*** **(16 Hrs.)**

Thermodynamics of Living cell- Exergonic and endergonic reactions, coupled reactions, biological oxidation reactions (*general idea*).

Oxygen Carriers: Oxygen transport in biological system-Hemoglobin and myoglobin, Structure and function. Oxygen transport mechanism, cooperativity of hemoglobin, Perutz mechanism, Bohr effect. Hemocyanin, Hemerythrin (*Structure and function only*).

Electron carriers: Ferredoxine, cytochromes (*Structure and function only*).

Photosynthesis: Photosynthetic pigments, Chlorophyll, Structure, Different types of chlorophyll. Photosystem-I, photosystem-II, Z- Scheme, photophosphorylation (*Elementary idea only*).

Unit 3: ***Enzymes and Nucleic acids*** **(16 Hrs.)**

Enzymes: Nomenclature, Classification, Metalloenzymes, prosthetic group, coenzyme, cofactors, characteristics of enzyme action, mechanism of enzyme action (*elementary idea only*).

Lock and key model, Induced fit model. Factors affecting enzyme action. Enzyme inhibition. Enzyme kinetics.

Structure and function of some important enzymes: peroxidase, catalase, cytochrome P-450. Carbonic anhydrase, Carboxy peptidase. Cytochrome oxidase. Vitamin B_{12}.

Na+/K+ ATPase-Sodium Potassium pump (*Detailed mechanism is not expected*).

Energy rich molecules: elementary structure of ATP and ADP.

*Nucleic acids***:** Chemical composition, structures of nucleosides and nucleotides. Structure of DNA & RNA. Biological Functions:-replication and protein synthesis.

Unit 4: *Chemistry and Agriculture* (12 Hrs.)

Plant nutrients- Non Mineral nutrients. Mineral nutrients-Macro nutrients- Primary and Secondary macro nutrients. Micronutrients. Their role in plant growth.

Fertilizers- NPK value, superphosphates, triple super phosphate, uses of mixed fertilizers, Bio-fertilizers. Plant growth hormones.

Pesticides-classifications with simple examples, mention of bio pesticides. Insecticides – stomach poisons, contact insecticides, fumigants. Examples. Method of preparation of DDT, BHC, pyrethrin.

Herbicides- structure and function of 2,4-D and 2,4,5 –T.

Fungicides- inorganic and organic- Bordeaux mixture, dithiocarbamates, Excessive use of pesticides – environmental hazards.

References:

1. I. L Finar, *Organic Chemistry*, Vol 1 & 2, 6th Edition, Pearson.
2. K. S. Tewari, N. K. Vishnoi, *A Text Book of Organic Chemistry*, 3rd edition, Vikas publishing House Pvt. Ltd, 2006.
3. J. D. Lee, *Concise Inorganic Chemistry* 5th edn. Wiley India Pvt. Ltd.2008.
4. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Milestone Publishers, New Delhi, 2010.
5. G.L. Meissler, D.A Tarr, *Inorganic Chemistry*, 3rd Edn. Pearson Education, 2004.
6. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, Pearson 2006.
7. A.C. Deb, *Fundamentals of Biochemistry*, 9th Edn. New Central Book Agency, 2001.
8. Rastogi, *Biochemistry*, Tata Mc Graw –Hill Publication, 1996.
9. http://en.wikipedia.org/wiki/Plant_nutrition.

SEMESTER IV

COURSE CODE	**23U4CPCHE4.2**
COURSE TITLE	**ADVANCED BIO-ORGANIC CHEMISTRY**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**54**

(*For students who have opted Botany and Zoology as main*)

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Explain the structure and properties of various biomolecules.*	**PO 1, PSO 1**	A	39
CO 2	*Appreciate the role of chemistry in medicine.*	**PO 1, PSO 1**	U	9
CO 3	*Describe the basics of chromatography and its application.*	**PO 1, PSO 1**	A	6

Unit 1: *Amino Acids and Proteins* (12 Hrs.)

Classification of amino acids, zwitter ion, general chemical properties of - amino acids, separation of amino acids, synthesis of glycine, alanine, phenyl alanine (*any one method*). Peptides – peptide bond, polypeptides. Proteins- amino acids as building block of proteins, classifications, prosthetic group, properties, denaturation. Structure of proteins- primary, secondary and tertiary structure.

Unit 2: *Carbohydrates* (10 Hrs.)

Classification of carbohydrates, preparation and properties of glucose, fructose and sucrose. Haworth configuration of α-D glucose and β-D glucose, α-D fructose, β-D fructose, maltose and cellobiose (*ring size determination not expected*). Mutarotation. Conversion of glucose to fructose and vice-versa. Structure of starch and cellulose. Industrial applications of cellulose.

Unit 3: *Vitamins, Steroids, Hormones and Lipids* (12 Hrs.)

Structure and biological activity of vitamin A, B and C.

Steroids- general introduction, cholesterol and bile acids.

Hormones (*structure not required*) - Introduction, steroid hormones peptide hormones, amine hormones, artificial hormones (general idea).

Simple lipids and complex lipids- isolation- properties. Analysis of oils and fats- acid value, saponification value, iodine value, Role of MUFA and PUFA in preventing heart diseases.

Unit 4: *Chemistry in Medicine* (9 Hrs.)

Essential and trace elements in biological system. Metal deficiency and disease- Iron, Zinc Copper. Metal toxicity- Toxicity due to Plutonium and mercury. Treatment for excess mercury and plutonium.

Classification of drugs. Structure, therapeutic uses and mode of action (synthesis not required) of *Antibiotics*: Ampicillin and Chloramphenicol, Sulpha drugs: Sulphanilamide and sulphapyridine,

Antipyretics and Analgesics: Paracetamol, Aspirin. *Antacids*: Ranitidine. *Antimalarials*: Chloroquine and *Anti-cancer drugs*: Chlorambucil, *Cis*-platin.

Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples.

Drug addiction and abuse: Prevention and treatment.

Unit 5: *Natural Products* (5 Hrs.)

Terpenoids: Essential oils- isolation, isoprene rule. Elementary study of citral, geraniol and natural rubber.

Alkaloids: Classification, source, isolation, general properties and structure of coniine, nicotine, piperine. Structure elucidation: coniine, nicotine.

Unit 6: *Chromatographic Techniques* (6 Hrs.)

Classification of chromatographic methods. Basic principle and uses of Column chromatography, Thin layer chromatography (TLC), Paper chromatography (PC), Rf value, Gas chromatography (GC), High Performance Liquid chromatography (HPLC), Ion Exchange chromatography (IEC).

References

1. I. L. Finar, *Organic Chemistry*, Vol 1 & 2, 6th edition, Pearson.
2. K. S. Tewari, N. K. Vishnoi, *A Text Book of Organic Chemistry*, 3rd edition, Vikas publishing House Pvt. Ltd ,2006.
3. Rastogi, *Biochemistry*, Tata McGraw –Hill Publication, 1996.
4. Dr. A.C. Deb, *Fundamentals of Biochemistry*.
5. C. N. R. Rao, *University General Chemistry*, Macmillion.
6. G. T. Austin, *Shreve's Chemical process Industries*, 5th edition, McGraw Hill, 1984.
7. G. R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
8. J.Ghosh, *A Textbook of Pharmaceutical Chemistry*, S. Chand & Co Ltd., 1997.
9. Bhat S.V., Nagasampagi, B.A. & Sivakumar M., *Chemistry of Natural Products*, Narosa, 2005.
10. R. A. Day Junior, A.L. *Underwood, Quantitative Analysis*, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988.
11. Vogel's *Text Book of Quantitative Chemical Analysis*, J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, 6th edn. Pearson Education (2003).

SEMESTER III &IV

PRACTICAL 2

COURSE CODE	**23U4PCCHE2.2**
COURSE TITLE	**ORGANIC CHEMISTRY PRACTICALS**
NO. OF CREDITS	**2**
NO. OF CONTACT HOURS	**72**

(*For students who have opted Botany and Zoology as main*)

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Identify and distinguish various organic compounds.*	**PO 1, PSO 2**	A	72

1. Tests for elements: Nitrogen, Halogen and Sulphur.

2. Study of reactions of common functional groups.

3. Qualitative analysis with a view to characterization of functional groups and identification of the following compounds: Naphathalene, chlorobenzene, benzyl chloride, benzyl alcohol, phenol, o-, m- and p- cresols, resorcinol, benzaldehyde, accetophenone, benzophenone, benzoic acid, phthalic acid, cinnamic acid, salicylic acid, ethyl benzoate, methyl salicylate, benzamide, urea, aniline, nitrobenzene, m-dinitrobenzene and glucose.

- Organic preparation involving halogenation, nitration, oxidation, reduction, acetylation, benozylation, hydrolysis, diazotization.

References:

1. A. I. Vogel, *A Text Book of Practical Organic Chemistry*, Longman.
2. F. G. Mann and B. C. Saunders, '*Practical Organic Chemistry*' Fourth Edition, Pearson Education.
3. V. K. Ahluwalia and S. Dhingra , *Comprehensive Practical Organic Chemistry*, Universities Press.

SYLLABUS OF OPEN COURSE
(*Offered by the Department of Chemistry for the students of other Departments*)

SEMESTER V

COURSE CODE	**23U5OCCHE1**
COURSE TITLE	**CHEMISTRY IN EVERYDAY LIFE**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**72**

	Course Outcomes	POs / PSOs	CL	Class Sessions
CO 1	*Appreciate the role of chemistry in everyday life.*	PO 1, PO 4, PO 5 PSO 2	U	72

Unit 1: ***Food additives and Flavours*** **(12 Hrs.)**

Functional food additives, adulteration, food laws. Food colours - permitted and non – permitted- Toxicology. Flavours – natural and synthetic- Toxicology .Other functional additives- Soft drinks- formulation Health drinks.

Unit 2: ***Soaps*** **(7 Hrs.)**

Soaps – Introduction, detergent action of soap. Toilet soap, bathing bars, washing soaps, liquid soap manufacture- additives, fillers and flavours. Significance of acidity and alkalinity.

Unit 3: ***Synthetic Detergents*** **(9 Hrs.)**

Detergents- Introduction, detergent action, types of detergents-cationic, anionic, amphiphilic detergents. Common detergent chemicals. Additives, excipients colours and flavours. Enzymes used in commercial detergents. Environmental hazards.

Unit 4: ***Cosmetics*** **(12 Hrs.)**

Cosmetics- Introduction, classification – bathing oils, face creams, toilet powder, skin products, dental cosmetics, hair dyes, shaving cream, shampoo, general formulation of each type. Toxicology of cosmetics.

Unit 5: ***Plastics, Paper and Dyes*** **(14 Hrs.)**

Plastics in everyday life. Brief idea of polymerization-Thermoplastic and thermosetting polymers. Use of PET, HDPE, PVC, LDPE, PP, ABS. Recycling of plastics. Biodegradable plastics. Environmental hazards of plastics. News print paper, writing paper, paper boards, cardboards. Organic materials, wood, cotton, jute and coir. International recycling codes, and symbols for identification. Natural and synthetic dyes (*basic idea only*).

Unit 6: ***Drugs*** **(6 Hrs.)**

Chemotherapy- types of drugs- analgesics, antipyretics, antihistamines, antacids tranquilizers, sedatives, antibiotics, antifertility drugs.

Unit 7: *Chemistry and Agriculture* (12 Hrs.)

Fertilizers- natural, synthetic, mixed, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers. Plant growth hormones.

Pesticides- Classification-insecticides, herbicides, fungicides. Excessive use of pesticides – environmental hazards. Bio pesticides. Antiseptics and Disinfectants-Oils - vegetable oils, mineral oil, essential oil-Sugars, artificial sugars

References:

1. T.P. Coultate, *Food- The Chemistry of its components*. Royal Society of Chemistry, London.
2. Shashi Chowls, *Engineering Chemistry*, Danpat Rai Publication.
3. B.K. Sharma. *Industrial Chemistry*.
4. CNR Rao, *Understanding chemistry*, Universities Press.
5. Puri and Sharma. *Advanced Organic Chemistry*.
6. Brown, *Insect control by chemicals*
7. A. K. De, *Environmental Chemistry*, New age International Ltd.
8. S. S. Dara, *A Textbook of Environmental chemistry and pollution con*trol, S. Chand & Company Ltd.
9. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. *Soil Fertility and Fertilizers*, Macmillian Publishing Company, New York, 1990.
10. Buchel, K.H., *Chemistry of Pesticides*, John Wiley & Sons, New York, 1983
11. P.C Pall, K. Goel, R.K Gupta, *Insecticides, pesticides and agrobased industries*.
12. Gowariker V.R., Viswanathan N.V. and Jayader Sreedhar, *Polymer Science*, Wiley Eastern Ltd., New Delhi.
13. I.I Singh, V.K Kapoor, *Organic Pharmaceutical Chemistry*.

PATTERN OF QUESTION PAPERS

SECTION	PATTERN	MARKS	CHOICE OF QUESTIONS	TOTAL MARKS
A	**Very Short Answer**	**1**	**8/8**	**8**
B	**Short Answer**	**2**	**6/8**	**12**
C	**Problem/ Short Essay**	**5**	**4/6**	**20**
D	**Long Essay**	**10**	**2/4**	**20**
			20/26	**60**

Question Paper Pattern for Open course and Environment Studies Course (Sem V) and Core Elective Course (Sem VI).

SECTION	PATTERN	MARKS	CHOICE OF QUESTIONS	TOTAL MARKS
A	**Very Short Answer**	**1**	**10/13**	**10**
B	**Short Answer**	**2**	**10/13**	**20**
C	**Problem/ Short Essay**	**5**	**5/8**	**25**
D	**Long Essay**	**10**	**2/4**	**20**
			27/38	**75**