BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Science
M. Sc. - Chemistry
New Syllabus

"Social Transformation Through Dinamic Education"

BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY)

YASHWANTRAO MOHITE COLLEGE OF ARTS, SCIENCE AND COMMERCE,

PUNE 411038

Accredited with 'A+' Grade (2017) by NAAC
'A' Grade University Status by MHRD, Govt. of India
Accredited (2004) & Reaccredited (2011) with 'A' Grade by NAAC

MASTER OF SCIENCE (M. Sc. CHEMISTRY) PROGRAME

(Analytical/Organic/Inorganic Chemistry)

CBCS 2018 COURSE STRUCTURE

Under the Faculty of Science

TO BE IMPLEMENTED FROM ACADEMIC YEAR 2018-19

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE (INDIA)

Master of Science (Analytical/Organic/Inorganic Chemistry)

(CBCS 2018 COURSE)

Learning Outcomes based Curriculum Framework (LOCF)

Under the Faculty of Science
(To be implemented from June 2018)

1. INTRODUCTION

The Master of Science (Analytical/Organic/Inorganic Chemistry), program is a full time 84 Credits program offered by BharatiVidyapeeth Deemed University, Pune.

2. GENERAL OBJECTIVES OF THE COURSE:

Chemistry is a pervasive subject. All the branches of science need chemistry. It is an experimental science and students need to train in practicals to get expertise in doing fine experiments and handle sophisticated instruments. Along with the data obtained its statistical analysis is also required to establish authenticity in the fields like environmental science, space chemistry and biotechnology. There are immense potentialities for chemistry and post graduates to undertake advanced research or in Industries as skilled chemists.

Goal of the Syllabus: To impart the thorough knowledge of Chemistry, capability of self thinking, self study, identifying the problems and develop the problem solving attitude. To make the student globally competent.

3. ELIGIBILITY FOR ADMISSION TO THIS COURSE

A student shall be eligible for admission to the First Year M.Sc (Analytical/Organic/Inorganic Chemistry) degree course who has completed B.Sc

(Chemistry) graduation from any recognized university satisfying the following conditions. The candidate should have secured at least 50% (45% for SC/ST) in aggregate at graduate level university examination.

4. INTAKE CAPACITY

The intake capacity of the course will be-

Analytical Chemistry – 80 seats

Organic Chemistry – 24 seats

Inorganic Chemistry – 24 seats

5. Nature and extent of the M.Sc Chemistry Programme

The scope of chemistry is very broad. The key areas for postgraduate study of chemistry comprise Organic chemistry, Inorganic Chemistry, and Analytical Chemistry. Organic chemistry deals with interpretation of organic molecules with NMR, IR, UV, Mass spectroscopic techniques, green chemistry, natural products with stereochemistry and important mechanisms and name reactions; inorganic chemistry deals with study of coordination compounds and their physical and chemical properties, nanomaterials, catalysis study. Analytical chemistry, in general, deals with identification and quantification of materials with modern analytical techniques. Thus, the postgraduate degree programme in chemistry also intended to cover overlapping areas of chemistry with material science, life science, biomaterials, nanomaterials, environmental chemistry, etc., has also been introduced which can be helpful for applications from job prospective point of view. This syllabus has been drafted to enable the students to equip for national level competitive exams such as SET and NET examinations that they may attempt after their postgraduation. To expand the employability of postgraduates, skill development courses are also introduced in this framework.

6. Program Learning Outcomes :

M. Sc (Analytical / Organic / Inorganic Chemistry)

After successful completion of two year postgraduate program in chemistry a student should be able to;

PO-1.	Demonstrate, solve and an understanding of major concepts in all disciplines of Chemistry.
PO-2.	Create an awareness of the impact of chemistry on the society, and development outside the scientific community.
PO-3.	Employ critical thinking and the scientific knowledge to design, carry

	out, record and analyze the results of Chemistry experiments.
PO-6.	To inculcate the scientific temperament in the students and outside the scientific community
PO-7	Students will be able to understand the characterization along with basic principle of equipments, instruments used in the chemistry laboratory
PO-8	The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

7. Attributes of a Chemistry Postgraduate:

Attributes of chemistry postgraduate under the outcome-based teaching-learning framework may encompass the following:

- **Core competency:** The chemistry postgraduates are expected to know the in depth knowledge of Organic, Inorganic, Physical and Analytical chemistry and also applied chemistry. These concepts would reflect the latest understanding of the field, and therefore, are dynamic in nature and require frequent and time-bound revisions.
- **Communication skills:** Chemistry postgraduates are expected to possess communication skills globally as opportunities are throughout the world. They are expected to read and understand documents with in-depth analyses and logical arguments.
- **Critical thinking:** Chemistry postgraduates are expected to know basics of cognitive biases, mental models, logical fallacies, scientific methodology and constructing cogent scientific arguments.
- **Psychological skills:** Students are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various sociocultural, economic and educational levels which includes self-compassion, selfreflection, goal-setting, interpersonal relationships, and emotional management.
- **Problem-solving:** Students are expected to be equipped with problem-solving in scientific temperament.
- **Analytical reasoning:** Students are expected to acquire formulate cogent arguments and spot logical flaws, inconsistencies, circular reasoning etc.
- **Research-skills:** Students are expected to be keenly observant about what is going on in the natural surroundings to awake their curiosity. Postgraduates are

expected to design a scientific experiment through statistical hypothesis testing and other *a priori* reasoning including logical deduction.

- **Digital Literacy:** Postgraduates are expected to be trained digitally literate for them to enroll and increase their core competency via e-learning resources such as swayam, MOOC and other digital tools for lifelong learning. Students should be able to spot data fabrication and fake news by applying rational skepticism and analytical reasoning.
- **Moral and ethical awareness:** Postgraduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.

8. Programme Specific Outcomes:

M. Sc Analytical Chemistry

PSO-1	Learn about the potential applications of analytical industrial chemistry.
PSO-2.	Carry out experiments in the area of organic analysis, estimation, separation, conduct metric and potentiometric analysis.
PSO-3.	Learn the classical status of thermodynamics and kinetics.
PSO-4.	Gathers attention about the physical aspects of atomic structure, various energy transformation, molecular assembly in nano level and significance of electrochemistry.
PSO-5.	Understand good laboratory practices and safety.
PSO-6.	Introduce advanced analytical techniques and ideas required in developing area of Chemistry.
PSO-7.	Make aware and handle the sophisticated instruments/equipments.
PSO-8.	Enhance students‟ ability to develop mathematical models for physical systems.

M. Sc Organic Chemistry

PSO-1	Know the structure and bonding in molecules/ ions and predict the Structure of molecule/ions.
PSO-2.	Understand the various type of aliphatic, aromatic, nucleophilic substitution reaction.
PSO-3.	Understand and apply principles of Organic Chemistry for understanding

	the scientific phenomenon in Reaction mechanisms.
PSO-4.	Learn the Familiar name reactions and their reaction mechanisms.
PSO-5.	Understand good laboratory practices and safety.
PSO-6.	Study of organometallic reactions.
PSO-7.	Study of free radical, bycyclic compound, conjugate addition of Enolates and pericyclic reactions.
PSO-8.	Study of biological mechanisms using amino acids.

M. Sc – Inorganic Chemistry

PSO-1	Know advances of various theories of chemical bonding.
PSO-2	Study of Inorganic solid state and polymer chemistry.
PSO-3	Analyze ores, alloys, soil samples, water samples with respect to inorganic constituents.
PSO-4	Understand Organometallic chemistry of nontransition and transition metals.
PSO-5	Apply nanoscience and nanotechnology to inorganic materials.
PSO-6	Study material chemistry and its properties.
PSO-7	Know modern instrumental techniques for characterization of Inorganic materials.
PSO-8	Study Inorganic pharmaceutical chemistry.
PSO-9	Study applications of Inorganic chemistry to Agriculture, Environmental and Space science.

9. COURSE STRUCTURE

1) The M.Sc. (Chemistry) course will be of four semesters and with a minimum of 84 credits. The medium of instruction and examination will be only English.
2) Credits for Semester I-12 Credits, Semester II -30 Credits, Semester III- 18 Credits and Semester IV- 24 Credits.
3) The assessment of 1 credit at Semester IV of M.Sc.(Chemistry) that is for Industrial Training programme will be carried out as follows :-

   i) A student will inform the department about the joining date of the above mentioned training.

   ii) The student will have to make presentation at the end of the programme and the student will have to submit a compiled report which will be assessed towards course credit as Internal Assessment Marks for Core Elective subject.
4) Each theory course prescribed for M. Sc. should be covered in 4 hours, each of 60 minutes duration per week per course

5) Each practical course will require 4 hours of laboratory work per week and the course will be extended over two semesters and will be examined at the end of the academic year.
6) For theory course the question paper should include at least 20 % weightage for problem solving. Problem solving would include numerical problems and may be objective type questions.
7) Thus M.Sc (Analytical/Organic/Inorganic Chemistry) degree examination has four semesters and shall be of 2100 marks and of minimum 84 credits altogether. The following shall be the course structure:

SEMESTER – I(Analytical Chemistry)

Semester	Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam.Hrs	Maximum Marks		
							Internal Assessment	University Examination	Total
Semester I	Core: Compulsory	PGCH- 101	Physical Chemistry- I	04	04	03	40	60	100
		PGCH- 102	Inorganic Chemistry-I	04	04	03	40	60	100
		PGCH- 103	Organic Chemistry-I	04	04	03	40	60	100

SEMESTER – II(Analytical Chemistry)

Semester II	Core: Compulsory	PGCH- 201	Physical Chemistry- II	04	04	03	40	60	100
		PGCH- 202	Inorganic Chemistry-II	04	04	03	40	60	100
		PGCH- 203	Organic Chemistry-II	04	04	03	40	60	100
		PGCH -204	Fundamentals of analytical Chemistry	04	04	03	40	60	100
		PGCH -205	Physical Chemistry practical*	04	02+02	06	40	60	100
		PGCH -206	Inorganic Chemistry practical*	04	02+02	06	40	60	100
		PGCH- 207	Organic Chemistry practical*	04	02+02	06	40	60	100
	Ability Enhancement Course	PGAEC- 208	Scientific Writing	02	02	02	20	30	50

SEMESTER – III (Analytical Chemistry)

Semester	Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam. /Hrs	Maximum Marks		
							Internal Assessment	University Examination	Total
Semester III	Core: Compulsory	PGAC 301	Thermal, Radio and Electro-analytical methods	04	04	03	40	60	100
		PGAC 302	Modern Aspects of Analytical Chemistry	04	04	03	40	60	100
		PGAC 303	Recent Analytical Techniques	04	04	03	40	60	100
		PGAC 304	Analysis of Pharmaceuticals	04	04	03	40	60	100
	Skill Enhancement Course	PGSEC 305	Assessment of Water Quality	02	02	02	20	30	50

SEMESTER- IV (Analytical Chemistry)

Semester IV	Core: Compulsory	PGAC 401	Advanced Analytical Techniques	04	04	03	40	60	100
		PGAC 402	Recent Separation Techniques	04	04	03	40	60	100
Any one from the following: From PGAC-403 to PGAC-405									
Semester IV	Core: Elective#	PGAC 403	Environmental Analysis	04	3+1	03	40	60	100
		PGAC 404	Computer Interface with Chemistry	04	3+1	03	40	60	100
		PGAC 405	Modern Methods of Analysis	04	3+1	03	40	60	100
	Core: Compulsory	PGAC 406	Practical Course -I*	02	2+2	06	40	60	100
		PGAC 407	Practical Course -II*	02	2+2	06	40	60	100
		PGAC 408	Practical Course –III * OR Project Work*	02	2+2	06	40	60	100

* Examination for practical courses will be conducted at the end of academic year.
# Core Elective Course includes Core: Elective subjects and Industrial project.
Industrial Project includes one day visit, Internet survey, project writing, presentation or oral and be evaluated as the internal marks for Core: Elective Course (PGAC-403, PGAC-404, PGAC-405).

SEMESTER – I (Organic Chemistry)

Semester	Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam.Hrs	Maximum Marks		
							Internal Assessment	University Examination	Total
Semester I	Core: Compulsory	PGCH- 101	Physical Chemistry- I	04	04	03	40	60	100
		PGCH- 102	Inorganic Chemistry-I	04	04	03	40	60	100
		PGCH- 103	Organic Chemistry-I	04	04	03	40	60	100

SEMESTER – II (Organic Chemistry)

Semester II	Core: Compulsory	PGCH- 201	Physical Chemistry- II	04	04	03	40	60	100
		PGCH- 202	Inorganic Chemistry-II	04	04	03	40	60	100
		PGCH- 203	Organic Chemistry-II	04	04	03	40	60	100
		PGCH -204	Fundamentals of analytical Chemistry	04	04	03	40	60	100
		PGCH -205	Physical Chemistry practical*	04	02+02	06	40	60	100
		PGCH -206	Inorganic Chemistry practical*	04	02+02	06	40	60	100
		PGCH- 207	Organic Chemistry practical*	04	02+02	06	40	60	100
	Ability Enhancement Course	PGAEC- 208	Scientific Writing	02	02	02	20	30	50

SEMESTER – III (Organic Chemistry)

Semester	Subject Type	Code	Title of the paper	Hrs/Week	Credits	Exam. Hrs	Maximum Marks		
							Internal Assessment	University Examination	Total
Semester III	Core: Compulsory	PGOC 301	Advanced Organic Reaction Mechanism	04	04	03	40	60	100
		PGOC 302	Spectroscopic Methods In Structure Determination	04	04	03	40	60	100
		PGOC 303	Advanced Stereochemistry	04	04	03	40	60	100
		PGOC 304	Medicinal Chemistry	04	04	03	40	60	100
	Skill Enhancement Course	PGSEC 305	Assessment of Water Quality	02	02	03	20	30	50

SEMESTER- IV (Organic Chemistry)

Semester IV	Core: Compulsory	PGOC-401	Synthetic Organic Chemistry	04	04	03	40	60	100
		PGOC-402	Chemistry Of Natural Products	04	04	03	40	60	100
Any one from the following: From PGAC-403 to PGAC-405									
Semester IV	Core: Elective#	PGOC-403	Green Chemistry	04	04	3+1	40	60	100
		PGOC-404	Applied Organic Chemistry	04	04	3+1	40	60	100
		PGOC-405	Bio-Organic Chemistry	04	04	3+1	40	60	100
	Core: Compulsory	PGOC-406	Mixture Separation*	02	2+2	06	40	60	100
		PGOC-407	Advanced Preparations*	02	2+2	06	40	60	100
		PGOC-408	Research Project / Laboratory Course*	02	2+2	06	40	60	100

* Examination for practical courses will be conducted at the end of academic year.
# Core Elective Course includes Core: Elective subjects and Industrial project.
Industrial Project includes one day visit, Internet survey, project writing, presentation or oral and be evaluated as the internal marks for Core: Elective Course (PGOC-403, PGOC-404, PGOC-405).

SEMESTER – I (Inorganic Chemistry)

Semester	Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam.Hrs	Maximum Marks		
							Internal Assessment	University Examination	Total
Semester I	Core: Compulsory	PGCH- 101	Physical Chemistry- I	04	04	03	40	60	100
		PGCH- 102	Inorganic Chemistry-I	04	04	03	40	60	100
		PGCH- 103	Organic Chemistry-I	04	04	03	40	60	100

SEMESTER – I (Inorganic Chemistry)

Semester II	Core: Compulsory	PGCH- 201	Physical Chemistry- II	04	04	03	40	60	100
		PGCH- 202	Inorganic Chemistry-II	04	04	03	40	60	100
		PGCH- 203	Organic Chemistry-II	04	04	03	40	60	100
		PGCH -204	Fundamentals of analytical Chemistry	04	04	03	40	60	100
		PGCH -205	Physical Chemistry practical*	04	02+02	06	40	60	100
		PGCH -206	Inorganic Chemistry practical*	04	02+02	06	40	60	100
		PGCH- 207	Organic Chemistry practical*	04	02+02	06	40	60	100
	Ability Enhancement Course	PGAEC- 208	Scientific Writing	02	02	02	20	30	50

SEMESTER – III (Inorganic Chemistry)

Semester	Subject Type	Code	Title of the paper	Hrs/Week	Credits	Exam. Hrs	Maximum Marks		
							Internal Assessment	University Examination	Total
Semester III	Core: Compulsory	PGIC-301	Advanced Coordination Chemistry	04	04	03	40	60	100
		PGIC-302	Bioinorganic Chemistry and Heterogeneous Catalysis	04	04	03	40	60	100
		PGIC-303	Inorganic Solid State Chemistry and Inorganic Polymer Chemistry	04	04	03	40	60	100
		PGIC-304	Inorganic Analytical Chemistry	04	04	03	40	60	100
	Skill Enhancement Course	PGSEC 305	Assessment of Water Quality	02	02	03	20	30	50

SEMESTER- IV(Inorganic Chemistry)

Semester IV	Core: Compulsory	PGIC-401	Organometallic Chemistry	04	04	03	40	60	100
		PGIC-402	Material Chemistry and Nanoscience and Nanotechnology Related to Inorganic Systems	04	04	03	40	60	100
Any one from the following: From PGAC-403 to PGAC-405									
Semester IV	Core: Elective#	PGIC-403	Modern Instrumental Techniques for Inorganic Analysis	04	3+1	03	40	60	100
		PGIC-404	Inorganic Pharmaceutical Chemistry	04	3+1	03	40	60	100
		PGIC-405	Applications of Inorganic Chemistry in Agriculture, Environmental Science and Space Science	04	3+1	03	40	60	100
	Core: Compulsory	PGIC-406	Practical Course-I*	02	2+2	06	40	60	100
		PGIC-407	Practical Course-II*	02	2+2	06	40	60	100
		PGIC-408	Research Project OR Practical Course-III*	02	2+2	06	40	60	100

* Examination for practical courses will be conducted at the end of academic year.
# Core Elective Course includes Core: Elective subjects and Industrial project.
Industrial Project includes one day visit, Internet survey, project writing, presentation or oral and be evaluated as the internal marks for Core: Elective Course (PGIC-403, PGIC-404, PGIC-405).

6. SCHEME OF CREDITS: The M.Sc (Analytical/Organic/Inorganic Chemistry) is of 84 credits. The distribution of credits over semesters is given below.

Course Type	Credits	SEM-I	SEM - II	SEM – III	SEM-IV	Total	Examination
		L(pw)	L(pw)	L(pw)	L(pw)	Credits	
Core Compulsory Theory	4	4 60Hrs	4 60Hrs	4 60Hrs	4 60Hrs	16C 240Hrs	University
Core Compulsory Theory-	4	4 60Hrs	4 60Hrs	4 60Hrs	4 60Hrs	16C 240Hrs	University
Core Compulsory Theory-	4	4 60Hrs	4 60Hrs	4 60Hrs	-	12C 180Hrs	University
Core Compulsory Theory-	4	-	4 60Hrs	4 60Hrs	-	8C 120Hrs	University
Core: Elective Theory	3	-	-	-	3 45Hrs	3C 45Hrs	University
Industrial Project	1	-	-	-	1 15Hrs	1C 15Hrs	Institute
Ability Enhancement Course	2	-	2 30Hrs	-	-	2C 30Hrs	University
Skill Enhancement Course	2	-	-	2 30Hrs	-	2C 30Hrs	University
Physical Chemistry Practical	2+2	2 60Hrs	2 60Hrs	-	-	4C 60Hrs	University
Inorganic Chemistry Practical	2+2	2 60Hrs	2 60Hrs	-	-	4C 60Hrs	University
Organic Chemistry Practical	2+2	2 60Hrs	2 60Hrs	-	-	4C 60Hrs	University
Practical Course –I	2+2	-	-	2 60Hrs	2 60Hrs	4C 60Hrs	University
Practical Course-II	2+2	-	-	2 60Hrs	2 60Hrs	4C 60Hrs	University
Practical Course-III OR Project Work	2+2	-	-	2 60Hrs	2 60Hrs	4C 60Hrs	University

Total Required Credits:

Semester	Core Courses	Elective Course	SEC / AECC	Total
I	12	----	----	12
II	28	----	02	30
III	16	----	02	18
IV	20	04	----	24
Grand Total	**76**	**04**	**04**	**84**

10. MEDIUM OF INSTRUCTION:

The medium of instruction and examination shall be English.

11. UNIVERSITY TERMS:

The dates for the commencement and conclusion of the First and the Second terms shall be fixed by the University authorities. The terms can be kept by students, who have registered their names with the University.

12. SCHEME OF EXAMINATION:

The Assessment of Regular students of Master of Science (M.Sc.) course in the academic session 2018-19 and thereafter shall be based on

(a) UniversityExaminations (UE),

(b) Continuous Internal Assessment (IA),

(c) Choice Based Credit System (CBCS), and

(d) Semester Grade Point Average (SGPA) and Cumulative Grade Point Average system (CGPA)

For each paper of 100 marks, there will be Internal Assessment of 40 marks and the University Examination of 60 marks/3 hours duration at the end of each semester. The 04 credit will be given to a student who secures atleast 40% of marks alloted to each paper. A candidate who does not pass the examination in any subject or subjects in one semester will be permitted to reappear in such failed subject or subjects along with the papers of following semesters.

The Internal Assessment (IA) for each paper will be of 40 marks which will be carried out by the department during the term. The Internal Assessment may be in the forms as follows: Attendance, Written tests, seminars, term papers, presentations, assignments, orals or any such others. There will be at least two types of assessments from the types given above.

At the end of each semester, a cumulative grade point average (CGPA) and also Semester grade point average (SGPA) will be calculated as a weighted average of the GPI of all courses in which the student has passed till that semester.

A candidate shall be permitted to proceed from the First Semester up to Fourth Semester irrespective of his/her failure in any of the Semester examinations subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subsequent) semester subjects.

13. Research Project Work:

There will be a Research Project optional for practical course –III to be prepared by a student.The objective of the project work is to introduce students to research methodology in the subject and prepare them for pursuing research in theoretical or experimental or computational areas of the subject. The project work is to be undertaken under guidance of a teacher allotted to a student by the department.

Division of Marks

Internal Assessment :40 Marks

A full Project Report&Viva Voce (University Assessment) : 60 Marks

As the Research Project is based on the self study done by the candidate and evaluated for 100 marks altogether, 04 credits will be awarded to a successful candidate in this subject. The project may be evaluated by three examiners one internal and two external, selected from the panel of PG examiners of the University.

The candidate has to submit the project report before the deadline annouanced by the department. A candidate who fails to submit the project may resubmit the same in the subsequent semester examination for evaluation. The project work activities must be duly supported by documentary evidences to be endorsed by the Head or the Guide.

14. STANDARD OF PASSING:

For all courses, both UE and IA constitute separate heads of passing. In order to pass in such courses and to earn the assigned credits, a student must obtain a minimum grade point of 5.0 (40% marks) at UE and also a minimum grade point of 5.0 (40% marks) at IA.

Even a student fails in IA, he/she shall be declared 'pass' in the course provided he/she obtains a minimum of 25% in IA and GPA for the course is at least 6.0 (50% in aggregate). The GPA for a course will be calculated only if the student passes at the UE.

A student who fails at UE in a course has to reappear only at UE as a backlog candidate and clear the head of passing. Similarly, a student who fails in a course at IA has to reappear only at IA as a backlog candidate and clear the head of passing.

The 10-point scale Grades and Grade Points according to the following table.

Range of Marks (Out of 100)	**Grade**	**Grade Point**
$80 \leq \text{Marks} \leq 100$	O	10
$70 \leq \text{Marks} < 80$	A+	9
$60 \leq \text{Marks} < 70$	A	8
$55 \leq \text{Marks} < 60$	B+	7
$50 \leq \text{Marks} < 55$	B	6
$40 \leq \text{Marks} < 50$	C	5
$\text{Marks} < 40$	D	0

The performances at UE and IA will be combined to obtain the Grade Point Average (GPA) for the course. The weighteg for performance at UE and IA shall be 60% and 40% respectively.

GPA is calculated by adding the UE marks out of 60 and IA marks out of 40. The total marks out of 100 are converted to grade point, which will be the GPA

FORMULA TO CALCULATE GRADE POINTS (GP):

Suppose that '*Max*' is the maximum marks assigned for an examination or evaluation based on which GP will be computed. In order to determine the GP, Set $x = Max / 10$ (since we have adapted 10-point system). Then GP is calculated by the formulas shown as below.

Range of Marks at the evaluation	Formula for the Grade Point
$8x \leq$ Marks $\leq 10x$	10
$5.5x \leq$ Marks $< 8x$	Truncate (Marks/x) +2
$4x \leq$ Marks $< 5.5x$	Truncate (Marks/x) +1

Two kinds of performance indicators, namely, the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA) shall be computed at the end of each term. The SGPA measures the cumulative performance of a student in all the courses in a particular semester, while the CGPA measures the cumulative performance in all courses since his/her enrolment to the course. The CGPA of learner when he/she completes the programme is the final result of the learner.

The SGPA is calculated by the formula SGPA= $\frac{\sum Ck \times GPk}{\sum Ck}$, where C_k is the credit-value assigned to a course and GP_k is the GPA obtained by the student in the course. In the above, the sum is taken over all the courses that the student has undertaken for the study during the semester, including those in which he/she might have failed or those for which he/ she remained absent. The SGPA shall be calculated up to two decimal place accuracy.

The CGPA is calculated by the formula $CGPA=\frac{\sum Ck \times GPk}{\sum Ck}$, where C_k is the credit-value assigned to a course and GP_k is the GPA obtained by the student in the course. In the above, the sum is taken over all the courses that the student has undertaken for the study from the time of his/her enrolment to the course and also during the semester for which CGPA is calculated, including those in which he/she might have failed or those for which he/she remained absent. The CGPA shall be calculated up to two decimals place accuracy.

The Formula to compute equivalent percentage marks for specified CGPA:

% Marks (CGPA) =	10 × CGPA – 10	if 5.00 ≤ CGPA ≤ 6.00
	5 × CGPA+ 20	if 6.00 ≤ CGPA ≤ 8.00
	10 × CGPA – 20	if 8.00 ≤ CGPA ≤ 9.00
	20 × CGPA – 110	if 9.00 ≤ CGPA ≤ 9.50
	40 × CGPA – 300	if 9.50 ≤ CGPA ≤ 10.00

15. AWARD OF HONOURS:

A student who has completed the minimum credits specified for the programme shall be declared to have passed in the programme. The final result will be in terms of letter grade only and is based on the CGPA of all courses studied and passed. The criteria for the award of honours are given below.

Range of CGPA	Final Grade	Performance Descriptor	Equivalent Range of Marks (%)
9.50 ≤CGPA≤ 10.00	O	Outstanding	80 ≤ Marks ≤ 100
9.00 ≤CGPA≤ 9.49	A+	Excellent	70 ≤ Marks < 80
8.00 ≤CGPA≤ 8.99	A	Very Good	60 ≤ Marks < 70
7.00 ≤CGPA≤ 7.99	B+	Good	55 ≤ Marks < 60
6.00 ≤CGPA≤ 6.99	B	Average	50 ≤ Marks < 55
5.00 ≤CGPA≤ 5.99	C	Satisfactory	40 ≤ Marks < 50
CGPA Below 5.00	F	Fail	Marks Below 40

A candidate shall be permitted to proceed further from the First Semester up to Fourth Semester irrespective of his/her failure in any of the Semester examinations subject to the condition that the candidates should register for all the backlog subjects of earlier semesters along with current (subsequent) semester subjects.

15. GRACING:

The gracing shall be done as per existing rules of the University.

16. VERIFICATION AND REVALUATION:

There is provision for verification and revaluation of the result. A student can apply for the verification and revaluation of the result within two weeks from the declaration of the results with the prescribed fee. The verification and revaluation shall be done as per the existing rules of the University.

17. FORMAT OF THE TRANSCRIPT:

The student will be given a transcript indicating his/her performance at the end of every semester examination. The transcript shall be given as per the following table along with other necessary details:

Course No.	Course Name	No. of Credits	University Examination		Internal Assessment		Grade Point Average	Result
			Grade	Grade Point	Grade	Grade Point		
1								
2								
3								
4								
5								
Total Cumulative Credits Completed			SGPA		CGPA		Equivalent Marks (%)	

Note: GPA is calculated by adding the UE marks out of 60 and IA marks out of 40. The total marks out of 100 are converted to Grade Point, which will be the GPA.

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BHARATI VIDYAPEETH
DEEMED UNIVERSITY, PUNE (INDIA)

SYLLABUS OF MASTER OF SCIENCE (CHEMISTRY)

Learning Outcomes based Curriculum Framework (LOCF)
for

M.Sc.I (ANALYTICAL/ORGANIC/INORGANIC CHEMISTRY)

SEMESTER-I

[CBCS- 2018 Course]

TO BE IMPLEMENTED FROM JUNE 2018

M.Sc.I (ANALYTICAL/ORGANIC/INORGANIC CHEMISTRY)
SEMESTER-I
(CBCS-2018 COURSE)

PGCH-101: PHYSICAL CHEMISTRY - I

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Learn second law of thermodynamics and the entropy, Free energy and chemical equilibrium, Maxwell's relation and interrelation of various thermodynamic properties
CO 2 : Discuss techniques for determination of shapes and size of macromolecules, molar mass and viscosity measurements, Adsorption of gases
CO 3 : Measurement of dipole moment and its Applications
CO 4 : Know the Collision Theory, Thermodynamic aspects, Reactive, collisions, Potential energy surfaces.
CO 5 : Understand photochemistry, Photochemical equilibrium, Photosensitization, Flash photolysis, Photo chemistry in life processes
CO 6 : Find out Phases, components and degrees of freedom; Phase rule, Two component system , Three component system

Course Content:

1) **Chemical Thermodynamics**
Second law of thermodynamics and the entropy, concept as state function, change of entropy with temperature and pressure, Entropy at absolute zero, Entropy changes in spontaneous processes, Frees energy and spontaneity, Free energy and chemical equilibrium, Gibbs – Helmholts's equation. Dependence of free energy on temperature, Maxwell's relation and interrelation of various thermodynamic properties, Free energy, enthalpy and entropy of mixing in ideal and non – ideal solutions. Partial molal quantities and their experimental determinations.

2) **A) Structure and Properties of Macromolecules.**
Techniques for determination of shapes and size of macromolecules, use of osmotic pressure to determine the molar mass of macromolecules, Distinction between Number Average and mass average molecular weights, Ultracentrifuge and determination of shape and molar mass of macromolecules from the rate of sedimentation, use of viscosity measurements and light scattering to molar mass and shapes of macromolecules.

B) Adsorption

Adsorption of gases: Physical adsorption and chemisorption, enthalpy of adsorption, adsorption isotherms; determination of surface area; Adsorption of liquid.

3) **Dipole Moment**

Dipole moment or electrical moment, Polarization of molecules in electric field, Polarization of polar molecules in electric field, Measurement of dipole moment, Determination of molecular radius by polarization, Applications of dipole moment (a) Determination of molecular structure (b) Calculation of percentage of ionic character in the bond (c) Calculation of bond angle (d) Determination of symmetry of molecules, Bond length, Bond energy.

4) **Molecular reaction Dynamics**

Collision Theory, Diffusion Controlled Reactions. The reaction coordinate and transition state, Eyring equation, Thermodynamic aspects, Reactive, collisions, Potential energy surfaces.

5)**Photochemistry**

Introduction, Absorption of light, Types of chemical reactions, laws of photo chemistry, Consequences of light absorption: primary and secondary processes, Electronic transitions in molecules, Potential energy curves for primary photo chemical processes, Excited states, Quantum yield, Luminescence of cold light, Photoluminescence, Chemiluminescence, Photochemical equilibrium, Photosensitization, Flash photolysis, Photo chemistry in life processes, Photo conductivity, Photo polymerization, Hot atom reactions, Mechanism of photo chemical reactions.

6) **Phase Rule**

Phases, components and degrees of freedom; Phase rule, Two component system vapour diagrams, temperature – composition diagrams, liquid – liquid phase diagrams, liquid – solid phase diagrams, ultrapurity and controlled impurity; Three component system : trianquilar phase diagrams, partially miscible liquids, the role of added salts. (freezing mixtures, such as NaCl – water-ice, $CaCl_2$–water-ice)

Reference Books:

1) Physical Chemistry, G.M.Barrow, Fifth Edition 1994, Tata McGraw-Hill.
2) Physical Chemistry, P.W.Atkins, Fifth edition 1994, ELBS.
3) Principles of Physical Chemistry, Maron and Prutton, Fourth edition, Macmillan Company.
4) An Introduction to Electrochemistry, S. Glasstone, Affiliated East-West Press Pvt.Ltd.
5) Physical chemistry. R.A. Alberty, R.S.Silby, Johncoilet 1995.
6) Advanced Physical Chemistry, D. N. Bajpai, A. S. Chand Co. Ltd.

Note:- Weightage to the problems 25% weightage should be given to the numerical problems in final question paper setting.

PGCH-102: INORGANIC CHEMISTRY - I

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : To understand structure of atom, The wave equation, particle in a box
CO 2 : Learn types of bonds, Lattice energy and size effects. Valence Band Theory, Symmetry and overlap, Hybridization
CO 3 : Understand types of solids, Band Theory, Intrinsic & photoexcited semiconductors, Impurity & defect semiconductors
CO 4 : Applications of VSEPR theory, molecular orbitals & molecular structure and solved numericals to clear the terms.
CO 5 : Study of Inorganic Chains, Rings, Cages and Clusters
CO 6 : Make aware of chemistry of Halogens & Noble gases

Course Content:

1. **The structure of atom:**

   The wave equation, particle in a box, The Hydrogen atom: Derivation of solutions of θ & ϕ parts, solution of R part, Angular wave functions, symmetry of orbitals, the polyelectronic atom.

2. **Bonding Models:**

   Ionic bond, Lattic energy, size effects, The covalent bond – preliminary approach, Valence Band Theory, Symmetry and overlap, Hybridization, Delocalization, Experimental measurement of charge distribution in Molecules

3. **The solid state:**

   Structures of complex ionic compounds, Imperfections in crystals, conductivity in ionic solids, solids held together by covalent bonding: Types of solids, Band Theory, Intrinsic & photoexcited semiconductors, Impurity & defect semiconductors.

4. **The covalent bond: Structure & Reactivity:**

   Structure of molecules, VSEPR theory, structures of molecules containing lone pairs of electrons, VSEPR rules, molecular orbitals & molecular structure, Hybridization, Bond lengths, Bond multiplicity, Experimental determination of molecular structure.

For topics 1-4, related problems should be solved in the class.

5. **Inorganic Chains, Rings, Cages and Clusters:**
Chains, catenation, Heterocatenation, Isopoly anions, Heteropoly anions, Rings, Borazines, Phosphazenes, Heterocyclic inorganic ring systems, Cages, Boron cage compounds, Boranes, carboranes, Metal clusters, binuclear clusters, trinuclear clusters, octahedral clusters, synthesis of metal clusters.

6. **Chemistry of Halogens & Noble gases** :

Introduction, Chemistry of Noble gases, bonding in noble gas halides, bond strengths in noble gas compounds

Chemistry of halogens, Interhalogen compounds, oxyacids of heavier halogens, Halogen oxides & oxyfluorides, pseudohalogens.

References

1. Theoretical Inorganic chemistry : M.C. Day and J. Selbin. Reinhardt EWAP (1987).
2. Structural Inorganic Chemistry, A.F. Wells, 5th edition (1984).
3. Inorganic Chemistry – Principles of structure and Reactivity: James E.Huheey, Harper and Row publisher Inc. New York, Third edition (1983).
4. Electronic processes in materials : L.V.Azoroff and J.J.Brophy, McGraw Hill publication.
5. Advanced Inorganic chemistry: F.A. Cotton, R.G.Willkinson (Wiely – Eastern).
6. Inorganic chemistry: A.G.Sharpe, ELBS edition (1984).
7. Concise Inorganic chemistry: J.D.Lee, 5th edition, ELBC (1986).

PGCH-103: ORGANIC CHEMISTRY - I

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Understand SN^1, SN^2, SNi, SN1', SN2' &SNi' with respect to mechanism and stereochemistry
CO 2 : Learn concept of Aromaticity, Arenium ion mechanism, orientation and reactivity inaromatic electrophilic substitutions.
CO 3 : Carry out SNAr and Aryne mechanism aromatic nucleophilic substitution
CO 4 : Mechanistic and stereochemical aspects of addition reactions of C-C multiple bonds including allenes,Ionic and free radical additions
CO 5 : Make students to understand E1, E2 & E1cB mechanisms and their orientation
CO 6 : Concept of chirality: Recognition of symmetry elements. enantiomers, diasteromers, racemic modification and their resolution, R/S nomenclature, geometrical isomerism, E & Z nomenclature,
CO 7 : Learn mechanism Rearrangements like Beckmann, Hoffmann, Schmidtetc
CO 8 : Non-Benzenoid Aromatics study

Course Content:

(1) **Aliphatic Nucleophilic substitutions**.

SN1, SN2, SNi, SN1', SN2' & SNi' with respect to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. Ambidient nucleophiles. Neighbouring group participation by σ,π and aromatic ring systems.

(2) **Aromatic Electrophilic Substitutions**.

Introduction, concept of Aromaticity, Arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Halogenation, Friedel – Craft reactions in aromatic systems. Energy profile diagrams. The orthol / para ratio, ipso attack orientation inringsystems, Diazo-Coupling, Jakobsen, Haworth, Henkel and halogen dance reaction.

(3) **Aromatic Nucleophilic Substitution**.

Introduction, specificity of the reactions, SNAr, Aromatic SN1 and Aryne mechanism. Effect of substrate structure, leaving group, attacking group, base & solvent.

(4) **Addition Reaction**

Mechanistic and stereochemical aspects of addition reactions of C-C multiple bonds including allenes,Ionic and free radical additions of halogens , halogen halides & hydration.Electrophilic addition involving Metal ions, Reg io and chemo selectivity, orientation and reactivity,Conjugate addition.

(5) **Elimination Reaction**

The E1, E2 & E1cB mechanisms. Orientation in elimination reactions. Reactivity, effect of substrate structures, attacking base, leaving group, nature of medium and pyrolytic elimination reactions.

(6) **Stereochemistry**.

Concept of chirality: Recognition of symmetry elements and chiral structures, prochiral relationship, enantiomers, diasteromers, racemic modification and their resolution, R/S nomenclature, geometrical isomerism, E & Z nomenclature, conformational analysis of mono and disubstituted cyclohexanes.

(7) **Rearrangements**.

Beckmann, Hoffmann, Schmidt, Curtius, Lossen, Claisen, Fries Benzilic acid, Favorskii and wolf rearrangement.

(8) **Non-Benzenoid Aromatics**.

Huckel's rule and concept of aromaticity, annulenes, heteroannulenes and fullerene (C_{60}).

Reference books.

1) Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill, 1988.
2) Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990.
3) Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976.
4) Stereochemistry of Carbon Compounds by E.L.Eliel, 9th Reprints, Tata – McGraw Hill, 1985.
5) Stereochemistry, Conformations and Mechanism by P.S.Kalsi, Wiley Eastern Ltd., 2nd edition, 1993.
6) Organic Reactions & their mechanism by P.S.Kalsi, 2nd edition, New Age International, 1998.

M.Sc.I (ANALYTICAL/INORGANIC/ORGANIC CHEMISTRY)
SEMESTER-II
(CBCS-2018 COURSE)

PGCH-201: PHYSICAL CHEMISTRY - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Recognize spectroscopy in microwave, Rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines
CO 2 : Study of Vibrating diatomic molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum. rotational and vibrational Raman Spectra
CO 3 : Learn Electronic spectra of diatomic molecules Born-oppenheimer approximation
CO 4 : Make Students aware of the fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy.
CO 5 : Understand Principles and Applications of Mossbauer spectroscopy
CO 6 : Understand concepts of Nuclear and Radiation Chemistry. Applications of Radioisotopes

Course Content:

1) **Microwave Spectroscopy**

Rotation of molecules, Rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines, determination of bond lengths, effect of isotope substitution, non–rigid rotator and its spectrum, Linear polyatomic molecules, symmetric and asymmetric top molecules.

2) **(A) Infra – Red Spectroscopy**

Vibrating diatomic molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, vibration – rotation spectra of carbon –monoxide, determination of force constant and bond strengths, interaction of radiation and vibrations, P, Q and R branches, fundamental vibration and overtone frequencies. Linear molecules, influence nuclear spin, Symmetric top molecules.

(B) Raman Spectroscopy:

Scattering of light and Raman Spectrum, Rayleigh scattering and Raman Effect, Classical and Quantum theory of Raman Effect, Pure rotational Raman Spectra, Linear, Symmetric top and asymmetric top molecules. Vibrational Raman Spectra Raman activity of vibrations, Rule of Mutual Exclusion Overtone and combination vibrations, Vibrational Raman Spectra, Rotational fine structures, Polarization of light

and Raman Effect. Vibration of spherical top molecules structure determination from Raman and Infrared spectra.

3) **Electronic Spectroscopy of Molecules**

Electronic spectra of diatomic molecules Born-oppenheimer approximation, Vibrational coarse structure, Franc-Condon Principle, Dissociation energy and dissociation products, rotational fine structure of electronic and vibrational transition, Fortrat Diagramme. Predisssociation, electronic structure of diatomic molecules, M.O. theory, Shapes of molecular orbitals.

4) **Electron Spin Resonance Spectroscopy:**

Introduction, The position of ESR absorption; the g factor, The fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy.

5) **Mossbauer Spectroscopy:**

Principles of Mossbauer spectroscopy, Applications of Mossbauer spectroscopy, The chemical shift, Quadrupole effects, effect of magnetic field.

Nuclear and Radiation Chemistry

1) **Radioactivity: Recapitulation**: **(06)**

Types of radioactive decay, decay Kinetics Detection and measurement of radiation (G.M. and scintillation counters)

2) **Elements of radiation chemistry:**

Interaction of radiation with matter, passage of neutrons through matter, interaction of y radiation with matter,units for measuring radiation absorption, radiation energy and radiation dosimetry-Fricke dosimeter, Radiolysis of water, Radiolysis of some aqueous solutions

3) **Applications of Radioisotopes:**

Physicochemical constants-Diffusion coefficient, surface area, solubility. Chemical pathways-Kinetic studies (isotope exchange reaction), organic reaction (Fridel craft reaction, oxidation of fumaric acid). Analytical applications-neutron activation analysis, dilution analysis, radiometric titration. Industrial-Radiation gauging, friction and wear out, gamma radiography, Carbon dating

Reference Book

1) Fundamentals of molecular spectroscopy, C.N.Banwell and E.McCasj, Tata McGraw Hill (1994)

2) Elements of Nuclear Chemistry H.J.Arnikar, 4th Edn. Wiley Eastern Ltd.

3) Source book on atomic energy-S.Glasstone (D.Van Nostrand company)
4) Chemical Application of radioisotopes H.J.M.Bowen Buttler and Tanner Ltd.
5) Introduction of Nuclear and Radiochemistry, G. Friedlaunder, T.W.Kennedy and J.M.Miller, John Wiley and sons 2nd Edn.
6) Nuclear Chemistry and its Applications, M.Haissinsky, Addison Welsley Publ. Company.

PGCH-202: INORGANIC CHEMISTRY - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Learn bonding in transition metal complexes, Valence bond theory, Crystal field theory, Molecular orbital theory
CO 2 : Study of structural trends, mononuclear oxocomplexes, polyoxometallates, intermediate oxidation states, metal-metal bonded compounds
CO 3 : Understand reaction mechanisms of d-metal complexes, Ligand substitution reactions. classification & theory of redox reactions, photochemical reactions
CO 4 : Study of structure, properties, reactions and synthesis of d-block carbonyls, Reactivity of d- and f-block organometallic compounds
CO 5 : Introduction, methods of separation and applications of Lanthanides, Actinides
CO 6 : Make aware of energy sources for life, metalloporphyrins, photosynthesis and Respiration, metalloenzymes, Nitrogen fixation basics of bioinorganic chemistry

Course Content:

1. **Coordination Chemistry :**
Introduction, Bonding in transition metal complexes, Valence bond theory, Crystal field theory, Molecular orbital theory. Electronic spectra and magnetic properties of transition metal compounds.

2. **Chemistry of Transition elements:**

Introduction, occurrence & recovery, High oxidation states, structural trends, mononuclear oxocomplexes, polyoxometallates, intermediate oxidation states, metal-metal bonded compounds, noble character.

3. **Reaction mechanisms of d-metal complexes.**

Introduction, Ligand substitution reactions, classification of mechanisms. The substitution of square-planar complexes, substitution of octahedral complexes, Rate

law and their interpretation, Activation of octahedral complexes, stereochemistry, Isomerization reactions, Redox reactions, classification & theory of redox reactions, photochemical reactions, d-d and charge-transfer reactions, Transitions in metal-metal bonded systems.

4. **d – block organometallic compounds:**

Bonding, valence electron count, d-block carbonyls, synthesis of carbonyls, structure, properties and reactions, Hydrogen and open-chain hydrocarbon ligands, cyclic polyene complexes, Reactivity of d-block and f-block organometallic compounds, Metal-metal bonding and metal clusters, structure and syntheses, Reactions of clusters, homogeneous catalysis

5. **f-block elements:**

Lanthaindes: Introduction, methods of separation of Lanthanides, Lanthanide contraction, applications of Lanthanides.

Actindes: Introduction, methods of preparation and separation of actinides, applications of actinides.

Transactinide elements: Introduction, applications of transactinide elements.

6. **Basics of Bioinorganic Chemistry:**

Introduction, Energy sources for life, metalloporphyrins, photosynthesis and Respiration, metalloenzymes, Nitrogen fixation, Biochemistry of Iron, Essential trace elements in biological systems, Biochemistry of non-metals.

Reference:

1. Concise Inorganic chemistry, J.D.Lee, 5th Edition, ELBS (1986).
2. Inorganic Chemistry: A.G.Sharpe, ELBS Edition (1984).
3. Inorganic Chemistry: D.F.Shriver, P.W.Atkins, 3rd Edition, Oxford University press (1999).
4. Inorganic Chemistry - Principles of structure and reactivity: J.E.Huheey, 3rd Edition (1983).
5. Inorganic Chemistry: D.F. Shriver, P.W.Atkins, C.H.Langford, ELBS, Oxford University press (1991).
6. Advanced Inorganic Chemistry: F.A.Cotton, R.G.Wilkinson, John Wiley (1984).
7. Structural Inorganic Chemistry: A.F. Wells, 5th Edition (1984).

PGCH-203: ORGANIC CHEMISTRY - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Learn Oxidation and reduction of organic compounds using variety of reagents
CO 2 : Understand Mechanism & Applications of different name reactions of Perkin, Michael, Mannich, Stobbe condensationetc
CO 3 : Determine and study of preparation of stabilized and destabilized 'P' and 'S' ylids. Their Reactions, applications
CO 4 : Study of organomettalics of Mg, Li, Zn and Ti with applications
CO 5 : Study and solve problems of Ultraviolet and Visible spectroscopy of organic molecules
CO 6 : Understand Infrared spectroscopy and its applications to structural problems.
CO 7 : Important terms and theory of Nuclear Magnetic Resonance spectroscopy. Its applications to structural problems.
CO 8 : Principle, working of Mass spectrometer, formation of different ions, Mclafferty rearrangement, fragmentation of alkanes, alkyl aromatics, alcohols, ketones and applications
CO 9 : Problems solved based on UV,IR, NMR & MS Spectroscopy to interpret structure.

Course Content:

(1) **Oxidation – Reduction**

Oxidation:-

(A) Olefin:- Alkaline KM_nO_4, OsO_4, Peracid, H_2O_2 and NaOH
(B) Alcohol:- Jone's reagent, Collin's reagent, MnO_2 and Oppenauer oxidation.
(C) Glycol – LTA.
(D) Ketone:- Baeyer –Villiger oxidation and SeO_2.

Reduction:-

$LiAlH_4$, $NaBH_4$, Clemmenson's reduction, Wolf Kishner reduction, Birch, Lindlar and MPV.

(2) **Name Reactions.**

Mechanism & Applications of –:
Perkin, Michael, Mannich, Stobbe condensation, Dieckmann Condensation, Vilsmayer, Dakin & Gatteamann – Koch.

(3) **Phosphorous & sulfur ylids**.

Preparation of stabilized and destabilized 'P' and 'S' ylids. Reactions, applications, stereochemistry and Emmons modification.

(4) **Organometallics**.
Mg, Li, Zn and Tl with applications.

(5) **Ultraviolet and Visible spectroscopy (UV-VIS).**

Introduction, Beer Lamberts law, instrumentation, Calculation for absorptron maxima of dienes, enones and aromatic ketones, Applications.

(6) **Infrared spectroscopy (IR).**

Introduction, instrumentation, Sampling technique selection rule, types of bonds,absorption of common functional groups, Factors affecting IR frequencies. Application to structural problems.

(7) **Nuclear Magnetic Resonance spectroscopy (NMR).**

Magnetic & non-magnetic nuclei, Larmor frequency, absorption of radio frequency,sample preparation, chemical shift, anisotropic effects, spin–
spin coupling, couplingconstants,applicationstostructural problems.

(8) **Mass spectroscopy (MS).**
Principle, working of Mass spectrometer, formation of different ions, Mclafferty rearrangement, fragmentation of alkanes, alkyl aromatics, alcohols, ketones and applications. Simple structural problems based on IR, UV, NMR and MS.

(9) **Problems based on UV,IR, NMR & MS Spectroscopy**.

Reference Books

1) Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill, 1988.
2) Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990.
3) Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976.
4) Spectroscopic methods in organic chemistry by Williams & Fleming, Tata – McGraw Hill, 4th edition, 1988.
5) Spectroscopy of organic Compounds by P.S.Kalsi, New Age International, 2nd edition, 1995.
6) Spectroscopic Identification of organic compounds by R.M.Silverstein and G.C.Bassler, 5th edition, 1991.

PGCH-204: FUNDAMENTALS OF ANALYTICAL CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

Unit-I

CO 1 : Role of analytical chemistry,Types of instrumental analysis. Selecting an analytical method. Laboratory operations and practices.

CO 2 : Statistical Analysis, Collection, treatment and presentation of analytical data in different forms

Unit-II

CO 1 : General principles, Classification, Techniques and applications of Chromatography

CO 2 : Basic principles, Significance of various terms and Techniques ofSolvent Extraction

Unit-III

CO 1 : Learn Spectrophotometry and Colorimetry, Applications of quantitative and qualitative analysis, Problems

CO 2 : Understand Instrumentation, experimental techniques, Interferences, analytical applications of AAS and FES

Unit-IV

CO 1 : origin of waste water, types, water pollutants and their effects. Measurements of DO, BOD, COD and their significance as pollution indicators

CO 2 : Make aware of Greenhouse effect, Sources of air pollution, air quality standards and sampling. Analysis of air pollutants

Unit-V

CO 1 : Learn Cell Structure and its Functions. building blocks of bio-macromolecules proteins, enzymes, DNA and RNA

CO 2 : Learn Chemical and enzymiatic hydrolysis of proteins to peptides, amino acid sequencing

CO 3 : Understand these Nucleic Acids and Chemical and enzymatic hydrolysis. Structure and function of RNA and DNA.

Unit-VI

CO 1 : Basic structure and functioning of computers. Introduction to UNIX and WINDOWS. Data processing.

CO 2 : Development of small computer codes involving simple formulae in chemistry, such as Vander Waal's equation, pH titration, kinetics, radioactive decay.

Course Content:

Unit-I

A Role of analytical chemistry, classification of analytical methods classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Laboratory operations and practices. Analytical balances (Semmicro and Micro balance) and their use in analytical chemistry. Techniques of weighing and errors. Volumetric glassware – cleaning and calibration of glassware. Methods of sampling,

Problems associated with Stoichiometric calculations based on gravimetry and titrimetry analysis of commercial samples. Transmission and storage of samples. Effects of sampling uncertainties samplers responsibility, sampling hazards.

B Statistical Analysis: (Emphasis should be placed on numerical problems) Collection, treatment and presentation of analytical data. True, standard and observed value. Definition of terms in mean and median. Errors in Chemical analysis, classification of errors, nature and origin of errors. Accuracy and precision. Average deviation and standard deviation and its physical significance. Normal Distribution curve and its properties. Co-efficient of variation. Confidence burt and probabiulity. Probability theorem, Probability curves, Comparison of analytical results. Tests for rejection of data. T-Test, F-test and Q-Test Significant figures and computation rules. Least squares method for deriving calibration graph. Curve fitting, Correlation co-efficient Limit of detection. Regression analysis and Statistical analysis of Chemical analysis.

Unit-II

Modern methods of separation:

A. Chromatography : General principles, Classification, Partition Chromatography, Adsorption Chromatography. Principles, Techniques and applications of Paper, Thin-Layer, Column, HPLC, Gas Chromatography and Electro Chromatography.

B. Ion-Exchange : Cation and Anion exchangers, Action of ion exchange resins. Ion-exchange equilibria and ion exchange capacity. Strongly and weakly acidic cation exchangers. Strongly and weakly basic anion exchangers. Liquid ion exchangers, chelating ion exchangers, techniques of ion exchange and application in analytical Chemistry. Separation using solvent mixtures.

C. Solvent Extraction: Basic principles, Significance of various terms. Classification, Factors favouring solvent extraction, Extraction equilibria. Synergetic effects, ion-pair extraction, salting out effect and stripping. Techniques of extraction by high molecular weight amines i.e. crown ethers, cryptands and calixarenes.

Unit-III

Optical Methods:

A. Spectrophotometry and Colorimetry. Interaction of radiations with matter, Fundamental laws of Spectrophotometry. Beer – Lambert's law and its limitations Verification of Beer's law and deviation fromBeer's law. Choice of solvent. Ringbom's plot. Photometric titrations. Pk value of indicator. Outline of construction and working of the UV – Visible spectrophotometers. (Single and double beam). Applications of quantitative and qualitative analysis, Problems. Theory, instrumentation and applications of fluorimetry, turbidimetry and Nephelometry.

B. Flame Emission and atomic spectrometry :

Flame photometry : Elementary theory of flame photometry, instrumentation and experimental techniques. Interferences, analytical techniques and applications Atomic Absorption Spectrometry (AAS); Introduction, Principle, Advantages of AAs over FES, Instrumentation, Flame atomization. Hollow cathod lamps, intereferences and applications.

Unit-IV

Environmental Chemistry:

A. Water pollution: origin of waste water, types, water pollutants and their effects. Sources of water pollution, domestic, industrial agricultural soil and radioactive wastes as sources of pollution.

Objectives of analysis, parameter for analysis colour, conductivity, acidity, alkalinity, hardness, chloride, sulphate, Fluoride, Silica, Phosphates and different forms of nitrogen. Heavy metal pollution

Public health significance of Lead, Manganese, Mercury and Arsenic. General survey of instrumental technique for water and aquatic life. Measurements of DO, BOD, COD and their significance as pollution indicators, Pesticides as water pollutants

B. Air Pollution: green house effect, Sources of air pollution, air quality standards and sampling. Analysis of air pollutants (CO, No_x, So_x and Hydrocarbons and particulates) Effects of air pollution, Acid rain, Photochemical smog and air pollution control.

Unit-V :

A. Cell Structure and Functions:

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their comparison. Origin of life-unique properties of carbon, chemical evolution and rise of living systems. Introduction of biomolecular, building blocks of bio-macromolecules proteins, enzymes, DNA and RNA). Helix coil transition.

B. Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Roll of sugars in biological recognition. Blood group substances. Ascorbic acid (Carbohydrate metabolism – Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphates pathway].

C. A mino-acids, Peptides and Proteins
Chemical and enzymiatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, a-helix, b-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of proteinfolding and domain structure. Quaternary structure.

Amino acid metabolism–degradation and hiosynthesis of amino acids, sequence determination. Chemical/enzymatic/mass spectral, recemiozation / detection.

D. Nucleic Acids.

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic Acids (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code.

Unit-VI :

A. Introduction to computers and computing.

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage. Computer Languages. Operating system with DOS as an example. Introduction to UNIX and WINDOWS. Data processing, principles of programming. Algorithms and flow-charts.

B. Programming in Chemistry.

Development of small computer codes involving simple formulae in chemistry, such as Vander Waal's equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy from experimental data. Linear simultaneous equation to solve secular equation within the Hockle theory. Elementary structural features such as bond lengths, bond angles of molecules extracted from data base such as Cambridge data base.

References:

1. Modern Spectroscopy – J.M.Hollas, John Wiley.
2. Applied Electron Specteroscopy for Chemical Analysis Ed.H.Windawi & F.L.Wo.Wiley Interscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V.Parish, Ellis Harwood.
4. Physical Methods in Chemistry – R.S.Drago, Saunders College.
5. Chemical Applications of Group Theory – F.A. Cotton.
6. Introduction to molecular Spectroscopy – G.M.Barrow, McGraw Hill.
7. Text book of Biochemistry, E.S.West; W.R.Todd; H.S.Mason, J.T.V.Bruggen oxford & IBH publishing co.pvt. Ltd.
8. Principles of Biochemistry, A.L.Lehniger, Worth Publisher.
9. Biochemistry, J.David Rawn, Neil Patterson.
10. Biochemistry, L.Stryer, W.H.Freeman.
11. Biochemistry, Vote and Voet, John Wiley.
12. Outlines of Biochemistry, E.E.Conn and P.K.Stmpf, John Wiley.
13. Environmental Chemistry, S.E.Manahan, Lewis Publishers.
14. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
15. Environmental Chemistry, A.K.De, Wiley Eastern.
16. Environmental Pollution Analysis, S.M.Khopkar, Wiley Eastern.
17. Environmental Toxicology, Ed. J.Rose, Gordon and Breach Science Publication.

18. Elemental Analysis of Airborne Particles, Ed.S.Landberger and M.Creatchman, Gordon and breach Science Publication.
19. Atmospheric Pollution, W.Buch, McGraw Hill, New York.
20. Fundamentals of Air Pollution, S.J.Williamson, Addison – Wesley Publishers.
21. Analytical Aspect of Environmental Chemistry, D.F.S.Natusch and P.K.Hopke, Hohn Willey & Sons. New York.
22. Analytical Chemistry – Problems and Solution – S.M.Khopkar, New Age International Publication.
23. Day & Underwood : Quantitative Analysis (Prentice Hall India Limited).
24. Findley: Practical Physical Chemistry:
25. A.I.Vogel A text book of quantitative inorganic Chemistry, ELBS, London.
26. Strouts Galfillal: Analytical Chemistry (Clarendon Press).
27. Yu.Lyalikov: Physicochemical Analysis (Mir Publishers).
28. Strouts Wilson & Parry Jones: Chemical Analysis Vol.I (Clarendon Press).
29. Meite4s and Thomas: Advanceds Analytical Chemistry, (McGraw Hill).
30. Willard Merritt and Dean: Instrumental methods of Analysis (Can Nostrand).
31. B.L.Kraayer, H.H.Willard, L.Merrit, J.A.Dean & F.A.Settle: Instrumental Methods of Analysis (CBS Pulishers, Delhi, 1986).
32. L.R.Shyder & C.H.Harvath: An Introduction to Separation Science (Wiley Interscience).
33. R.D.Brown Instrumental Methods of Chemical Analysis (Tata McGra Hill).
34. F.J.Wicher Robert : Standard Methods of Chemical Analysis.
35. Dr.G.L.David Krupadanam, D.Vijay Prasad, K.Varaprasad Rao, KLN. Reddy, C.Sudhakar, Analytical Chemistry.

N.B.: Select any two units.

M.Sc.I (ANALYTICAL/INORGANIC/ORGANIC CHEMISTRY)
(CBCS-2018 COURSE)

(SEMESTER-I & II)

PGCH-206: PHYSICAL CHEMISTRY PRACTICAL 2Credits

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Calculate molar and normal solution of various concentrations. Analysis of a given binary mixture by colorimetry
CO 2 : Find out the acidity, Basicity and PKa Value on pH meter.
CO 3 : Determination of ionic product of water and Titration of a mixture by conductometrically.
CO 4 : Study the stability of complex ion and stranded free energy change and equilibrium constant by potentiometry.
CO 5 : Study the energy of activation and second order reaction
CO 6 : Determine the half wave potential and unknown concentration of ion polargraphically.
CO 7 : Illustrate the experiment of non instrumental methods like chemical kinetics,

viscosity, partial molar volume and steam distillation.

A) **Colorimetry**

1. pk Value of an acid base indicator.
2. Analysis of a given binary mixture by colorimetry.
3. Copper – EDTA Photometric Titration.

B) **pH Metry**

4. Hydrolysis of metal ions by pH – metry.
5. Determination of the acid and base dissociation constants of an amino acid and hence the isolectric point of the acid.
6. Dissociation constant of a weak acid using Henderson's equation.
7. Titration of a tribasic acid (Phosphoric acid) against sodium hydroxide and determination of pka values.

C) **Conductometry**

8. Determination of ionic product of water conductometrically.
9. Hydrolysis of Sodium Acetate/Aniline Hydrochloride.
10. Titration of a mixture of a Strong Acid & Weak acid against a Strong base.

D) **Potentiometry**

11. Determination of ionic product of water potentiometrically.
12. Solubility of sparingly soluble salt.
13. Esttimation of halide in a mixture
14. Determination of the dissociation constant of monobasic 1 dibasic acid by Albert – Serjeant method.

E) **Chemical Kinetics**

15. Bronsted primary salt effect.
16. Calculation of energy of activation by clock reaction of reaction between potassium Persulphate and potassium iodide.
17. Kinetics of iodination of acetone / aniline by colorimetry.
18. Determination of an order of a reaction between potassium persulphate and potassium iodide.

F) **Polarography**

19. Determine the half wave potential and unknown concentration of ion polargraphically.

G) **Noninstrumental**

20. Determination of surface area of given sample (Industrial pigment) by B.E.T method.

21. Radius of glycerol molecule by viscosity measurements.
22. Latent heat of fusion of naphthalene in Benzene / Toluene.
23. Heat of ionization.
24. To determine molecular weight of given organic liquid by steam distillation method.
25. Freundich and Langmuir isotherms for adsorption of acetic acid on charcoal.
26. Statistical Treatment of experimental data.

Each candidate should perform a minimum of 18 experiments with at least one experiment from each technique.

References

1) Practical Physical Chemistry, A. Finday, T.A. Kitchnner (Longmans, Green and Co.)

2) Experiments in Physical Chemistry J.M.Wilson, K.J.Newcomble, A.R.Denko, R.M.W. Richett (Pergamon Press).

3) Senior Practical Physical Chemistry, B.D.Khosla and V.S.Garg (R.Chand and Co., Delhi).

4) Advanced Practical in Physical Chemistry, Pande Datar Bhadance, Manali Prakashan.

PGCH-207: INORGANIC CHEMISTRY PRACTICAL 2Credits

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Study the gravimetric and volumetric analysis of ores and alloy.
CO 2 : Prepare and characterize various inorganic complexes and determine its % purity.
CO 3 : To understand the chromatographic techniques.
CO 4 : Learn to calculate and understand equilibrium constant, Simultaneous determination and Effect of Temperature, time and pH on the stability of M-L systems by Colorimetry
CO 5 : Study experiments based on Thermochemistry
CO 6 : Complexometric determination using potentiometry, analysis and interpretation learn

I. **Ore Analysis (any two of the following):**

1) Determination of Mn from pyrolusite by a) gravimetric & b) volumetric methods.

2) Determination of Fe from haematite by a) gravimetric & b) volumetric methods

3) Determination of Cu from chalcopyrite by a) gravimetric & b) volumetric method.

4) Determination of Ti from ilmenite by a) gravimetric & b) volumetric methods

II. Alloy Analysis (any two of the following)

1) Determination of Tin and Lead from solder.
2) Determination of Copper & Nickel from cupronickel.
3) Determination of Chromium & Nickel from nichrome.

III. Preparation and characterization of inorganic compounds by physical or chemical methods (any five of the following)

1. Reinecke's salt.
2. Potassium trisoxalato aluminate (III).
3. Potassium trisoxalato ferrate (III).
4. Trisethylene diammine nickel (II) thiosulphate.
5. Tristhiourea copper (I) chloride.
6. Potassium trisoxalato manganate (III).
7. Chloropentammine cobalt (III) chloride.

IV. Colorimetry (two of the following)

1. Equilibrium constant for M-L systems such as

   (i) Fe (III) – Salicylic acid.
   (ii) Fe (III) – Sulphosalicylic acid.
   (iii) Fe (III) – β – resorcilic acid

   By Job's method and mole – ratio method.

2. Determination of

   (i) Ni^{+2} with Dimethyl glyoxime.
   (ii) Ti^{+4} with Hydrogen peroxide.
   (iii) Simultaneous determination of the following (any two).

   (a) Cr^{+6} and Mn^{+7} from given mixture.
   (b) Ti^{+4} and V^{+5} from given mixture.
   (c) Co^{+2} and Ni^{+2} from given mixture.

3. Effect of Temperature, time and pH on the stability of M-L systems such as

(i) Fe (III) – Sulphosalicylic acid.
(ii) Co (II) – R – Nitroso salt.
(iii) Fe (III) – thiocyanate.

4. Effect of impurity on Beer's law for

(i) Ni^{+2} on Co^{+2} – R – Nitroso salt.
(ii) Fe^{+3} on V^{+5} – Hydrogen peroxide.
(iii) Cu^{+2} on Fe^{+3} – Sulphosalicylic acid.

5. Photometric titrations such as

(i) Cu^{+2} – EDTA.
(ii) Fe^{+3} – sulphosalicylic acid.
(iii) Co^{+2} – R – nitroso salt.
(iv) Ni^{+2} – ethylenediammine.

V. Thermochemistry (any two of the following).

1. Lattice energy of binary salts by heat of dissolution systems such as $CaCl_2$, $CuCl_2$, $MnCl_2$, $CoCl_2$, $NiCl_2$.
2. Thermometric titrimetry of M – L systems such as

(i) Cu (II) – ammonia.
(ii) Hg (II) – iodide.
(iii) Ni (II) – EDTA.

3. Spectrochemical series: Systems such as

(i) Cu (II), Ni (II), Co (II) with conc. HCl, ammonia, EDTA.

VI. Potentiometry (any one of the following) :

1. Complexometric determination using disodium – EDTA of

(i) Ni (II)
(ii) Co (II)
(iii) Al (III)
(iv) Cu (II).

2. Determination of Zn with K_4 [Fe $(CN)_6$].

VII. Conductometry (any one of the following:

1. Electrolytic nature of transition metal compounds such as $[Co(NH_3)_6]$. Cl_3; K_3 $[Co(NO_3)_6]$; K_3 [Al $(C_2O_4)_3$].
2. Conductometric titration of H_3PO_4 with NaOH.

Reference :-

1. A test-book of quantitative inorganic analysis : A.I.Vogel, ELBS, 4th Edition.
2. Instrumental methods of analysis: H.H. Willard, J.A. Dean & L.L. Merit. (CBS).
3. Instrumental methods of analysis: Chatwal and Anand.
4. Principles of Instrumental analysis: D.Skoog and D.West.

PGCH-208: ORGANIC CHEMISTRY PRACTICAL 2Credits

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Summarize the purification technique, separation and identification technique i.e. Recrystallization, distillation fractional distillation, chromatography and solvent extraction are used for all types of organic compound.
CO 2 : Analyze the preparation process such as nitration, oxidation and reduction, esterification, and chalcone formation
CO 3 : Preparation of organic compounds and derivatives, their purifications and run TLC
CO 4 : Judge the reaction mechanism and synthesis process.
CO 5 : Determination of physical constant: Melting point, Boiling point.
CO 6 : Learn and understand different separation techniques.

Content:

(1) Techniques:- Crystallisation, fractional crystallization, simple distillation, fractional distillation, vacuum distillation, steam distillation, sublimation and TLC.
(2) Derivatives:- 2,4 DNP, Semicarbazone, Acetyl and Oxime.
(3) Single stage preparations. (Any five)

(i) Benzaldehyde to Cinnamic acid.
(ii) Benzil to Benzilic acid.
(iii) Benzoin to Benzil.
(iv) Cyclohexanol to Cyclohexanone.
(v) Phthalimide to Anthranilic acid.
(vi) Benzoic acid to Benzamide.
(vii) Cyclohexanone to Adipic acid.
(viii) Nitrobenzene to Aniline.

(4) Two stage preparations (Any three)

(i) Cyclohexanone $\longrightarrow$ oxime $\longrightarrow$ Caprolactum.
(ii) Nitrobenzene $\longrightarrow$ m-dinitrobenzene $\longrightarrow$ m-nitroaniline.
(iii) Aniline $\longrightarrow$ benzenediazonium chloride $\longrightarrow$ Iodobenzene.

(iv) Benzaldehyde ⟶ chalcone ⟶ Epoxide.

(v) Chlorobenzene ⟶ 2,4 dinitrochlorobezene ⟶ 2,4 dinitrophenol.

(5) Binary mixtures (Ether separation only) (Any six).

Separation & characterization of two Components.

Solid –Solid, Solid – Liquid, Liquid – Liquid (non-volatile)

(6) Computer applications: (1) Conformational energetics of simple organic molecules through molecular mechanics force fields.
(2) Insights for reaction mechanisms of simple SN1 and SN2 reactions.

Reference Books –

1) A text-book of practical organic chemistry by A.I.Vogel,4th edition, ELBS / Longman.
2) A hand book of quantitative and qualitative analysis by H.T.Clarke, Orient Longman.
3) Practical organic chemistry by Mann and Saunders.
4) Practical organic chemistry by O.P.Agarwal.

PGAEC-209: SCIENTIFIC WRITING

Total Credits: 02 **Total Lectures: 30Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 Learn to write different scientific documents
CO 2 Understand report writing of project work, presentations
CO 3 Learn writing of paper as per format

Course Content:

UNIT I: General aspects.

Organising time, Organizing information and ideas eg. writing - adopting a scientific style, Developing technique, Getting Started Revising your text with

the help of words and phrases, sentences, paragraphs, using dictionaries, using a thesaurus, using guides for written English.

UNIT II: Review writing

Organizing time, making a plan Construct possible content and examples, construct an outline, Start writing, Reviewing your write-up.

UNIT III: Reporting practical and project work

Practical & project reports Thesis Structure of reports of experiment works - Title, Authors & their institution, Abstract Summary, List of Contents. Abbreviations, Introduction, Materials and Methods Results Discussion / conclusions, Acknowledgements, Literature cited (Bibliography) Production of a practical report choose the experiment, make up plants, write, Revise, prepare final version. Submit Producing a Scientific paper Assessing potential content, choosing a journal, writing, submitting. Responding to referees comments checking proofs & waiting for publication.

UNIT IV: Writing literature surveys

Selecting a topic Scanning the literature and organizing references, Deciding on Structure and content Introduction, Main body of the text, conclusion, References, Style of literature surveys.

UNIT V: Organizing a poster display

Preliminaries, Design, Layout, Title Text, Sub titles and headings, Colour Content. Introduction, Materials and Methods, Results and conslusion. The poster session.

UNIT VI: Giving an oral presentation.

Preparation - Preliminary information, Audio - Visual aids, Audience. Content - Introductory remarks, the main message. Concluding remarks on presentation.

UNIT VII: Writing research paper:

Title, Authors and address, Abstract, Key words, Introduction, Materials and Methods, Results & Discussion / conclusions, Acknowledgements, Literature cited (Bibliography)

Literature Cited

1. Day Robert A. : How to write and publish a scientific paper.
2. Gibaldi Joseph: MLA handbook for Writers of Research Papers.
3. Kothari R. C. : Research Methodology, Methods and Techniques, 2nd revised edition, New Age International.
4. Ranjit Kumar: Research Methodology.

BHARATI VIDYAPEETH
DEEMED UNIVERSITY, PUNE (INDIA)

SYLLABUS OF MASTER OF SCIENCE (CHEMISTRY)

Learning Outcomes based Curriculum Framework (LOCF)
for

M.Sc.II (ANALYTICAL CHEMISTRY)

SEMESTER-III

[CBCS- 2018 Course]

TO BE IMPLEMENTED FROM JUNE 2018

M.Sc.II (ANALYTICAL HEMISTRY)

SEMESTER-III

PGAC- 301 : THERMAL, RADIO AND ELECTROANALYTICALMETHODS

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : To study polarography and advancement in polarography.
CO 2 : Study of voltametry method of analysis
CO 3 : Study of coulometry with its limitations and applications
CO 4 : Study of amperometry and their applications
CO 5 : To know about radioanalytical methods of analysis and their principles and applications.
CO 6 : To know about thermal methods of analysis like TGA, DTA and DSC.
CO 7 : To understand spectroelectrochemistry and their applications

Course Content:

1) Introduction to Electroanalytical methods:

A) Classical polarography:
Principles, construction and working of DME, polarographic wave, Factors affecting the wave, role of supporting electrolyte, maxima suppressor and N_2 flushing, Applications.

B) Advancements in polarography:
Electrodes, excitation signals, DC polarography pulse and differential pulse polarography, square wave polarography.

2) Voltametry:
Principles, instrumentation, linear sweep voltammetry, hydrodynamic and cyclic voltammetry, Stripping voltammetry, applications.

3) Coulometry:
Theory, principles, Instrumentation, various coulometers, coulometric titrations, advantages, limitations and applications.

4) Amperometry:
Principles, instrumentation, amperometric titrations, applications.

5) Radioanalytical methods of analysis :
a) Neutron activation analysis, principle, technique, steps involved in neutron

activation analysis. Radiochemical and instrumental methods of analysis, important applications of NAA.

b) Isotope dilution analysis-principle and types of isotope dilution analysis. Typical applications of isotope dilution analysis.

c) Radiometric titrations–principle and techniques based on complex formation and precipitation, Radiometric titration curves for estimation of ions from their mixture.

6) Thermal Methods of Analysis :

Effect of heat on Materials, Chemical decomposition and TG curves, Analysis of TG curve to show nature of decomposition reactions , the product and qualities of compounds expelled, applications, instrumentation , TG in controlled atmosphere DTA: instrumentation and Methodology, applications, DSC: theory, instrumentation and applications, Thermometric titrations and applications.

7) Spectroelectrochemistry:

Principle and applications of spectroelectrochemistry and chemically modified electrodes and electrochemical sensors.

Reference Books:

1) Introduction to instrumental analysis - By R. D. Braun McGraw Hill (1987).

2) Instrumental methods of chemical analysis - By H.H. Willard, L.L. Merrit, Jr. J.A. Dean and F.A. Settle Jr. Sixth Edition CBS (1986).

3) Thermal analysis - By W.W. Wendlandt, John Willy, N.Y. (1986).

4) Fundamentals of analytical chemistry - By D.A. Skoog, D.M. West and H.J. Holler, Sixth Edition (1992).

5) Cyclic Voltametry and Frontiers of electrochemistry - By N. Noel and K.I. Vasu, IBH, New Delhi (1990).

6) Essentials of Nuclear Chemistry, H. J. Arnikar, Wilay Eastern Limited, Fourth edition (1995).

7) Principles of Instrumental Analysis, D.A. Skoog, F.J. Holler and J.A. Nieman, Fifth Edition, Saunders College Publishers (1998).

PGAC- 302 : MODERN ASPECTS OF ANALYTICAL CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

CO 1 : To study about RC and LC circuits, Ohms Law, Krichhoffs Law, Faradays Laws of electrolysis and its applications.
CO 2 : To learn about semiconductors and its aspects.
CO 3 : To learn about amplifiers, NPN and PNP transistors.
CO 4 : To understand digital electronics in brief
CO 5 : To know about minerals and ores like ilmenite, monazite, chalcopyrite etc.
CO 6 : To study about analysis of steels.
CO 7 : To study the analysis of copper based alloys.
CO 8 : To know about estimation of micronutrients, nitrogen, phosphorus, potassium etc, from fertilizer samples
CO 9 : To understand analysis of cement and its aspects.

Course Content:

A) Electronics in Chemical Instrumentation.

1) Introduction to Components :

Resistors, capacitors, inductors, transformers, charging and discharging of condensers, LC and RC circuits, parallel circuits, Ohm's law. Kirchhoff's law, Faradays laws of electrolysis and its applications.

2) Semiconductors :

Classification of semiconductors on the basis of band theory, Intrinsic and Extrinsic semiconductors, p-n junctions, basic principles of operations, p-n diode and its applications, Zener diode and its use in voltage regulation. Light emitting diodes, photodiodes and photo resistors.

3) Amplifiers :

Classification of amplifiers depending on coupling, mode of operation and frequency response NPN and PNP transistors.

4) Digital electronics:

Binary number, Decimal number and their conversion Binary addition of 4 bit number, logic gates, AND, OR, NOT, NAND, NOR, block diagram of computer, modem PC specification, IC (integrated circuits), classification, characteristic of ICS.

B) Modern Techniques of Analysis of Selected Inorganic Materials :

5) Analysis of Minerals and Ores:

Principles underlying the separation and determination of constituents of minerals and ores like chalcopyrite, ilmenite, monazite, etc.

6) Analysis of steels:

Analysis of steels for the determination of elements like carbon, sulphur, silicon, phosphorus, boron, chromium, tungsten, molybdenum, vanadium, nickel, etc.

7) Analysis of copper based alloys :

Alloys such as brass, bronze, gun metal, etc.

8) Analysis of Fertilizers:

Estimation of macronutrients, nitrogen, phosphorus, potassium from fertilizer samples. Estimation of micronutrients like boron, manganese, zinc and molybdenum.

9) Analysis of cement :

Introduction, composition and ingredients in cement. Principles in the analysis of cement. Analysis of silica, calcium, iron etc. by different methods of analysis.

Reference Books:

1) Introduction to chemical Analysis - By R.D. Braun, McGraw Hill 1987.

2) Instrumental Methods of Analysis - By H.H. Willard, L.L. Merritt Jr, J. A. Dean and F.A. Settle Jr. 6th Edition, CBS publishers and distributors (1986).

3) Principles of Instrumental Analysis - By D.A. Skoog, F.J.Holler and T.A.Nieman, 5th edition, Saundess College Publishers.

4) Voegel's Textbook of Quantitative Chemical analysis, Fifth edition - By G.H.Jeffery, J. Basset, J. Mendham and R.C. Denney, ELBS (1997).

5) Standard methods of chemicals analysis
F.J. Welcher - Sixth edition, Volume two - Part-B.
Robert E. Krieger publishing company, Malabar, Florida, (1975).

6) Standard methods of chemical analysis :
F.J. Welcher - Sixth edition, Volume three - Part-B.
Robert E. Krieger publishing company, Malabar, Florida (1975).

7) Digital electronics by Malvino.

8) Fundamentals of electronics – U. K. Mehata.

PGAC- 303 : RECENT ANALYTICAL TECHNIQUES
Total Credits-04 Total Lectures – 60Hrs

Course learning outcomes

CO 1 : To study and understand about electromagnetic radiation, analysis of EMR, laser based techniques in analytical spectroscopy
CO 2 : Study in brief Atomic absorption spectroscopy and their aspects
CO 3 : Study in brief mass spectroscopy, MS- MS principle and its applications.
CO 4 : To know about methods of clinical analysis in body fluids and human nutrition
CO 5 : Learn and understand automated analysis.
CO 6 : Study the analysis of degradation of alcohol suitable material, sulphonated and unsulphonated material.

Course Content:

1. Analytical Spectroscopy

I. Electromagnetic radiation, properties, interaction of radiation with matter, classification of analytical methods based on EMR spectrum.

II. Instrumentation: Sources of radiations, monochromators, sample containers, detectors for various types of radiations.

III. Types of Analysis of EMR : Absorption, Beer's law, Deviations from Beer's law; instrumental causes for deviations from Beer's law; instrumental noise, chemical causes for deviations from Beer's law.

IV. Laser Based Technique: Atomic fluorescence spectroscopy, resonance ionization spectroscopy, laser enhanced ionization, principle, types of transition tunable laser, classification of medium pumping and controlling mechanism, instrumentation, detecting of various gases, liquid and solids, sources, cell, monochromators, detector.

2. Atomic Absorption Spectroscopy

Theory, sources, burners, atomic emission spectra, atomic absorption spectra, effect of temperature on emission, absorption and fluorescence, electrothermal atomizers, radiation sources for atomic absorption methods, Instrumentation for AAS, spectral interferences, applications in Industry.

3. Mass Spectroscopy

Inductively coupled plasma and direct current plasma emission spectroscopy. Atomic and molecular mass spectrometry including ICP-MS and tandem mass spectroscopy, MS-MS principle, instrumentation, applications.

4. Methods of Clinical Analysis :

1) Body fluids :

Composition and detection of abnormal levels of certain constituents

leading to diagnosis of diseases. Analysis of Physiological fluids - urine, blood and serum, physiological and nutritional significance of water soluble and fat-soluble vitamins, minerals, analytical techniques for vitamins including microbiological techniques.

2) Human - nutrition :

Estimation of enzymes, carbohydrates, essential amino acids, proteins and lipids.

Automated Analysis :

Automated laboratory analysis, computerization, automated laboratory apparatus - continuous flow analyzers, flow injection analyzers, discrete sample analysis, centrifugal force analyzers, automatic titrators, robots, process control - process-control analyzers.

Analysis of detergents :

General scheme of analysis, sampling, Alcohol soluble materials, Test for sulphonated and unsulphonated material.

Reference Books:

1) Encyclopedia of analytical chemistry.

2) Introduction to instrumental analysis - By R.D. Braun McGraw Hill (1987).

3) Instrumental methods of chemical analysis - By H.H. Willard, L.L. Merrit, Jr. J.A. Dean and F.A. settle, Jr. Sixth Edition CBS, (1986).

4) Analytical chemistry of foods - By Ceiwyn S. James.
Blackie academic and professional - Chapman and Hall publisher, Madras, 1st Edn. (1995).

5) Introduction to food science and technology - food science and technology series - By G.F. Stewart and M.A. Amerine, Academic Press.

6) Chemical analysis of food - By Pearson.

7) Practical Biochemistry in clinical Medicine - By R.L.Nath, Academic Publishers, Calcutta 2nd Edn. (1990).

PGAC- 304 : ANALYSIS OF PHARMACEUTICALS

Credits-04 Total Lectures – 60Hrs

Course learning outcomes

CO 1 : To study the Drug Laws, Govt. Act and its schedules
CO 2 : To know about LD50, ED50 and clinical trials.
CO 3 : To understand relative quality system, ISO, WHO and applications in pharmaceutical industries.
CO 4 : To know about impurities like pharmacopoeias, monographs etc.
CO 5 : To know principles of assays of few drugs.
CO 6 : To study about dosage forms, their classifications and standards for various dosage forms.
CO 7 : To study pathways of degradation and calculations of shelf life.

Course Content:

1) Introduction :

Drug laws and schedules:
Drug and Cosmetics Act: Govt. Analyst, Drug Inspector, Requirement for approval of quality control laboratories, Administrative, Analytical and Executive bodies for analytical purpose, Introduction of new drugs.

2) Good Laboratory Practices:
LD_{50}, ED_{50}, Teratogenicity, Mutagenicity, Clinical Trials, etc.

3) Relative Quality System:
ISO, WHO etc. and their application in Pharmaceutical industry, Regulatory requirements related to current good, manufacturing practices in Pharmaceutical industry [Q. C. areas], Quality assurance, Quality control [Documents and Formats], Validation and Analytical methods.

4) Impurities:
Introduction to Pharmacopoeias and Monographs; Sources and types of impurities, Tests for purity, Limits of impurities, Factors considered for fixing limits and limit tests, Limit tests for chloride, sulphate, heavy metals, arsenic, iron and lead.

5) Quantitative Assay :

Principles of assays of following drugs:
Aspirin, Trimethoprim, Aminophylline, Calcium gluconate, Hydrogen peroxide, Ascorbic acid, Ferrous sulphate, Ciprofloxacin, Insulin.

6) Quality Control of Dosage Forms :

Introduction to dosage forms and their classification, Quality control, standards for various dosage forms i.e. Tablet, Capsule, Parentrals, Injections, Powders, Ointments,

Creams, Solutions, Suspensions, Emulsions.
Test for sterility, Microbial assay of antibiotics and vitamins, Microbial limit tests, Quality control of Glass, Plastic, Rubber containers and closures.
Inprocess quality control, statistical quality control.

7) Stability studies
Introduction, Pathways of degradation, Calculation of shelf life.

Reference Books:

1) Pharmacopoeia of India, Vol. I and Vol. II ; Published - By Government of India, Ministry of Health and Family Welfare, [Latest edition.]

2) United States Pharmacopoeia, Published - By British Pharmacopoeia Commission.

3) British Pharmacopoeia, Vol. I and II, Published - By British Pharmacopoeia Commission.

4) Pharmaceutical Analysis, Vol. I and II - By A. V. Ksture, S. G. Wododkar, K.R. Mahadik and H. More.

5) Practical Pharmaceutical Chemistry, Vol. I and II - By A. H. Beckett and J. B. Stalake, [C. B. S. Publishers, Delhi.]

6) Modern Dispensing Pharmacy - By Dr. A. P. Pawar and R. S. Gaud, [Carrer Publications, Second Edition.]

7) Pharmaceutical Microbiology and Biotechnology - By Dr. C. R. Kokare, [Nirali Publication, Third Edition.]

8) Pharmaceutical facilities, [Design, layout and validation] by Dr. Manohar A. Potdar .

9) Pharmaceutical Quality Assurance by Dr. Manohar A. Potdar .[NiraliPrakashan]

PGSEC 305: ASSESSMENT OF WATER QUALITY

Credits: 02 Total Lectures: 30Hrs

Course learning outcomes

CO 1 : To Improve the awareness and skills in modern techniques of analysis of water
CO 2 : To study about physical tests such as Colour, pH, temp.
CO 3 : Learn about hardness, TDS, DO, COD, BOD
CO 4 : To know about WHO, CPCB and BSI Standard

Course Content:

The main objective of course is to improve the awareness and skills of the students in modern techniques of analysis of water for research and extension activities. Use of instruments and their general upkeep/maintenance, interpretation of analytical data and formulation of reports/recommendations.

The course is designed to cover water characteristics, testing techniques and methods of interpretation of data, so as to make it more useful in the context of global competition in quality and precision of analysis.. About the Course: The course will cover some theory lectures on topics most relevant to the subject along with appropriate number of practical exercises with greater emphasis on analytical techniques adopting a demonstration and learning-by-doing type of approach. Interpretation of test results and formulation of recommendations and/or reports will be a vital component.

The course context: Collect samples in scientific way from residential plumbing and municipal distribution systems for analysis Take physical tests like (Colour, pH, Temp etc) at the spot and use preservatives for further analysis Conduct chemical tests of samples in lab (e.g. Alkalinity, Hardness, TDS. DO, COD etc with biological tests) as possible as. To conduct chlorine residual or turbidity tests.Compare the obtained values with WHO, CPCB or BSI Standards

Reference Books:

1. Hand Book of Methods in Env. Studies by S.K. MAITI ABD Publishers, Jaipur, India.
2. Instrumental methods of chem. Analysis G. R. Chatwal and Anand Himalaya publishing house, New Delhi.
3. Environmental Science Principle &Pract. R. C. Das &Behera Prentice Hall of India pvt. Ltd. New Delhi.

BHARATI VIDYAPEETH
DEEMED UNIVERSITY, PUNE (INDIA)

SYLLABUS OF MASTER OF SCIENCE (CHEMISTRY)

Learning Outcomes based Curriculum Framework (LOCF)
for

M.Sc.II (ANALYTICAL/INORGANIC/ORGANIC CHEMISTRY)

SEMESTER-IV

[CBCS- 2018 Course]

TO BE IMPLEMENTED FROM JUNE 2018

M.Sc. (ANALYTICAL CHEMISTRY), SEMESTER-IV

PGAC- 401: ADVANCED ANALYTICAL TECHNIQUES

Total Credits: 04 **Total Lectures: 60Hrs**

Course learning outcomes

At the end of course student will be able to –

CO 1 : Study of Infra Red spectroscopy and its aspects
CO 2 : Learn and understand in brief about Raman Spectroscopy and its applications.
CO 3 : Learn and Distinguish between Nephelometry, Turbidimetry, Colourimetry, Spectrophotometry.
CO 4 : Understand aspects of Fluorimetry, Phosphorimetry and its applications
CO 5 : Know about NMR and its chemical shifts, kinetic study and limitations of NMR
CO 6 : Study of Electron paramagnetic spectroscopy and applications
CO 7 : Learn X-ray method in brief
CO 8 : Study of ESCA, ESCA satellite peaks and their applications
CO 9 : Understand an introduction to Electron microscopy, SEM and TEM applications

Course Content:

1) **Infra Red Spectroscopy:**
i) MID IR, Absorption spectroscopy, sample handling, Qualitative and Quantitative analysis
ii) MID IR, Reflection spectroscopy, types of reflection, Instrumentation, ATR
iii) Near IR Spectroscopy, Instrumentation, applications of near IR absorbance and reflectance spectrometry
iv) Far IR spectroscopy and IR emission spectroscopy

2) **Raman Spectroscopy :** Theory, Mechanism, Instrumentation, Applications of Raman spectroscopy to biological materials, Inorganic and organic species.

3) **Nephelometry and Turbidimetry**
Introduction, Turbidimetry and Colorimertry, Nephelometry and Fluorimetry, Choice Between Nephelometry and Turbidimetry Theory, Comparision of Spectrophotometry,Turbidimetry and Nephelometry, Instrumentation, Applications of Turbidimetry and Nephelometry

4) **Fluorimetry and Phosphorimetry**
Introducton, Comparision of Absorption and Fluorescence Methods, Theory, Instrumentation, Application of Fluorimetry, Application of Phosphorimetry, ComparisionFluorimetry and Phosphorimetry, Comparison Fluorimetry and Phosphorimetry with Absorption Methods

5) **Nuclear magnetic resonance spectroscopy** - Introduction, theory, chemical shifts, spin splitting, solvents, qualitative and quantitative analysis, non-protonic NMR spectra, multiple resonance, nuclear overhauser effect.NMR spectra of solids, kinetic studies, Limitations of NMR spectroscopy, 2-D NMR magnetic resonance imaging.

6) **Electron paramagnetic spectroscopy** - Introduction, theory, instrumentation, applications to qualitative and quantitative analysis.

7) **X-ray methods of analysis :**
Principle of x-ray analysis, instrumentation, x-ray absorption apparatus, applications of x-ray absorption methods, Non-dispersive x-ray absorption method, x-ray diffraction methods, applications of x-ray methods.

8) **Electron spectroscopy** - Principle of ESCA, ESCA satellite peaks, chemical shifts, Instrumentation and typical analytical applications, Augar electron spectroscopy.

9) **Electron microscopy** - Introduction, Principle, instrumentation and applications, Electron stimulated microanalysis methods, SEM and TEM applications to nano materials, the atomic force microscopy, typical applications

Reference Books:

1. Introduction to instrumental analysis - By R.D. Braun, McGraw Hill - International Edn.

2. Principles of Instrumental Analysis - By D.A. Skoog, F.J. Holler and T.A. Nieman, 5th edition, Saundess College Publishers (1998).

3. Fundamentals of Analytical chemistry - By D.A. Skoog, D.M. West and F.J. Holler, 6th edition, Saunder College Publisher (1992).

4. Instrumental Methods of Analysis - By H.H.Willard, L.L. Merritt Jr, J.A. Dean and F.A. Settle Jr. 6th edition, CBS publishers and Distributors (1986).

5. Analytical Chemistry - By G.D. Christian, 5th Edition, Gopsons Papers Ltd., Noida.

6. Analytical chemistry principles - By John H. Kenedey.
- Second edition, Saunders College Publishing.

7. Electron microscopy in the study of material - By P.J., Grundt and G. A. Jones, Edward Aznold.

8. Standard methods of chemical analysis - By F.J. Welcher, Vol. 3.
Part-A sixth edition (1966) D.vanNostrand Company, Inc.

PGAC- 402: RECENT SEPARATION TECHNIQUES

Total Credits: 04 **Total Lectures: 60Hrs**

Course learning outcomes

At the end of course student will be able to –

CO 1 : Learn and Understand solvent extraction, relation between KD & D, extraction techniques
CO 2 : To study the introduction and theory of Chromatography
CO 3 : To understand Liquid Chromatography
CO 4 : To understand High Performance liquid Chromatography
CO 5 : To understand Gas- Chromatography
CO 6 : Know the applications of High-Phenated techniques
CO 7 : Learn about Ultracentrifugation in nano-materials and its aspects

Course Content:

1) Solvent Extraction:

Introduction, Principle of the technique, Distribution coefficient (D), Distribution ration (KD), Relation between KD & D. Different recent theories of solvent extraction, Sequence in the extraction process, Analytical separation techniques, Bath extraction, Continuous extraction, counter – Current extraction, Solid phase extraction, Solvent extraction by flow, Infection analysis, Solvent extraction systems, Chelate systems, Influence of solvents, Ion association systems, Special extraction systems.

2) Introduction to chromatography :

Theory, chromatographic band broadening, efficiency, resolution.

3) Liquid chromatography :

a) Liquid - solid chromatography, LSC stationary phases, LSC mobile phases, LSC detectors, functional groups adsorbed on LSC columns.
b) Liquid-Liquid chromatography, Ion-exchange chromatography - Ion exchange resins, Ion - exchange apparatus, Ion-chromatography.

4) High performance liquid chromatography :

Stationary phases, mobile phases, instrumentation, applications in pharmaceutical, chemical and biological fields.
Size-exclusion chromatography and Gel chromatography.

5) Gas- chromatography :

Retention time and retention volume, apparatus, carrier gases, injectors,

columns– packed columns, open tabular columns, stationary phases, detectors, Temperature effects, qualitative and quantitative analysis, super critical fluid chromatography.

6) High-phenated techniques :

Applications of GC-MS, GC-IR, MS-MS, HPLC-MS. LC-MS

7) Ultracentrifugation in nano-materials :

Principle, sedimentation, methodology and applications, separation by distillation, crystallization, sublimation zone-refining, reverse osmosis, freezing.

Reference Books:

1. Analytical chemistry - By G.D. Christian 5th Edn. 2001.

2. Introduction to instrumental analysis - By R. D. Braun, McGraw Hill international Edu.

3. Principles of Instrumental Analysis - By D.A. Skoog, F.J. Holler and T.A. Nieman, 5th Edn., Saunders College Publishers.

4. Fundamentals of Analytical chemistry - By D.A. Skoog, D.M. West and F.J. Holler 6th Edn. SaundersCollege Publishers.

5. Instrumental methods of analysis - By B. L. Krager, H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle ; C. B. S. - Publishers, Delhi (1986).

6. An introduction to separation sciences - By L. R. Shyder and C. H. Harvath, Wilfey - Interscience.

7. Basic concepts of analytical chemistry - By S. M. Khopkar, New Age International (P) Limited Publishers, (1999).

8. Quantitative analytical chemistry - By J. S. Eritz and G. H. Scliek, 5th Edn.,Allyn and Racon (1987).

9. Environmental Chemical analysis - By M. S. Cress and Morr, American Publication (1988).

PGAC- 403: ENVIRONMENTAL ANALYSIS

Total Credits: 03 **Total Lectures: 45 Hrs**

Course learning outcomes

At the end of course student will be able to –

CO 1 : Study of Industrial Water pollution Control
CO 2 : Learn about chemical techniques used in industrial waste water treatment
CO 3 : Know about Electroplating industry
CO 4 : Understand Dye industry
CO 5 : Understand about Green chemistry and its aspect with sustainable future

Course Content:

1. Industrial Water pollution Control
a) Introduction – Industrial, Domestic, Drinking water quality
b) Undesirable Industrial Water characteristics.
c) Toxicity identification of effluent.
d) In-plant waste control.
e) Waste water treatment process and process selection.
f) Pre and primary treatment (Common treatment technologies).

2. Physico-chemical and chemical techniques used in industrial waste water treatment
a) Adsorption
b) Ion-exchange
c) Ultra filtration
d) Reverse osmosis
e) Co-agulation precipitation
f) Chemical oxidation with O_3, H_2O_2, Cl_2 etc.

3. Electroplating Industry
a) Raw material by-product and their role in process selection.
b) Chromate removal and water reuse.
c) Restoration of heavy metal.

4. Dye Industry
a) Natural and Synthetic dyes.
b) Characterization of liquid effluents.
c) Physical, chemical and biological treatment.

5. Green chemistry for a sustainable future
a. Introduction
b. The key concept of atom economy
c. Hazard Reduction
d. Beed stocks

e. Reagents
f. Media
g. The role of catalysts
h. Biological alternatives
i. Applications of green chemistry

Reference Books:

1. Environmental Chemistry, 5th edition, By A. K. De, New Age International Ltd.

2. Environmental Chemistry, By S. K. Banerji, Prentice Hall of India Pvt. Ltd., New Delhi.

3. Environmental Pollution Analysis, By S. M. Khopkar, Wiley Eastern Ltd.

4. Environmental Chemistry, By S. E. Manthan, 6th edition.

5. Standard methods of Water and Waste water Analysis, By A. K. De.

6. Water Analysis, By J. Rodier.

7. Industrial Water Pollution Control, 3rd Edition, W. Wesley Eckenfelder, Jr. McGRAW HILL Internationl Edition.

8. Environmental Biotechnology, InduShekhar Thakur, IK Internationl.

PGAC- 404 : COMPUTER INTERFACE WITH CHEMISTRY

Total Credits: 03 **Total Lectures: 45 Hrs**

Course learning outcomes

At the end of course student will be able to –

CO 1 : To learn Curve fitting
CO 2 : To study Interpolation and Intrapolatin
CO 3 : To know about how to solve the Algebraic equations.
CO 4 : To study the numerical integration
CO 5 : To understand the Unconstraint optimization in chemistry.
CO 6 : To know the Monto-Carlo method while tudying the computer interface
CO 7 : Study of Molecular Modelling
CO 8 : Study of Structure of Crystals
CO 9 : Learn to use Chem Draw

Course Content:

1. Curve fitting (Functional approximation)

2. Interpolation and Intrapolatin

3. Solving algebraic equations [f(x) = 0]
Bisection, Newton-Raphlson, Secant method

4. Numerical integration
Trapeloidal, Simpson one third method, Simpson three by eight method

5. Unconstraint optimization

6. Monte-Carlo method
i) For calculating integral
ii) For computing area

7. Molecular modeling with examples

8. Structure of crystals with examples

9. Learning to use Chem 3D (Chem Draw)

Reference Books:

Numerical Algorithms - By Krishnamurthy and Sen Manual for Chem 3D

PGAC -405 : MODERN METHODS OF ANALYSIS

Total Credits: 03 **Total Lectures: 45 Hrs**

Course learning outcomes

At the end of course student will be able to –

CO 1 : Understand the analysis of Cosmetics
CO 2 : To learn about Analysis of forensic samples and forensic science act
CO 3 : Study of Analysis and testing of polymers

Course Content:

1) Analysis of Cosmetics :

a) Determination of water, Ethanol, Tropanol Glycol in cosmetics, Analysis of deoderants and anti-perspirants, aluminum, zinc, zircomium, boric acid, chloride, sulphate, Hexachlorophyll, Methanovin, Phenol sulphonate urea.

b) Analysis of face - powder: Fats, fatty-acids, Boric acid, calcuium, magnesium, barium, titanium and iron. Oxides of titanium, iron and aluminium (Total).

c) Analysis of Hair - tonic preparation : 2, 5-diammino tolune, $KBrO_3$, Sodium per borate, pyrogallol, resorcinol, salicylic acid and dithioglycodic acid.

d) Analysis of vanishing creams : Types of Emulsions, chloroform soluble material, glycerol, homo-genizers, stabilizer and antioxidants.

2) Analysis of Forensic Samples :

a) Toxicology : Isolation, identification and determination of following :

i) Narcotics : Heroin and cocaine
ii) Stimulants : Caffeine, amphetamines
iii) Depressants ; Barbiturats, benzodiazepines
iv) Hallucinodens : LSD
v) Metabolloids : Drugs in blood and urine of addicts.

b) Forensic science acts :

i) Drugs and cosmetic acts
ii) Medicinal and toilet preparation (Excise duties) act.
iii) Narcotics and psychotropics - substances act.

3) Analysis and testing of polymers :

a) Chemical analysis of polymers : X-ray diffraction, thermal analysis, TGA, DTA.

b) Physical testing of polymers : Mechanical properties, fatigue testing, impact testing, Tear - Resistance, Hardness, Brassion resistance.

c) Thermal properties : Softening temperature, flammability.

d) Optical properties :Colour transmittance and transparency.

e) Electrical properties : Dielectric constant and Loss factor, resistivity, dielectric strength, electronic properties.

f) Chemical properties : Resistance to solvents, vapour permeability, weathering.

Reference Books:

1. Standard methods of chemical analysis, volume 3, Part-B - By F.J. Welcher.

2. Cosmetics - By W.D. Poucher three volumes.

3. Industrial water pollution control 3rd Edition - By W.W. Ecken and elder, Jr. McGraw-Hill (2000).

4. Analytical methods of Forensic Chemistry, Ed. Homath, Ellis Horwood (1990).

5. Text book of Forensic Pharmacy - By B. M. Mithal, 9th edn. (1993), National Centre, Calcutta.

6. V. Malik, Drug and Cosmetic Act.

7. Drug and Cosmetics Act - V. Malik.

8. Textbook of Polymer Science IIIrd Edition - By Fred. W. Billmeyer Junior IIIrd Edition John Willey and Sons. (1994).

9. Principles of Polymer Systems - By F. Rodrigue Tata McGraw Hill New-Delhi.

10. Principles of Polymer Chemistry - By P.J. Flory Cornel uni press New-York.

11. Polymer Chemistry - An Introduction Seymour-Carraher-Marcel Dekker, Inc.New - York.

12. Polymer Science - By VasantGowarikar Wiley Eastern New - York, (1988).

13. Polymer Science - By V.R. Gowarikar, N.B. Vishvanathane, New Age International Ltd. Publishers, Relevant Pages, 1998.

14. Textbook of Polymer Science - By Fred. W. Billmeyer Junior IIIrd Edition,

Relevant Pages. 1994.

M. Sc II (Organic Chemistry), Semester-III

PGOH-301: ADVANCED ORGANIC REACTION MECHANISM

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

After completion of these courses students should be able to;

CO 1 : Study of carbanion-formation, stability and related name reaction
CO 2 : Understand the NGP.
CO 3 : Learn the carbenes and nitrenes.
CO 4 : Study of oxidative coupling and SNAr reaction.
CO 5 : Study of heterocyclic chemistry: Five and six member heterocyclic with one or two hetero atoms.
CO 6 : Study the synthesis, reactivity, aromatic character and importance of heterocyclic compounds.

Course Content:

Carbanions in Organic Chemistry

Ionization of carbon hydrogen bond and prototopy, base and acid catalysed halogenation ketones, keto-enol equilibria, Structure and rate in enolisation, Concerted and carbanion mechanis for tautomerism, Carbanion character in phenoxide and pyrrolyl anions, Geometry of carbanio Hydrolysis of haloforms, Aldol, Mannich, Cannizzaro, Darzens, Dieckmann, Claisen Bayl Hillman reactions, Knoevenagel, Benzoin Condensation, Alkylation of enolates.
Reactions of carbenes and nitrenes.

Heterocyclic Chemistry

Synthesis and reactions of : Furon, Pyrrole, Thiophene, Benzofuran, Indole, Benzothiphe Pyridine, Quinoline, Isoquinoline, Imidazole, Oxazole, Thiazole.

Synthesis of Chloroquine, Papavarine, Amlodipine, Bromouidine, Ranitidine, Vitamin-E Tryptophan, Thiamine, Histidine.

PGOH-302: SPECTORSCOPIC METHODS IN STUCTURE DETERMINATION

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Study ^{1}H NMR Spectroscopy: Chemical Shift, deshielding, correlation for protons bonded to carbon and other nuclei.

CO 2 : Study of ^{13}C NMR spectroscopy: FT- NMR, type of ^{13}C NMR spectra, proton decoupled , off resonance, Chemical shift, nuclear and hetero nuclear coupling constant

CO 3 : 2D NMR techniques: COSY, HETCOR and applications of PMR

CO 4 : Study of mass spectrometry: Instrumentation, various methods of ionization, EIMS, SIMS, FAB, MALDI. Different detectors rules of fragmentations of different functional groups.

CO 5 : To solve the problems based on joint application of UV, IR, NMR, CMR and Mass.

Course Content:

1.Recapitulation of UV, IR and ^{1}H NMR.

2. ^{1}H NMR

(Advanced ideas) FT – techniques, Spin Coupling, Ramsay mechanism of spin coupling, Different spin systems (AB, AX, AMX systems, Calculation of line intensities), Factors affecting coupling constants, Rate processes. Different types of coupling. Methods used for simplification of PMR spectra. NOE, Spin decoupling. Two dimensional (2D) NMR Techniques, COSY, HETCOR. Applications of PMR**.**

3. ^{13}C NMR

Elementary ideas, Instrumental problems, Chemical shift features of hydrocarbons, Effect of substituents on chemical shifts, Different type of carbons (alkene, alkyne, allene and carbonyl). DEPT(with 3 different angles), Application of ^{13}CNMR**.**

4. Mass Spectrometry

Theory, Instrumentation, Various methods of ionization (field ionisation, EIMS, SIMS, FAB, MALDI), Different detectors (magnetic analyzer, ion cyclotron analyzer, Quadrupole mass filter, Time of flight (TOF). Rules of fragmentation of different functional groups, Factors controlling fragmentation. Application of Mass spectroscopy**.**

5. Problems based on joint application of UV, IR, PMR, CMR, and Mass.

(Including reaction sequences)

PGOC-303: ADVANCED STEREOCHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Study of stereochemistry of six member ring.
CO 2 : Learn the stereochemistry of rings other than six members.
CO 3 : Understand fused bridge and Caged rings.
CO 4 : Learn resolution of racemic modification, stereochemistry of organic compound using NMR.
CO 5 : Learn stereochemistry of Morphine, Quinine and Strychnine

Course Content:

1. Stereochemistry of rings other than six membered

2. Fused Bridged and Caged rings

3. Recapitulation of prochirality, Homotopic and Heterotopic ligands, Stereoselectivity in cyclic compounds, Enantioselectivity, Diastereoselectivity, Stereoselective aldol reactions. Cram's rule, Felkin Anh rule, Cram's chelate model. Asymmetric synthesis use of chiral auxiliaries, Chiral reagents and catalysts, Asymmetric hydrogenation, Asymmetric epoxidation and asymmetric dihydroxylation.

4. Stereochemistry of Morphine, Quinine and Strychnine

PGOC-304: MEDICINAL CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :
At the end of course student will be able to –

CO 1 : Analyse the important technology in medicinal chemistry.
CO 2 : Learn the medicinal chemistry, the action and discovery.
CO 3 : Discuss drug metabolism.
CO 4 : Study antimicrobial drugs.
CO 5 : Elaborate mechanism of action of antibiotic.

Course Content:

1: Concepts of Medicinal Chemistry.
Important terminology in medicinal chemistry: Drugs, Pharmacy, Pharmaceutics, Toxicology; Pharmacodynamic agents, Pharmacophore, Pharmacodynamics, metabolite and antimetabolites, chemotherapy. Mechanism of chemotherapeutic actions: 1) Biological defences 2) Chemical defences. a) Surface active agent, b) Metabolic antagonism. Assay of Drugs: Chemical assay, Biological assay, Immunological assay, LD-50 and ED-50.

2: Drug metabolism.
Introduction, Oxidation, Reduction, Hydrolysis, Conjugation.

3: Antimicobacterial drugs.
Introduction, First-line agents (Primary tubercular drugs): Structure and activity of streptomycin and dihydro-streptomycin, Synthesis and SAR of 4-amino salicylic acid and isoniazid.

4: Antibiotics. 1.
Introduction, classification of antibiotics,
2. Cell wall synthesis,
3. Mechanism of action of antibiotics, a) Inhibition of cell-wall synthesis, b) Inhibition of bacterial protein synthesis, c) Disorganization of the cytoplasmic membrane, d) Interference in the bacterial nucleic acid synthesis, e) Inhibition of the tetrahydro-folate biosynthesis.
4. Cell wall synthesis inhibitors (β-Lactam antibiotics): Synthesis of Penicillin-G, Amoxicillin, Aampicilin from 6-APA, Cephalexin, Structure and activity of benzyl penicillin, Semi-synthetic penicillin, Cephalosporin, Mode of action of penicillin and cephalosporin.

PGSEC-305- ASSESMENT OF WATER QUALITY

Total Credits: 04 **Total Lectures: 30Hrs**

Course Learning Outcomes :
At the end of course student will be able to –

CO 1 : Study the modern techniques of analysis of water for research and extension activity.
CO 2 : Use of instruments and their general maintenance.
CO 3 : Learn the interpretation of analytical data and formulation of reports/ recommendations.

Course Content:

The main objective of course is to improve the awareness and skills of the students in modern techniques of analysis of water for research and extension activities. Use of instruments and their general upkeep/maintenance, interpretation of analytical data and formulation of reports/recommendations.

The course is designed to cover water characteristics, testing techniques and methods of interpretation of data, so as to make it more useful in the context of global competition in quality and precision of analysis.. About the Course: The course will cover some theory lectures on topics most relevant to the subject along with appropriate number of practical exercises with greater emphasis on analytical techniques adopting a demonstration and learning-by-doing type of approach. Interpretation of test results and formulation of recommendations and/or reports will be a vital component.

The course context: Collect samples in scientific way from residential plumbing and municipal distribution systems for analysis Take physical tests like (Colour, pH, Temp etc) at the spot and use preservatives for further analysis Conduct chemical tests of samples in lab (e.g. Alkalinity, Hardness, TDS. DO, COD etc with biological tests) as possible as. To conduct chlorine residual or turbidity tests.

Compare the obtained values with WHO, CPCB or BSI Standards

M. Sc II (Organic Chemistry), Semester-IV

PGOC-401: SYNTHETIC ORGANIC CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Study of transition metal complexes in organic synthesis.
CO 2 : Learn designing of organic synthesis
CO 3 : Use of boron and silicon in organic synthesis.
CO 4 : Study Umpolung in organic synthesis.
CO 5 : Protection and deprotection of hydroxyl, amino, carboxyl, ketone and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide.

Course Content:

1. Transition metal complexes in organic synthesis; only Pd, Ni, Co, Pt, Fe, Rh, Ru; Grubb's catalyst, Ziegler Natta catalyst.
2. Use of Boron, Silicon and Tin in organic synthesis.

Ref.2, chapter 47

3. Designing of organic synthesis.
4. Umpolung in organic synthesis.
5. Protection and deprotection of hydroxyl, amino, carboxyl, ketone and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide.

Books/References:

1. Modern Synthetic Reactions – H. O. House (Benjamin).
2. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
3. Designing of Organic Synthesis – S. Warren (Wiley).
4. Some Modern Methods of Organic Synthesis – W. Carruthers (Cambridge).
5. Organic Synthesis – M. B. Smith.
6. Organometallics in Organic Synthesis – J. M. Swan and D. C. Black (Chapman and Hall).
7. Advanced Organic Chemistry, Part B – F. A Carey and R. J. Sundberg 5^{th} edition (2007).

PGOC-402: CHEMISTRY OF NATURAL PRODUCT

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Learn biogenesis of terpenoides.
CO 2 : Study biogenesis of alkaloids.
CO 3 : Study biogenesis of steroids.
CO 4 : Study biogenesis and physiological effect of Prostaglandins.
CO 5 : Study biogenesis of Cholesterol, Flavons, Coumarins, Carbohydrates and Proteins.
CO 6 : Synthesis of biotin and Vitamin B2, Synthesis of Vitamin B1, Biological functions of B_6, B_{12}, folic acid and thiamine.

Course Content:

1) Terpenoids
Structure and synthesis of Abietic acid, Zingiberene, Santonin, Cuparenonne and Caryophyllene.

2) Alkaloids
Structure, Stereochemistry, Synthesis and biosynthesis of morphine, reserpine, ephedrine, (+) conin.

3) a) Steroids
Occurrence, Nomenclature, Basic skeleton, Diels hydrocarbon and study of the following Hormones: Androsterone, Testosterone, Estrone, Progesterone, Aldosterone and Cartisone. Biosynthesis of steroids.

b) Prostaglandins
Occurrence, nomenclature, classification, biogenesis and physiological effects, synthesis of PGE2 and PGF2

4) Biogenesis
Alkaloids (pyridine, morphine and indole type) Terpenoids, Cholesterol, Flavones, Coumarins, Carbohydrates and Proteins.

5) Vitamins

Synthesis of biotin and vitamin B2, Synthesis of vitamin B1, Biological functions of B_6, B_{12}, folic acid and thiamine.

Books/ References:

1. The total synthesis of natural products- Apsimon.
2. Alkaloids - Manskey and Holmes.
3. Chemistry of Terpenes - A.A. Newmen.
4. The chemistry of natural products- P. D B.Mayo.
5. Terpenes- Simonson.
6. Aspects of terpenoid chemistry and biochemistry- T.W. Goddwin.
7. Vitamins and Co-enzymes- Woguer.
8. Chemistry of Natural products- P. W. Bently.
9. Steriods - Fieser and Fieser.
10. Organic Chemistry Vol. II and I- I. Finar.
11. The molecules of nature - J.B. Hendrickson.
12. The biogenesis of natural products Peter Bernfield.
13. Total synthesis of steroids- R.T. Slickenstaff A.C. Ghosh and G.C. Wole .
14. The chemistry of natural products- vol. Nakanishi.

PGOC-403: GREEN CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Elaborate basic principles of green chemistry.
CO 2 : Understand solvent free microwave assisted organic synthesis.
CO 3 : Use of green reagent in green synthesis.
CO 4 : Study of green catalyst.
CO 5 : Study phase transfer catalyst in green synthesis.
CO 6 : Advantages of PTC reactions to green synthesis.
CO 7 : Learn microwave assisted reactions in water.
CO 8 : Learn microwave assisted reactions in organic solvent.
CO 9 : Understand ultrasound assisted reactions.

Course Content:

1. Introduction to Green Chemistry.

Introduction, Principles, atom economy and scope, Inception to green chemistry, Introduction to alternative approaches, Solvent free reactions-principle, scope, utility of solvent free conditions, controlling solvent free reactions. Phase changes, optimum reaction temperatures, miscibility of reactants and catalysts.

Solvent free microwave assisted organic synthesis: Introduction, solvents free techniques-Reactions on solid mineral support, solid-solid phase transfer catalysts reactions without solvent, support or catalyst. Microwave activation-benefits, limitations, equipments, microwave effects-according to reaction medium and according to reaction mechanism.

2. Approaches to Green Chemistry.

Basic principles of green synthesis:

a) Use of green reagents in green synthesis-dimethyl carbonate, polymer supported reagents-per acids, chromic acids.
b) Green catalysts: Acid catalysts, oxidation catalysts, and basic catalysts.
c) Phase transfer catalyst in green synthesis: Aliquat 336, benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride.

d) Advantages of PTC reactions to green synthesis. Applications of PTC's in C-alkylation, N-alkylation, S-alkylation, darzens reaction, Williamsons synthesis and Wittig reaction.

3. Microwave induced and ultrasound assisted green synthesis.

Introduction to synthetic organic transformations under microwave.

a) Microwave assisted reactions in water: Hoffmann elimination, hydrolysis, oxidation, saponification reactions.

b) Microwave assisted reactions in organic solvents: Esterification reactions, Fries rearrangement, Ortho ester Claisen rearrangement, Diels-Alder reaction, decarboxylation.

c) Microwave solvent free reactions (solid state reactions): Deacetylation, Deprotection, saponification of ester, alkylation of reactive methylene compounds, synthesis of nitriles from aldehydes, and reductions.

d) Ultrasound assisted reactions: Introduction, substitution, addition, oxidation, reduction reactions.

Books /References:

1. Organic Chemistry, vol-2, I.- L. Finar, ELBS.
2. Stereoselective Synthesis: A practical Approach- M. Nogrudi, VCH.
3. Organic Synthesis in water- Paul A. Grieco Blackie.
4. Green Chemistry, theory and practice- Paul T. Anastas and John C. Warner.
5. New Trends in Green chemistry- V. K. Ahluwalia and M. Kidwai.
6. Organic Synthesis: Special techniques- V. K. Ahluwalia and Renu Aggarwal.

PGOC-404: APPLIED ORGANIC CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Study carbamate pesticides.
CO 2 : Learn organophosphorous pesticides.
CO 3 : General survey and synthesis of insect repellents.
CO 4 : Understand structure and synthesis of Juvenile harmones.
CO5 : Synthesis of Pheromones.
CO 6 : Synthesis of important dyes and intermediates.

Course Content:

1) Agrochemical:

a. Carbamate pesticides: Introduction, carbaryl, Baygon, Aldicarb, Ziram, Zineb
b. Organophosphorus pesticides: Malathion, monocrotophos, dimethoate, phorate, mevinphos
c. Insect repellents: General survey and synthesis
d. Juvenile harmone: introduction structures JHA importance synthesis
e. Pheromones: introduction, examples, and importance in IPM synthesis of juvabione bombycol, grandisol, and disparure

2) Dyes and Intermediates:

Synthesis of important dye intermediates. Commercial processes for Azo dyes, reactive dyes, optical brighteners, thermal sensitive dyes, dispenses dyes.

References/ Books:

1. Colour Chemistry – Allan.
2. Chemistry of Synthetic Dyes Vol- 1 to 7.- K. Venkataraman
3. Dyes & their intermediates- Abrahart.
4. The Chemistry of Pesticides and formulations - N. N. Melikov.
5. Chemistry of Pesticides- K. H. Buchel.
6. Pesticides - R. Cleymlin.
7. Text book of Polymer Science- F. W. Billmeyer.
8. Contemporary Polymer Chemistry- H. R. Alcock and F. W. Lambe.
9. Physics & Chemistry of Polymers- J. M. G. Cowie, Blackie.
10. Unit Processes in Organic Synthesis- P. H. Groggins.
11. Perfumary Technology-. B. Biollot & P. V. Wells
12. A formulary of Cosmetic Preparations- M. Ash & I. Ash.

PGOC-405: BIO-ORGANIC CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Study Classification and nomenclature of enzymes.
CO 2 : Learn advantages and limitations of enzymes in organic synthesis.
CO 3 : Study enzyme selectivity-Chemo, region, diastereo and enantio selectivity-Illustration with suitable examples.
CO 4 : Study structure and synthesis of nucleosides and nucleotides.
CO 5 : Study structure of DNA.

Course Content:

1: Enzymes

Definition, Classification and nomenclature of enzymes. Factors affecting the enzyme catalysed reactions. Advantages and limitations of enzymes in organic synthesis-mechanistic aspects of enzyme catalysis -Lock and Key mechanism, Induced-Fit mechanism, Michaelis-Menten Equation, Desolvation and salvation-substitution theory, Three point attachment rule. Factors affecting the enzyme catalysed reactions. Enzyme selectivity-Chemo, regio, diastereo and enantio selectivity-Illustration with suitable examples.

2: Nucleic acids

Introduction, Hydrolysis of nucleic acids, Structure physical and chemical properties of the heterocyclic bases-Adenine, Guanine, Cytosine, Uracil and Thiamine. structure and synthesis of nucleosides and nucleotides. Deoxyribose nucleic acid (DNA): Primary, secondary, tertiary structure of DNA. Structure of RNA. Types of RNA- mRNA, rRNA and tRNA.

Books/ References:

1. Natural products: Chemistry and Biological significance- J.Mann, R.S.Davidson, J.B.Hobbs, D.V., Banthropde & J. B. Harborne, Longm, an, Essex.

PGOC-407: MIXTURE SEPERATION

Total Credits: 02

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Ternary mixture seperation
CO 2 : Study ternary mixture separation on microscale using ether.
CO 3 : To separate the three components from each other using ether.
CO 4 : Determine the type, functional group of each component.
CO 5 : Determine the melting point/ boiling point of the components.

Course Content:

TERNARY MIXTURE SEPARATION:

Separation of at least ten mixtures containing three components. The mixtures should also involve separation of nitro phenols, amino acids, low boiling substances, water soluble substances. Amines, Phenols and acids used should also contain other elements and functional groups. The mixture separation should be carried out on micro-scale using ether.

PGOC-408: ADVANCED PREPARATIONS

Total Credits: 02

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Spectral analysis best on instrumental techniques.
CO 2 : Preparation of organic compounds, their purifications and run TLC.
CO 3 : Determination of physical constant: Melting point, Boiling point.

Course Content:

SINGLE STAGE AND TWO STAGE PREPARATIONS:

At least eight single stage and eight two stage preparations from the following should be carried out. The preparations should be carried out on micro scale.

Single Stage Preparations:

1. Acetophenone → Ethyl Benzene
2. Anthranilic acid → ortho Iodobenzoic acid
3. Diels-Alder reaction using Anthracene and Maleic anhydride
4. Benzyl cyanide → p-Nitro benzyl cyanide
5. Bromobenzene → p-Nitro bromobenzene
6. 2-Naphthol → 2,2'-Dihydroxybinaphthyl
7. Glycine → Hippuric acid
8. Salicylic acid → 5-Nitrosalicylic acid
9. Resorcinol Resacetophenone
10. 2-Methoxynephthalene →1-Formyl-2-methoxynaphthalene
11. p-Xylene →Ter-phthalic acid
12. o-Nitrotoluene + Benzaldehyde $\xrightarrow{\text{Base}}$ condensation

TWO STAGE PREPARATION

At the end of course student will be able to –

CO 4 : Spectral analysis best on instrumental techniques.
CO 5 : Preparation of organic compounds, their purifications and run TLC.
CO 6 : Determination of physical constant: Melting point, Boiling point.
CO 7 : Use of different separation techniques.

Course Content:

Two Stage Preparations:

1. Benzophenone → Oxime → Benzanilide
2. Benzoin → Benzil → Benzilquinoxaline
3. Benzaldehyde + Acetophenone → Benzalacetophenone → Epoxide
4. 4-Nitrotoluene → 4-Nitrobenzoic acid → 4-Aminobenzoic acid
5. Resorcinol → 4-methyl-7-hydroxycoumarin → 4-methyl-7-acetoxy -coumarin
6. Phenol →Salicyaldehyde →Coumarin
7. Cyclohexanone → Phenylhydrazone →1,2,3,4- tetrahydrocarbazole
8. Acetanilide → p-Nitroacetanilide → p-Nitroaniline
9. Hydroquinone → Quinone → 1,2,4- Triacetoxybenzene
10. Cyclohexanone → Oxime → Caprolactum
11. Hydroquinone → Diacetate → 2,5-Dihydroxy acetophenone
12. 4-Chlorophenol → 4-Chlorophenyl acetate → 5-Chloro-2-hydroxyacetophenone

Interpretation of NMR, IR and Mass Spectra of about 15 compounds. Minimum 2 three stage preparations to demonstrate how to develop a synthetic sequence.

PGOC-409: LAB COURSE/ PRACTICALS

Total Credits: 02

Course Learning Outcomes :

At the end of course student will be able to –

CO 1 : Students should carry out a small research project.

CO 2 : Students should familiar with literature survey, research methodology, identification of products by analytical and spectral methods.

CO 3 : Students should go through preparation of organic compounds, their purifications and run TLC

CO 4 : Students should familiar with different separation and purification techniques i.e. Recrystallization, distillation, fractional distillation, chromatography and solvent extraction.

Course Content:

PROJECT AND PRACTICALS:

1. Students should carry out a small research project. This should make them familiar with literature survey, research methodologies, Identification of products by analytical and spectral methods and familiarity with chromatographic techniques.

2. Students who are not assigned the project should carry out at least 12 experiments and students who are assigned project work should carry out at least 6 experiments to illustrate the principles of organic reaction mechanism, stereochemistry or selectivity of reagents.

Suggested reagents and reactions –

$LiAlH_4$ (reduction of ethyl benzoate to benzyl alcohol), $NaBH_4$ (reduction of anisaldehyde to p- methoxy benzyl alcohol), SeO_2, NBS(bromination of p-nitrotoluene), Grignard Reaction (preparation of triphenyl carbinol or diphenyl methyl carbinol), Wittig Reaction (preparation of ethyl cinnamate from benzaldehyde), Cannizzaro's reaction (on benzaldehyde) Asymmetric reduction, Phase transfer catalyst isolation of natural products (like Eugenol from cloves, Limonene from orange peels, Trimyristin from nutmeg etc.), photochemical reaction, Peracid and lead tetra acetate oxidation, rearrangement reactions, synthesis of heterocyclic compounds like Hydantoin, thiohydantoin, pyrazolone, Biginelli reaction (synthesis of 4-aryl-3,4-dihydropyrimidinone).

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Science
M. Sc. - Chemistry
Old Syllabus

"Social Transformation Through Dinamic Education"

BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY)

YASHWANTRAO MOHITE COLLEGE OF ARTS, SCIENCE AND COMMERCE, PUNE 411038

Accredited with 'A+' Grade (2017) by NAAC
'A' Grade University Status by MHRD, Govt. of India
Accredited (2004) & Reaccredited (2011) with 'A' Grade by NAAC

MASTER OF SCIENCE (M. Sc. CHEMISTRY) PROGRAME

(Analytical/Organic/Inorganic Chemistry)

CBCS 2016 COURSE STRUCTURE

Under the Faculty of Science

TO BE IMPLEMENTED FROM ACADEMIC YEAR 2016-17

SYLLABUS OF M.Sc.I (ANALYTICAL/INORGANIC/ORGANIC CHEMISTRY) (SEMESTER-I)

PGCH-101 PHYSICAL CHEMISTRY - I 5 Credits

Total No. of Lectures= 60Hrs

SECTION-I

1) **Chemical Thermodynamics** **(12)**

Second law of thermodynamics and the entropy, concept as state function, change of entropy with temperature and pressure, Entropy at absolute zero, Entropy changes in spontaneous processes, Frees energy and spontaneity, Free energy and chemical equilibrium, Gibbs – Helmholts's equation. Dependence of free energy on temperature, Maxwell's relation and interrelation of various thermodynamic properties, Free energy, enthalpy and entropy of mixing in ideal and non – ideal solutions. Partial molal quantities and their experimental determinations.

2) **A) Structure and Properties of Macromolecules.** **(10)**

Techniques for determination of shapes and size of macromolecules, use of osmotic pressure to determine the molar mass of macromolecules, Distinction between Number Average and mass average molecular weights, Ultracentrifuge and determination of shape and molar mass of macromolecules from the rate of sedimentation, use of viscosity measurements and light scattering to molar mass and shapes of macromolecules.

B) Adsorption

Adsorption of gases: Physical adsorption and chemisorption, enthalpy of adsorption, adsorption isotherms; determination of surface area; Adsorption of liquid.

3) **Dipole Moment** **(8)**

Dipole moment or electrical moment, Polarization of molecules in electric field, Polarization of polar molecules in electric field, Measurement of dipole moment, Determination of molecular radius by polarization, Applications of dipole moment (a) Determination of molecular structure (b) Calculation of percentage of ionic character in the bond (c) Calculation of bond angle (d) Determination of symmetry of molecules, Bond length, Bond energy.

SECTION-II

4) **Molecular reaction Dynamics** **(10)**

Collision Theory, Diffusion Controlled Reactions. The reaction coordinate and transition state, Eyring equation, Thermodynamic aspects, Reactive, collisions, Potential energy surfaces.

5) **Photochemistry** **(10)**

Introduction, Absorption of light, Types of chemical reactions, laws of photo chemistry, Consequences of light absorption: primary and secondary processes, Electronic transitions in molecules, Potential energy curves for primary photo chemical processes, Excited states, Quantum yield, Luminescence of cold light, Photoluminescence, Chemiluminescence, Photochemical equilibrium, Photosensitization, Flash photolysis, Photo chemistry in life processes, Photo conductivity, Photo polymerization, Hot atom reactions, Mechanism of photo chemical reactions.

6) **Phase Rule** **(10)**

Phases, components and degrees of freedom; Phase rule, Two component system vapour diagrams, temperature – composition diagrams, liquid – liquid phase diagrams, liquid – solid phase diagrams, ultrapurity and controlled impurity; Threecomponent system : trianquilar phase diagrams, partially miscible liquids, the role of added salts. (freezing mixtures, such as NaCl – water-ice, $CaCl_2$–water-ice)

Reference Books:

1) Physical Chemistry, G.M.Barrow, Fifth Edition 1994, Tata McGraw-Hill.
2) Physical Chemistry, P.W.Atkins, Fifth edition 1994, ELBS.
3) Principles of Physical Chemistry, Maron and Prutton, Fourth edition, Macmillan Company.
4) An Introduction to Electrochemistry, S. Glasstone, Affiliated East-West Press Pvt.Ltd.
5) Physical chemistry. R.A. Alberty, R.S.Silby, Johncoilet 1995.
6) Advanced Physical Chemistry, D. N. Bajpai, A. S. Chand Co. Ltd.

Note:- Weightage to the problems 25% weightage should be given to the numerical problems in final question paper setting.

(SEMESTER-I)

PGCH-102 INORGANIC CHEMISTRY-I 5 Credits

Total No. of Lectures= 60Hrs

1. **The structure of atom: (8)**

The wave equation, particle in a box, The Hydrogen atom: Derivation of solutions of θ & ϕ parts, solution of R part, Angular wave functions, symmetry of orbitals, the polyelectronic atom.

2. **Bonding Models: (6)**

The ionic bond, Lattic energy, size effects, The covalent bond – preliminary approach, Valence Band Theory, Symmetry and overlap, Hybridization, Delocalization, Experimental measurement of charge distribution in Molecules

3. **The solid state: (10)**

Structures of complex ionic compounds, Imperfections in crystals, conductivity in ionic solids, solids held together by covalent bonding: Types of solids, Band Theory, Intrinsic & photoexcited semiconductors, Impurity & defect semiconductors.

4. **The covalent bond: Structure & Reactivity: (8)**

Structure of molecules, VSEPR theory, structures of molecules containing lone pairs of electrons, VSEPR rules, molecular orbitals & molecular structure,Hybridization, Bond lengths, Bond multiplicity, Experimental determination of molecular structure.

For topics 1-4, related problems should be solved in the class.

5. **Inorganic Chains, Rings, Cages and Clusters: (8)**

Chains, catenation, Heterocatenation, Isopoly anions, Heteropoly anions,

Rings, Borazines, Phosphazenes, Heterocyclic inorganic ring systems,

Cages, Boron cage compounds, Boranes, carboranes,

Metal clusters, binuclear clusters, trinuclear clusters, octahedral clusters, synthesis of metal clusters.

6. **Chemistry of Halogens & Noble gases** : **(8)**

Introduction, Chemistry of Noble gases, bonding in noble gas halides, bond strengths in noble gas compounds

Chemistry of halogens, Interhalogen compounds, oxyacids of heavier halogens, Halogen oxides & oxyfluorides, pseudohalogens.

References

1. Theoretical Inorganic chemistry : M.C. Day and J. Selbin. Reinhardt EWAP (1987).
2. Structural Inorganic Chemistry, A.F. Wells, 5th edition (1984).
3. Inorganic Chemistry – Principles of structure and Reactivity: James E.Huheey, Harper and Row publisher Inc. New York, Third edition (1983).
4. Electronic processes in materials : L.V.Azoroff and J.J.Brophy, McGraw Hill publication.
5. Advanced Inorganic chemistry: F.A. Cotton, R.G.Willkinson (Wiely – Eastern).
6. Inorganic chemistry: A.G.Sharpe, ELBS edition (1984).
7. Concise Inorganic chemistry: J.D.Lee, 5th edition, ELBC (1986).

BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

SYLLABUS OF M.Sc.I (CHEMISTRY)
(SEMESTER-I)

PGCH-103 ORGANIC CHEMISTRY-I 5 Credits

Total No. of Lectures= 60Hrs

(1) **Aliphatic Nucleophilic substitutions**. **(11)**

SN1, SN2, SNi, SN1', SN2' & SNi' with respect to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. Ambidient nucleophiles. Neighbouring group participation by σ,π and aromatic ring systems.

(2) **Aromatic Electrophilic Substitutions**. **(10)**

Introduction, concept of Aromaticity, Arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Halogenation, Friedel – Craft reactions in aromatic systems. Energy profile diagrams. The orthol / para ratio, ipso attack orientation inringsystems,Diazo-Coupling, Jakobsen, Haworth, Henkel and halogen dance reaction.

(3) **Aromatic Nucleophilic Substitution**. **(5)**

Introduction, specificity of the reactions, SNAr, Aromatic SN1 and Aryne mechanism. Effect of substrate structure, leaving group, attacking group, base & solvent.

(4) **Addition Reaction** **(6)**

Mechanistic and stereochemical aspects of addition reactions of C-C multiple bonds including allenes,Ionic and free radical additions of halogens , halogen halides & hydration.Electrophilic addition involving Metal ions, Reg io and chemo selectivity, orientation and reactivity,Conjugate addition.

(5) **Elimination Reaction** **(6)**

The E1, E2 & E1cB mechanisms. Orientation in elimination reactions. Reactivity, effect of substrate structures, attacking base, leaving group, nature of medium and pyrolytic elimination reactions.

(6) **Stereochemistry**. **(8)**

Concept of chirality: Recognition of symmetry elements and chiral structures, prochiral relationship, enantiomers, diasteromers, racemic modification and their resolution, R/S nomenclature, geometrical isomerism, E & Z nomenclature, conformational analysis of mono and disubstituted cyclohexanes.

(7) **Rearrangements**. **(8)**

Beckmann, Hoffmann, Schmidt, Curtius, Lossen, Claisen, Fries Benzilic acid, Favorskii and wolf.

(8) **Non-Benzenoid Aromatics**. **(6)**

Huckel's rule and concept of aromaticity, annulenes, heteroannulenes and fullerene (C_{60}).

Reference books.

1) Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill, 1988.
2) Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990.
3) Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976.
4) Stereochemistry of Carbon Compounds by E.L.Eliel, 9th Reprints, Tata – McGraw Hill, 1985.
5) Stereochemistry, Conformations and Mechanism by P.S.Kalsi, Wiley Eastern Ltd., 2nd edition, 1993.
6) Organic Reactions & their mechanism by P.S.Kalsi, 2nd edition, New Age International, 1998.

(SEMESTER-II)

PGCH-201 PHYSICAL CHEMISTRY – II 5 Credits

Total No. of Lectures= 60Hrs

SECTION-I

1) **Microwave Spectroscopy. (08)**

Rotation of molecules, Rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines, determination of bond lengths, effect of isotope substitution, non – rigid rotator and its spectrum, Linear polyatomic molecules, symmetric and asymmetric top molecules.

2) **(A) Infra – Red Spectroscopy: (08)**

Vibrating diatomic molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, vibration – rotation spectra of carbon – monoxide, determination of force constant and bond strengths, interaction of radiation and vibrations, P, Q and R branches, fundamental vibration and overtone frequencies. Linear molecules, influence nuclear spin, Symmetric top molecules.

(B) Raman Spectroscopy: (06)

Scattering of light and Raman Spectrum, Rayleigh scattering and Raman Effect, Classical and Quantum theory of Raman Effect, Pure rotational Raman Spectra, Linear, Symmetric top and asymmetric top molecules. Vibrational Raman Spectra Raman activity of vibrations, Rule of Mutual Exclusion Overtone and combination vibrations, Vibrational Raman Spectra, Rotational fine structures, Polarization of light and Raman Effect. Vibration of spherical top molecules structure determination from Raman and Infrared spectra.

3) **Electronic Spectroscopy of Molecules: (04)**

Electronic spectra of diatomic molecules Born-oppenheimer approximation, Vibrational coarse structure, Franc-Condon Principle, Dissociation energy and dissociation products, rotational fine structure of electronic and vibrational transition, Fortrat Diagramme. Predisssociation, electronic structure of diatomic molecules, M.O. theory, Shapes of molecular orbitals, Molecular.

4) **Electron Spin Resonance Spectroscopy: (06)**

Introduction, The position of ESR absorption; the g factor, The fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy.

5) **Mossbauer Spectroscopy: (04)**

Principles of Mossbauer spectroscopy, Applications of Mossbauer spectroscopy, The chemical shift, Quadrupole effects, The effect of magnetic field.

SECTION-II

Nuclear and Radiation Chemistry

1) **Radioactivity: Recapitulation**: **(06)**

Types of radioactive decay, decay Kinetics Detection and measurement of radiation (G.M. and scintillation counters)

2) **Elements of radiation chemistry: (08)**

Interaction of radiation with matter, passage of neutrons through matter, interaction of y radiation with matter, units for measuring radiation absorption, radiation energy and radiation dosimetry-Fricke dosimeter, Radiolysis of water, Radiolysis of some aqueous solutions

3) **Applications of Radioisotopes: (08)**

Physicochemical constants-Diffusion coefficient, surface area, solubility. Chemical pathways-Kinetic studies (isotope exchange reaction), organic reaction (Fridel craft reaction, oxidation of fumaric acid). Analytical applications-neutron activation analysis, dilution analysis, radiometric titration.Industrial-Radiation gauging, friction and wear out, gamma radiography, Carbon dating

Reference Book

1) Fundamentals of molecular spectroscopy, C.N.Banwell and E.McCasj, Tata McGraw Hill (1994)
2) Elements of Nuclear Chemistry H.J.Arnikar, 4th Edn. Wiley Eastern Ltd.
3) Source book on atomic energy-S.Glasstone (D.Van Nostrand company)
4) Chemical Application of radioisotopes H.J.M.Bowen Buttler and Tanner Ltd.
5) Introduction of Nuclear and Radiochemistry, G. Friedlaunder, T.W.Kennedy and J.M.Miller, John Wiley and sons 2nd Edn.
6) Nuclear Chemistry and its Applications, M.Haissinsky, Addison Welsley Publ. Company.

(SEMESTER-II)

PGCH-202 INORGANIC CHEMISTRY-II 5 Credits

Total No. of Lectures= 60Hrs

1. **Coordination Chemistry : (8)**

Introduction, Bonding in transition metal complexes, Valence bond theory, Crystal field theory, Molecular orbital theory. Electronic spectra and magnetic properties of transition metal compounds.

2. **Chemistry of Transition elements: (8)**

Introduction, occurrence & recovery, High oxidation states, structural trends, mononuclear oxocomplexes, polyoxometallates, intermediate oxidation states, metal-metal bonded compounds, noble character.

3. **Reaction mechanisms of d-metal complexes. (8)**

Introduction, Ligand substitution reactions, classification of mechanisms. The substitution of square-planar complexes, substitution of octahedral complexes, Rate law and their interpretation, Activation of octahedral complexes, stereochemistry, Isomerization reactions, Redox reactions, classification & theory of redox reactions, photochemical reactions, d-d and charge-transfer reactions, Transitions in metal-metal bonded systems.

4. **d – block organometallic compounds: (8)**

Bonding, valence electron count, d-block carbonyls, synthesis of carbonyls, structure, properties and reactions, Hydrogen and open-chain hydrocarbon ligands, cyclic polyene complexes, Reactivity of d-block and f-block organometallic compounds, Metal-metal bonding and metal clusters, structure and syntheses, Reactions of clusters, homogeneous catalysis

5. **f-block elements:** **(8)**

Lanthaindes: Introduction, methods of separation of Lanthanides, Lanthanide contraction, applications of Lanthanides.

Actindes: Introduction, methods of preparation and separation of actinides, applications of actinides.

Transactinide elements: Introduction, applications of transactinide elements.

6. **Basics of Bioinorganic Chemistry:** **(8)**

Introduction, Energy sources for life, metalloporphyrins, photosynthesis and Respiration, metalloenzymes, Nitrogen fixation, Biochemistry of Iron, Essential trace elements in biological systems, Biochemistry of non-metals.

Reference:

1. Concise Inorganic chemistry, J.D.Lee, 5th Edition, ELBS (1986).
2. Inorganic Chemistry: A.G.Sharpe, ELBS Edition (1984).
3. Inorganic Chemistry: D.F.Shriver, P.W.Atkins, 3rd Edition, Oxford University press (1999).
4. Inorganic Chemistry - Principles of structure and reactivity: J.E.Huheey, 3rd Edition (1983).
5. Inorganic Chemistry: D.F. Shriver, P.W.Atkins, C.H.Langford, ELBS, Oxford University press (1991).
6. Advanced Inorganic Chemistry: F.A.Cotton, R.G.Wilkinson, John Wiley (1984).
7. Structural Inorganic Chemistry: A.F. Wells, 5th Edition (1984).

(SEMESTER-II)

PGCH-203 ORGANIC CHEMISTRY-II 5 Credits

Total No. of Lectures= 60Hrs

(1) **Oxidation – Reduction** **(06)**

Oxidation:-

(A) Olefin:- Alkaline $KMnO_4$, OsO_4, Peracid, H_2O_2 and NaOH

(B) Alcohol:- Jone's reagent, Collin's reagent, MnO_2 and Oppenauer oxidation.

(C) Glycol – LTA.

(D) Ketone:- Baeyer – Villiger oxidation and SeO_2.

Reduction:- **(05)**

$LiAlH_4$, $NaBH_4$, Clemmenson's reduction, Wolf Kishner reduction, Birch, Lindlar and MPV.

(2) **Name Reactions.** **(08)**

Mechanism & Applications of –:
Perkin, Michael, Mannich, Stobbe condensation, Dieckmann Condensation, Vilsmayer, Dakin & Gatteamann – Koch.

(3) **Phosphorous & sulfur ylids**. **(04)**

Preparation of stabilized and destabilized 'P' and 'S' ylids. Reactions, applications, stereochemistry and Emmons modification.

(4) **Organometallics**. **(07)**

Mg, Li, Zn and Tl with applications.

(5) **Ultraviolet and Visible spectroscopy (UV-VIS).** **(05)**

Introduction, Beer Lamberts law, instrumentation, Calculation for absorptron maxima of dienes, enones and aromatic ketones. Applications.

(6) **Infrared spectroscopy (IR).** **(07)**

Introduction, instrumentation, Sampling technique selection rule, types of bonds,absorption of common functional groups, Factors affecting IR frequencies. Application to structural problems.

(7) **Nuclear Magnetic Resonance spectroscopy (NMR).** **(08)**

Magnetic & non-magnetic nuclei, Larmor frequency, absorption of radio frequency,sample preparation, chemical shift, anisotropic effects, spin–spin coupling, couplingconstants,applicationstostructural problems.

(8) **Mass spectroscopy (MS).** **(05)**

Principle, working of Mass spectrometer, formation of different ions, Mclafferty rearrangement, fragmentation of alkanes, alkyl aromatics, alcohols, ketones and applications. Simple structural problems based on IR, UV, NMR and MS.

(9) Problems based on UV,IR, NMR & MS Spectroscopy. **(05)**

Reference Books

1) Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill, 1988.
2) Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990.
3) Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976.
4) Spectroscopic methods in organic chemistry by Williams & Fleming, Tata – McGraw Hill, 4th edition, 1988.
5) Spectroscopy of organic Compounds by P.S.Kalsi, New Age International, 2nd edition, 1995.
6) Spectroscopic Identification of organic compounds by R.M.Silverstein and G.C.Bassler, 5th edition, 1991.

(SEMESTER - II)

PGCH-204 FUNDAMENTALS OF ANALYTICAL CHEMISTRY 5 Credits

TOTAL NO. OF LECTURES: 60 HRS.

Unit-I

A Role of analytical chemistry, classification of analytical methods classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Laboratory operations and practices. Analytical balances (Semmicro and Micro balance) and their use in analytical chemistry. Techniques of weighing and errors. Volumetric glassware – cleaning and calibration of glassware. Methods of sampling, Problems associated with Stoichiometric calculations based on gravimetry and titrimetry analysis of commercial samples. Transmission and storage of samples. Effects of sampling uncertainties samplers responsibility, sampling hazards.

(15)

B Statistical Analysis: (Emphasis should be placed on numerical problems) Collection, treatment and presentation of analytical data. Tru, standard and observed value. Definition of terms in mean and median. Errors in Chemical analysis, classification of errors, nature and origin of errors. Accuracy and precision. Average deviation and standard deviation and its physical significance. Normal Distribution curve and its properties. Co-efficient of variation. Confidence burt and probabiulity. Probability theorem, Probability curves, Comparison of analytical results. Tests for rejection of data. T-Test, F-test and Q-Test Significant figures and computation rules. Least squares method for deriving calibration graph. Curve fitting, Correlation co-efficient Limit of detection. Regression analysis and Statistical analysis of Chemical analysis.

(15)

Unit-II

Modern methods of separation:

A. Chromatography : General principles, Classification, Partition Chromatography, Adsorption Chromatography. Principles, Techniques and applications of Paper, Thin-Layer, Column, HPLC, Gas Chromatography and Electro Chromatography.

(10)

B. Ion-Exchange : Cation and Anion exchangers, Action of ion exchange resins. Ion-exchange equilibria and ion exchange capacity. Strongly and weakly acidic cation exchangers. Strongly and weakly basic anion exchangers. Liquid ion exchangers, chelating ion exchangers, techniques of ion exchange and application in analytical Chemistry. Separation using solvent mixtures.

(10)

C. Solvent Extraction: Basic principles, Significance of various terms. Classification, Factors favouring solvent extraction, Extraction equilibria. Synergetic effects, ion-pair extraction, salting out effect and stripping. Techniques of extraction by high molecular weight amines i.e. crown ethers, cryptands and calixarenes.

(10)

Unit-III

Optical Methods: (15)

A. Spectrophotometry and Colorimetry. Interaction of radiations with matter, Fundamental laws of Spectrophotometry. Beer – Lambert's law and its limitations Verification of Beer's law and deviation fromBeer's law. Choice of solvent. Ringbom's plot. Photometric titrations. Pk value of indicator. Outline of construction and working of the UV – Visible spectrophotometers. (Single and double beam). Applications of quantitative and qualitative analysis, Problems. Theory, instrumentation and applications of fluorimetry, turbidimetry and Nephelometry.

B. Flame Emission and atomic spectrometry : (15)

Flame photometry : Elementary theory of flame photometry, instrumentation and experimental techniques. Interferences, analytical techniques and applications Atomic Absorption Spectrometry (AAS); Introduction, Principle, Advantages of AAs over FES, Instrumentation, Flame atomization. Hollow cathod lamps, intereferences and applications.

Unit-IV

Environmental Chemistry: (07)

A.WATER POLLUTION: origin of waste water, types, water pollutants and their effects. Sources of water pollution, domestic, industrial agricultural soil and radioactive wastes as sources of pollution.

(05)

B. Objectives of analysis, parameter for analysis colour, conductivity, acidity, alkalinity, hardness, chloride, sulphate, Fluoride, Silica, Phosphates and different forms of nitrogen. Heavy metal pollution

(05)

C. public health significance of Lead, Manganese, Mercury and Arsenic. General survey of instrumental technique for water and aquatic life. Measurements of DO, BOD, COD and their significance as pollution indicators, Pesticides as water pollutants

B. AIR POLLUTION: green house effect, Sources of air pollution, air quality standards and sampling. Analysis of air pollutants (CO, No_x, So_x and Hydrocarbons and particulates) Effects of air pollution, Acid rain, Photochemical smog and air pollution control.

(13)

Unit-V :

A. Cell Structure and Functions: (08)

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their comparison. Origin of life-unique properties of carbon, chemical evolution and rise of living systems. Introduction of biomolecular, building blocks of bio-macromolecules proteins, enzymes, DNA and RNA). Helix coil transition.

(08)

B. Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Roll of sugars in biological recognition. Blood group substances. Ascorbic acid (Carbohydrate metabolism – Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphates pathway].

C. A mino-acids, Peptides and Proteins (06)

Chemical and enzymiatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, a-helix, b-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of proteinfolding and domain structure. Quaternary structure.

Amino acid metabolism – degradation and hiosynthesis of amino acids, sequence determination. Chemical/enzymatic/mass spectral, recemiozation / detection.

D. Nucleic Acids. (08)

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic Acids (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code.

Unit-VI :

A. Introduction to computers and computing. (15)

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage. Computer Languages. Operating system with DOS as an example. Introduction to UNIX and WINDOWS. Data processing, principles of programming. Algorithms and flow-charts.

B. Programming in Chemistry. (15)

Development of small computer codes involving simple formulae in chemistry, such as Vander Waal's equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy from experimental data. Linear simultaneous equation to solve secular equation within the Hockle theory. Elementary structural features such as bond lengths, bond angles of molecules extracted from data base such as Cambridge data base.

References:

1. Modern Spectroscopy – J.M.Hollas, John Wiley.
2. Applied Electron Specteroscopy for Chemical Analysis Ed.H.Windawi & F.L.Wo.Wiley Interscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V.Parish, Ellis Harwood.
4. Physical Methods in Chemistry – R.S.Drago, Saunders College.
5. Chemical Applications of Group Theory – F.A. Cotton.
6. Introduction to molecular Spectroscopy – G.M.Barrow, McGraw Hill.
7. Text book of Biochemistry, E.S.West; W.R.Todd; H.S.Mason, J.T.V.Bruggen oxford & IBH publishing co.pvt. Ltd.
8. Principles of Biochemistry, A.L.Lehniger, Worth Publisher.
9. Biochemistry, J.David Rawn, Neil Patterson.
10. Biochemistry, L.Stryer, W.H.Freeman.
11. Biochemistry, Vote and Voet, John Wiley.
12. Outlines of Biochemistry, E.E.Conn and P.K.Stmpf, John Wiley.
13. Environmental Chemistry, S.E.Manahan, Lewis Publishers.
14. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
15. Environmental Chemistry, A.K.De, Wiley Eastern.
16. Environmental Pollution Analysis, S.M.Khopkar, Wiley Eastern.
17. Environmental Toxicology, Ed. J.Rose, Gordon and Breach Science Publication.
18. Elemental Analysis of Airborne Particles, Ed.S.Landberger and M.Creatchman, Gordon and breach Science Publication.
19. Atmospheric Pollution, W.Buch, McGraw Hill, New York.
20. Fundamentals of Air Pollution, S.J.Williamson, Addison – Wesley Publishers.

21. Analytical Aspect of Environmental Chemistry, D.F.S.Natusch and P.K.Hopke, Hohn Willey & Sons. New York.
22. Analytical Chemistry – Problems and Solution – S.M.Khopkar, New Age International Publication.
23. Day & Underwood : Quantitative Analysis (Prentice Hall India Limited).
24. Findley: Practical Physical Chemistry:
25. A.I.Vogel A text book of quantitative inorganic Chemistry, ELBS, London.
26. Strouts Galfillal: Analytical Chemistry (Clarendon Press).
27. Yu.Lyalikov: Physicochemical Analysis (Mir Publishers).
28. Strouts Wilson & Parry Jones: Chemical Analysis Vol.I (Clarendon Press).
29. Meite4s and Thomas: Advanceds Analytical Chemistry, (McGraw Hill).
30. Willard Merritt and Dean: Instrumental methods of Analysis (Can Nostrand).
31. B.L.Kraayer, H.H.Willard, L.Merrit, J.A.Dean & F.A.Settle: Instrumental Methods of Analysis (CBS Pulishers, Delhi, 1986).
32. L.R.Shyder & C.H.Harvath: An Introduction to Separation Science (Wiley Interscience).
33. R.D.Brown Instrumental Methods of Chemical Analysis (Tata McGra Hill).
34. F.J.Wicher Robert : Standard Methods of Chemical Analysis.
35. Dr.G.L.David Krupadanam, D.Vijay Prasad, K.Varaprasad Rao, KLN. Reddy, C.Sudhakar, Analytical Chemistry.
36. Analytical Chemistry of Macrocyclic and supramolecular and Compounds – S.M.Khopkar – Narosa publication.
37. Perspectives in Environmental studies – Kaushik & Kaushik – New Age".

N.B.: Select any two units.

SYLLABUS OF M.Sc.I (ANALYTICAL/INORGANIC/ORGANIC CHEMISTRY)

(SEMESTER-I & II)

PGCH-206 PHYSICAL CHEMISTRY PRACTICALS 5 Credits

A) **Colorimetry**

1. pk Value of an acid base indicator.
2. Analysis of a given binary mixture by colorimetry.
3. Copper – EDTA Photometric Titration.

B) **pH Metry**

4. Hydrolysis of metal ions by pH – metry.
5. Determination of the acid and base dissociation constants of an amino acid and hence the isolectric point of the acid.
6. Dissociation constant of a weak acid using Henderson's equation.
7. Titration of a tribasic acid (Phosphoric acid) against sodium hydroxide and determination of pka values.

C) **Conductometry**

8. Determination of ionic product of water conductometrically.
9. Hydrolysis of Sodium Acetate/Aniline Hydrochloride.
10. Titration of a mixture of a Strong Acid & Weak acid against a Strong base.

D) **Potentiometry**

11. Determination of ionic product of water potentiometrically.
12. Solubility of sparingly soluble salt.
13. Esttimation of halide in a mixture
14. Determination of the dissociation constant of monobasic 1 dibasic acid by Albert – Serjeant method.

E) **Chemical Kinetics**

15. Bronsted primary salt effect.
16. Calculation of energy of activation by clock reaction of reaction between potassium Persulphate and potassium iodide.
17. Kinetics of iodination of acetone / aniline by colorimetry.
18. Determination of an order of a reaction between potassium persulphate and potassium iodide.

F) **Polarography**

19. Determine the half wave potential and unknown concentration of ion polargraphically.

G) **Noninstrumental**

20. Determination of surface area of given sample (Industrial pigment) by B.E.T method.
21. Radius of glycerol molecule by viscosity measurements.
22. Latent heat of fusion of naphthalene in Benzene / Toluene.
23. Heat of ionization.
24. To determine molecular weight of given organic liquid by steam distillation method.
25. Freundich and Langmuir isotherms for adsorption of acetic acid on charcoal.
26. Statistical Treatment of experimental data.

Each candidate should perform a minimum of 18 experiments with at least one experiment from each technique.

References

1) Practical Physical Chemistry, A. Finday, T.A. Kitchnner (Longmans, Green and Co.)

2) Experiments in Physical Chemistry J.M.Wilson, K.J.Newcomble, A.R.Denko, R.M.W. Richett (Pergamon Press).

3) Senior Practical Physical Chemistry, B.D.Khosla and V.S.Garg (R.Chand and Co., Delhi).

4) Advanced Practical in Physical Chemistry, Pande Datar Bhadance, Manali Prakashan.

(SEMESTER-I & II)

PGCH-207 INORGANIC CHEMISTRY PRACTICALS 5 Credits

I. Ore Analysis (any two of the following):

1) Determination of Mn from pyrolusite by a) gravimetric & b) volumetric methods.

2) Determination of Fe from haematite by a) gravimetric & b) volumetric methods

3) Determination of Cu from chalcopyrite by a) gravimetric & b) volumetric method.

4) Determination of Ti from ilmenite by a) gravimetric & b) volumetric methods

II. Alloy Analysis (any two of the following)

1) Determination of Tin and Lead from solder.
2) Determination of Copper & Nickel from cupronickel.
3) Determination of Chromium & Nickel from nichrome.

III. Preparation and characterization of inorganic compounds by physical or chemical methods (any five of the following)

1. Reinecke's salt.
2. Potassium trisoxalato aluminate (III).
3. Potassium trisoxalato ferrate (III).
4. Trisethylene diammine nickel (II) thiosulphate.
5. Tristhiourea copper (I) chloride.
6. Potassium trisoxalato manganate (III).
7. Chloropentammine cobalt (III) chloride.

IV. Colorimetry (two of the following)

1. Equilibrium constant for M-L systems such as

   (i) Fe (III) – Salicylic acid.
   (ii) Fe (III) – Sulphosalicylic acid.
   (iii) Fe (III) – β – resorcilic acid

   By Job's method and mole – ratio method.

2. Determination of

   (i) Ni^{+2} with Dimethyl glyoxime.
   (ii) Ti^{+4} with Hydrogen peroxide.
   (iii) Simultaneous determination of the following (any two).

      (a) Cr^{+6} and Mn^{+7} from given mixture.
      (b) Ti^{+4} and V^{+5} from given mixture.
      (c) Co^{+2} and Ni^{+2} from given mixture.

3. Effect of Temperature, time and pH on the stability of M-L systems such as

   (i) Fe (III) – Sulphosalicylic acid.
   (ii) Co (II) – R – Nitroso salt.
   (iii) Fe (III) – thiocyanate.

4. Effect of impurity on Beer's law for

   (i) Ni^{+2} on Co^{+2} – R – Nitroso salt.
   (ii) Fe^{+3} on V^{+5} – Hydrogen peroxide.
   (iii) Cu^{+2} on Fe^{+3} – Sulphosalicylic acid.

5. Photometric titrations such as

   (i) Cu^{+2} – EDTA.
   (ii) Fe^{+3} – sulphosalicylic acid.
   (iii) Co^{+2} – R – nitroso salt.
   (iv) Ni^{+2} – ethylenediammine.

V. Thermochemistry (any two of the following).

1. Lattice energy of binary salts by heat of dissolution systems such as $CaCl_2$, $CuCl_2$, $MnCl_2$, $CoCl_2$, $NiCl_2$.
2. Thermometric titrimetry of M – L systems such as

   (i) Cu (II) – ammonia.
   (ii) Hg (II) – iodide.
   (iii) Ni (II) – EDTA.

3. Spectrochemical series: Systems such as

   (i) Cu (II), Ni (II), Co (II) with conc. HCl, ammonia, EDTA.

VI. Potentiometry (any one of the following) :

1. Complexometric determination using disodium – EDTA of

   (i) Ni (II)
   (ii) Co (II)
   (iii) Al (III)
   (iv) Cu (II).

2. Determination of Zn with K_4 [Fe $(CN)_6$].

VII. Conductometry (any one of the following:

1. Electrolytic nature of transition metal compounds such as $[Co(NH_3)_6]$. Cl_3; K_3 $[Co(NO_3)_6]$; K_3 [Al $(C_2O_4)_3$].
2. Conductometric titration of H_3PO_4 with NaOH.

Reference :-

1. A test-book of quantitative inorganic analysis : A.I.Vogel, ELBS, 4th Edition.
2. Instrumental methods of analysis: H.H. Willard, J.A. Dean & L.L. Merit. (CBS).
3. Instrumental methods of analysis: Chatwal and Anand.
4. Principles of Instrumental analysis: D.Skoog and D.West.

SYLLABUS OF M.Sc.I (CHEMISTRY)
(SEMESTER I & II)

PGCH-208 ORGANIC CHEMISTRY PRACTICALS 5 Credits

(1) Techniques:- Crystallisation, fractional crystallization, simple distillation, fractional distillation, vacuum distillation, steam distillation, sublimation. and TLC.
(2) Derivatives:- 2,4 DNP, Semicarbazone, Acetyl and Oxime.
(3) Single stage preparations. (Any five)

(i) Benzaldehyde to Cinnamic acid.
(ii) Benzil to Benzilic acid.
(iii) Benzoin to Benzil.
(iv) Cyclohexanol to Cyclohexanone.
(v) Phthalimide to Anthranilic acid.
(vi) Benzoic acid to Benzamide.
(vii) Cyclohexanone to Adipic acid.
(viii) Nitrobenzene to Aniline.

(4) Two stage preparations (Any three)

(i) Cyclohexanone $\longrightarrow$ oxime $\longrightarrow$ Caprolactum.

(ii) Nitrobenzene $\longrightarrow$ m-dinitrobenzene $\longrightarrow$ m-nitroaniline.

(iii) Aniline $\longrightarrow$ benzenediazonium chloride $\longrightarrow$ Iodobenzene.

(iv) Benzaldehyde $\longrightarrow$ chalcone $\longrightarrow$ Epoxide.

(v) Chlorobenzene $\longrightarrow$ 2,4 dinitrochlorobezene $\longrightarrow$ 2,4 dinitrophenol.

(5) Binary mixtures (Ether separation only) (Any six).

Separation & characterization of two Components.

Solid –Solid, Solid – Liquid, Liquid – Liquid (non-volatile)

(6) Computer applications: (1) Conformational energetics of simple organic molecules through molecular mechanics force fields.
(2) Insights for reaction mechanisms of simple SN1 and SN2 reactions.

Reference books –

1) A text-book of practical organic chemistry by A.I.Vogel,4th edition, ELBS / Longman.
2) A hand book of quantitative and qualitative analysis by H.T.Clarke, Orient Longman.
3) Practical organic chemistry by Mann and Saunders.
4) Practical organic chemistry by O.P.Agarwal.
5)

BHARATI VIDYAPEETH
DEEMED UNIVERSITY, PUNE (INDIA)

Master of Science (Organic Chemistry)

M.Sc.-II (ORGANIC CHEMISTRY)

SEMESTER-III & IV

[2013 Course]

Choice Based Credit and Grade System
Under the Faculty of Science

SYLLABUS

(To be implemented from June 2013)

SYLLABUS OF ORGANIC CHEMISTRY PART-II

COURSE NO.	COURSE NAME	CREDITS
SEMESTER- III		
PGOC-301	Advanced Organic Reaction Mechanism	5 Credits
PGOC-302	Spectroscopic Methods In Structure Determination	5 Credits
PGOC-303	Advanced Stereochemistry	5 Credits
PGOC-304	Medicinal Chemistry	5 Credits
SEMESTER-IV		
PGOC-401	Synthetic Organic Chemistry	5 Credits
PGOC-402	Chemistry Of Natural Products	5 Credits
Elective Paper (Any One from PGOC-403 to PGOC-405)		
PGOC-403	Green Chemistry	3 Credits
PGOC-404	Applied Organic Chemistry	3 Credits
PGOC-405	Bio-Organic Chemistry	3 Credits
PGOC-406	Industrial Project	2 Credits
Lab Course / Practicals*		
PGOC-407	Mixture Separation	5 Credits
PGOC-408	Advanced Preparations	5 Credits
PGOC-409	Research Project / Laboratory Course	5 Credits

- University examination for the practical courses PGOC-407, PGOC-408, PGOC-409 will be conducted at the end of the year.

Bharati Vidyapeeth
Deemed University, Pune (India)

SYLLABUS OF M Sc (ORGANIC CHEMISTRY)
Semester III

Advanced Organic Reaction Mechanism

PGOC-301 **5 Credits**

Total No. of Lectures-60Hrs

Carbanions in Organic Chemistry **(25)**

Ionization of carbon hydrogen bond and prototopy, base and acid catalysed halogenation of ketones, keto-enol equilibria, Structure and rate in enolisation, Concerted and carbanion mechanism for tautomerism, Carbanion character in phenoxide and pyrrolyl anions, Geometry of carbanions, Hydrolysis of haloforms, Aldol, Mannich, Cannizzaro, Darzens, Dieckmann, Claisen Baylis-Hillman reactions, Knoevenagel, Benzoin Condensation, Alkylation of enolates.
Reactions of carbenes and nitrenes.

Heterocyclic Chemistry **(20)**

Synthesis and reactions of : Furon, Pyrrole, Thiophene, Benzofuran, Indole, Benzothiphene, Pyridine, Quinoline, Isoquinoline, Imidazole, Oxazole, Thiazole.

Synthesis of Chloroquine, Papavarine, Amlodipine, Bromouidine, Ranitidine, Vitamin-B6, Tryptophan, Thiamine, Histidine. **(15)**

Books/References:

1. Mechanism and structure in Organic Chemistry – E.S. Gould (Holt, Rinehart and Winston).
2. Advanced Organic Chemistry Part-A. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007).
3. Advanced Organic Chemistry by J. March, 6th Ed.
4. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers. Oxford University Press (2001).
5. Modern Heterocyclic Chemistry – L. A. Paquette (Benjamin).
6. Heterocyclic Chemistry – J. A. Joule and K. Mills 4th Edition Blackwell Publishing (2007).

Spectroscopic Methods in Structure Determination

PGOC-302 **5 Credits**

Total No. of Lectures- 60Hrs

1. Recapitulation of UV, IR and ^{1}H NMR**.** **(02)**

2. ^{1}H NMR **(23)**

(Advanced ideas) FT – techniques, Spin Coupling, Ramsay mechanism of spin coupling, Different spin systems (AB, AX, AMX systems, Calculation of line intensities), Factors affecting coupling constants, Rate processes. Different types of coupling. Methods used for simplification of PMR spectra. NOE, Spin decoupling. Two dimensional (2D) NMR Techniques, COSY, HETCOR. Applications of PMR**.**

3. ^{13}C NMR **(12)**

Elementary ideas, Instrumental problems, Chemical shift features of hydrocarbons, Effect of substituents on chemical shifts, Different type of carbons (alkene, alkyne, allene and carbonyl). DEPT(with 3 different angles), Application of ^{13}CNMR**.**

4. Mass Spectrometry **(15)**

Theory, Instrumentation, Various methods of ionization (field ionisation, EIMS, SIMS, FAB, MALDI), Different detectors (magnetic analyzer, ion cyclotron analyzer, Quadrupole mass filter, Time of flight (TOF). Rules of fragmentation of different functional groups, Factors controlling fragmentation. Application of Mass spectroscopy**.**

5. Problems based on joint application of UV, IR, PMR, CMR, and Mass. **(08)**

(Including reaction sequences)

Books/References:

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).
2. Spectrometric Identification of Organic Compounds - R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic Methods in Organic Chemistry - D. H. Williams and I. Flemming Mc Graw Hill
4. Absorption Spectroscopy of Organic Molecules – V. M. Parikh
5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986).
6. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
7. Organic Structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press(1998).
8. Organic Structural Spectroscopy- Joseph B.Lambert, Shurvell, Lightner, Cooks, Prentice-Hall
9. Organic structures from spectra –Field L.D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and Sons Ltd.

Advanced Stereochemistry

PGOC-303 **5 Credits**

Total No. of Lectures- 60Hrs

1. Stereochemistry of rings other than six membered **(10)**
   Ref. 1, 6, 7

2. Fused Bridged and Caged rings **(10)**
   Ref.1, 2, 6, 7

3. Recapitulation of prochirality, Homotopic and Heterotopic ligands, Stereoselectivity in cyclic compounds, Enantioselectivity, Diastereoselectivity, Stereoselective aldol reactions. Cram's rule, Felkin Anh rule, Cram's chelate model. Asymmetric synthesis use of chiral auxiliaries, Chiral reagents and catalysts, Asymmetric hydrogenation, Asymmetric epoxidation and asymmetric dihydroxylation. **(20)**
   Ref. 3 chapters 33, 34, 35

6. Stereochemistry of Morphine, Quinine and Strychnine **(20)**
   Ref. 4, 5, 6

Books/References:

1. Stereochemistry of Carbon Compounds - E. L. Eliel.
2. Stereochemistry of Carbon Compounds - E. L. Eliel and S. H. Wilen.
3. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
4. Chemistry of Natural Products – N. R. Krishnaswamy (University Press).
5. Organic Chemistry vol. II - I. L. Finar, 5th edition (Longman).
6. Stereochemistry of Organic Compounds –Nasipuri.
7. Stereochemistry of Organic Compounds – P. Kalasi.
8. Organic Stereochemistry – Jagadamba Singh.

Medicinal Chemistry

PGOC-304 **5 Credits**

Total No. of Lectures-60Hrs

1: Concepts of Medicinal Chemistry. (15)

Important terminology in medicinal chemistry: Drugs, Pharmacy, Pharmaceutics, Toxicology; Pharmacodynamic agents, Pharmacophore, Pharmacodynamics, metabolite and antimetabolites, chemotherapy. Mechanism of chemotherapeutic actions: 1) Biological defences 2) Chemical defences. a) Surface active agent, b) Metabolic antagonism. Assay of Drugs: Chemical assay, Biological assay, Immunological assay, LD-50 and ED-50.

2: Drug metabolism. (10)

Introduction, Oxidation, Reduction, Hydrolysis, Conjugation.

3: Antimicobacterial drugs. (15)

Introduction, First-line agents (Primary tubercular drugs): Structure and activity of streptomycin and dihydro-streptomycin, Synthesis and SAR of 4-amino salicylic acid and isoniazid.

4: Antibiotics. (20)

1. Introduction, classification of antibiotics,
2. Cell wall synthesis,
3. Mechanism of action of antibiotics, a) Inhibition of cell-wall synthesis, b) Inhibition of bacterial protein synthesis, c) Disorganization of the cytoplasmic membrane, d) Interference in the bacterial nucleic acid synthesis, e) Inhibition of the tetrahydro-folate biosynthesis.
4. Cell wall synthesis inhibitors (β-Lactam antibiotics): Synthesis of Penicillin-G, Amoxicillin, Aampicilin from 6-APA, Cephalexin, Structure and activity of benzyl penicillin, Semi-synthetic penicillin, Cephalosporin, Mode of action of penicillin and cephalosporin.

Books/References:

1. Medicinal Chemistry-William O. Foye
2. T. B. of Organic Medicinal and Pharmaceutical Chemistry-Wilson and Gisvold's (Ed. Robert F. Dorge).
3. An Introduction to Medicinal Chemistry-Graham L. Patrick
4. Principles of Medicinal Chemistry (Vol. I and II)-S. S. Kadam, K. R. Mahadik and K. G. Bothara (Nirali Prakashan).
5. Medicinal Chemistry (Vol. I and II)-Burger.
6. An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international).
7. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press).
8. Strategies for organic drug synthesis and design-D. Lednicer Wiley.
9. Pharmacological Basis of Therapeutics-Goodman and Gilman's (McGraw Hill).

Mixture Separation

PGOC- 407 **5 Credits**

TERNARY MIXTURE SEPARATION:

Separation of at least ten mixtures containing three components. The mixtures should also involve separation of nitro phenols, amino acids, low boiling substances, water soluble substances. Amines, Phenols and acids used should also contain other elements and functional groups. The mixture separation should be carried out on micro-scale using ether.

Advanced Preparations

PGOC-408 **5 Credits**

SINGLE STAGE AND TWO STAGE PREPARATIONS:

At least eight single stage and eight two stage preparations from the following should be carried out. The preparations should be carried out on micro scale.

Single Stage Preparations:

1. Acetophenone → Ethyl Benzene
2. Anthranilic acid → ortho Iodobenzoic acid
3. Diels-Alder reaction using Anthracene and Maleic anhydride
4. Benzyl cyanide → p-Nitro benzyl cyanide
5. Bromobenzene → p-Nitro bromobenzene
6. 2-Naphthol → 2,2'-Dihydroxybinaphthyl
7. Glycine → Hippuric acid
8. Salicylic acid → 5-Nitrosalicylic acid
9. Resorcinol Resacetophenone
10. 2-Methoxynephthalene →1-Formyl-2-methoxynaphthalene
11. p-Xylene →Ter-phthalic acid
12. o-Nitrotoluene + Benzaldehyde $\xrightarrow{\text{Base}}$ → condensation

Two Stage Preparations:

1. Benzophenone → Oxime → Benzanilide
2. Benzoin → Benzil → Benzilquinoxaline
3. Benzaldehyde + Acetophenone → Benzalacetophenone → Epoxide
4. 4-Nitrotoluene → 4-Nitrobenzoic acid → 4-Aminobenzoic acid
5. Resorcinol → 4-methyl-7-hydroxycoumarin → 4-methyl-7-acetoxy -coumarin
6. Phenol →Salicyaldehyde →Coumarin
7. Cyclohexanone → Phenylhydrazone →1,2,3,4- tetrahydrocarbazole
8. Acetanilide → p-Nitroacetanilide → p-Nitroaniline
9. Hydroquinone → Quinone → 1,2,4- Triacetoxybenzene
10. Cyclohexanone → Oxime → Caprolactum

11. Hydroquinone → Diacetate → 2,5-Dihydroxy acetophenone
12. 4-Chlorophenol → 4-Chlorophenyl acetate → 5-Chloro-2-hydroxyacetophenone

Interpretation of NMR, IR and Mass Spectra of about 15 compounds. Minimum 2 three stage preparations to demonstrate how to develop a synthetic sequence.

Syllabus of M Sc (Organic Chemistry), Semester-IV

Synthetic Organic Chemistry

PGOC-401 **5 Credits**

Total No. of Lectures- 60Hrs

1. Transition metal complexes in organic synthesis; only Pd, Ni, Co, Pt, Fe, Rh, Ru; Grubb's catalyst, Ziegler Natta catalyst. **(15)**
2. Use of Boron, Silicon and Tin in organic synthesis. **(12)**
   Ref.2, chapter 47
3. Designing of organic synthesis. **(20)**
4. Umpolung in organic synthesis. **(05)**
5. Protection and deprotection of hydroxyl, amino, carboxyl, ketone and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide. **(08)**

Books/References:

1. Modern Synthetic Reactions – H. O. House (Benjamin).
2. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
3. Designing of Organic Synthesis – S. Warren (Wiley).
4. Some Modern Methods of Organic Synthesis – W. Carruthers (Cambridge).
5. Organic Synthesis – M. B. Smith.
6. Organometallics in Organic Synthesis – J. M. Swan and D. C. Black (Chapman and Hall).
7. Advanced Organic Chemistry, Part B – F. A Carey and R. J. Sundberg 5^{th} edition (2007).

Chemistry of Natural Products

PGOC-402 **5 Credits**

Total No. of Lectures-60Hrs

1) Terpenoids **(15)**

Structure and synthesis of Abietic acid, Zingiberene, Santonin, Cuparenonne and Caryophyllene.

2) Alkaloids **(15)**

Structure, Stereochemistry, Synthesis and biosynthesis of morphine, reserpine, ephedrine, (+) conin.

3) a) Steroids **(08)**

Occurrence, Nomenclature, Basic skeleton, Diels hydrocarbon and study of the following Hormones: Androsterone, Testosterone, Estrone, Progesterone, Aldosterone and Cartisone. Biosynthesis of steroids.

b) Prostaglandins **(07)**

Occurrence, nomenclature, classification, biogenesis and physiological effects, synthesis of PGE2 and PGF2

4) Biogenesis **(08)**

Alkaloids (pyridine, morphine and indole type) Terpenoids, Cholesterol, Flavones, Coumarins, Carbohydrates and Proteins.

5) Vitamins **(07)**

Synthesis of biotin and vitamin B2, Synthesis of vitamin B1, Biological functions of B_6, B_{12}, folic acid and thiamine.

Books/ References:

1. The total synthesis of natural products- Apsimon.
2. Alkaloids - Manskey and Holmes.
3. Chemistry of Terpenes - A.A. Newmen.
4. The chemistry of natural products- P. D B.Mayo.
5. Terpenes- Simonson.
6. Aspects of terpenoid chemistry and biochemistry- T.W. Goddwin.
7. Vitamins and Co-enzymes- Woguer.
8. Chemistry of Natural products- P. W. Bently.
9. Steriods - Fieser and Fieser.
10. Organic Chemistry Vol. II and I- I. Finar.
11. The molecules of nature - J.B. Hendrickson.

12. The biogenesis of natural products Peter Bernfield.
13. Total synthesis of steroids- R.T. Slickenstaff A.C. Ghosh and G.C. Wole .
14. The chemistry of natural products- vol. Nakanishi.

Green Chemistry

PGOC-403 **3 Credits**

Total No. of Lectures-30Hrs

1. Introduction to Green Chemistry. (10)

Introduction, Principles, atom economy and scope, Inception to green chemistry, Introduction to alternative approaches, Solvent free reactions-principle, scope, utility of solvent free conditions, controlling solvent free reactions. Phase changes, optimum reaction temperatures, miscibility of reactants and catalysts.

Solvent free microwave assisted organic synthesis: Introduction, solvents free techniques-Reactions on solid mineral support, solid-solid phase transfer catalysts reactions without solvent, support or catalyst. Microwave activation-benefits, limitations, equipments, microwave effects-according to reaction medium and according to reaction mechanism.

2. Approaches to Green Chemistry. 10)

Basic principles of green synthesis:

a) Use of green reagents in green synthesis-dimethyl carbonate, polymer supported reagents-per acids, chromic acids.
b) Green catalysts: Acid catalysts, oxidation catalysts, and basic catalysts.
c) Phase transfer catalyst in green synthesis: Aliquat 336, benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride.
d) Advantages of PTC reactions to green synthesis. Applications of PTC's in C-alkylation, N-alkylation, S-alkylation, darzens reaction, Williamsons synthesis and Wittig reaction.

3. Microwave induced and ultrasound assisted green synthesis. (10)

Introduction to synthetic organic transformations under microwave.

a) Microwave assisted reactions in water: Hoffmann elimination, hydrolysis, oxidation, saponification reactions.
b) Microwave assisted reactions in organic solvents: Esterification reactions, Fries rearrangement, Ortho ester Claisen rearrangement, Diels-Alder reaction, decarboxylation.
c) Microwave solvent free reactions (solid state reactions): Deacetylation, Deprotection, saponification of ester, alkylation of reactive methylene compounds, synthesis of nitriles from aldehydes, and reductions.

d) Ultrasound assisted reactions: Introduction, substitution, addition, oxidation, reduction reactions.

Books /References:

1. Organic Chemistry, vol-2, I.- L. Finar, ELBS.
2. Stereoselective Synthesis: A practical Approach- M. Nogrudi, VCH.
3. Organic Synthesis in water- Paul A. Grieco Blackie.
4. Green Chemistry, theory and practice- Paul T. Anastas and John C. Warner.
5. New Trends in Green chemistry- V. K. Ahluwalia and M. Kidwai.
6. Organic Synthesis: Special techniques- V. K. Ahluwalia and Renu Aggarwal.

Applied Organic Chemistry

PGOC-404 **3 Credits**

Total No. of Lectures-30Hrs

1) Agrochemical: **(15)**

a. Carbamate pesticides: Introduction, carbaryl, Baygon, Aldicarb, Ziram, Zineb
b. Organophosphorus pesticides: Malathion, monocrotophos, dimethoate, phorate, mevinphos
c. Insect repellents: General survey and synthesis
d. Juvenile harmone: introduction structures JHA importance synthesis
e. Pheromones: introduction, examples, and importance in IPM synthesis of juvabione bombycol, grandisol, and disparure

2) Dyes and Intermediates: **(15)**

Synthesis of important dye intermediates. Commercial processes for Azo dyes, reactive dyes, optical brighteners, thermal sensitive dyes, dispenses dyes.

References/ Books:

1. Colour Chemistry – Allan.
2. Chemistry of Synthetic Dyes Vol- 1 to 7.- K. Venkataraman
3. Dyes & their intermediates- Abrahart.
4. The Chemistry of Pesticides and formulations - N. N. Melikov.
5. Chemistry of Pesticides- K. H. Buchel.
6. Pesticides - R. Cleymlin.
7. Text book of Polymer Science- F. W. Billmeyer.
8. Contemporary Polymer Chemistry- H. R. Alcock and F. W. Lambe.
9. Physics & Chemistry of Polymers- J. M. G. Cowie, Blackie.

10. Unit Processes in Organic Synthesis- P. H. Groggins.
11. Perfumary Technology-. B. Biollot & P. V. Wells
12. A formulary of Cosmetic Preparations- M. Ash & I. Ash.

Bio-Organic Chemistry

PGOC-405 **3 Credits**

Total No. of Lectures-30Hrs

1: Enzymes **(15)**

Definition, Classification and nomenclature of enzymes. Factors affecting the enzyme catalysed reactions. Advantages and limitations of enzymes in organic synthesis-mechanistic aspects of enzyme catalysis -Lock and Key mechanism, Induced-Fit mechanism, Michaelis-Menten Equation, Desolvation and salvation-substitution theory, Three point attachment rule. Factors affecting the enzyme catalysed reactions. Enzyme selectivity-Chemo, regio, diastereo and enantio selectivity-Illustration with suitable examples.

2: Nucleic acids **(15)**

Introduction, Hydrolysis of nucleic acids, Structure physical and chemical properties of the heterocyclic bases-Adenine, Guanine, Cytosine, Uracil and Thiamine. structure and synthesis of nucleosides and nucleotides. Deoxyribose nucleic acid (DNA): Primary, secondary, tertiary structure of DNA. Structure of RNA. Types of RNA- mRNA, rRNA and tRNA.

Books/ References:

1. Natural products: Chemistry and Biological significance- J.Mann, R.S.Davidson, J.B.Hobbs, D.V., Banthropde & J. B. Harborne, Longm, an, Essex.

Lab Course/ Practicals

PGOC-409 5 Credits

PROJECT AND PRACTICALS:

1. Students should carry out a small research project. This should make them familiar with literature survey, research methodologies, Identification of products by analytical and spectral methods and familiarity with chromatographic techniques.

2. Students who are not assigned the project should carry out at least 12 experiments and students who are assigned project work should carry out at least 6 experiments to illustrate the principles of organic reaction mechanism, stereochemistry or selectivity of reagents.

Suggested reagents and reactions –

$LiAlH_4$ (reduction of ethyl benzoate to benzyl alcohol), $NaBH_4$ (reduction of anisaldehyde to p- methoxy benzyl alcohol), SeO_2, NBS(bromination of p-nitrotoluene), Grignard Reaction (preparation of triphenyl carbinol or diphenyl methyl carbinol), Wittig Reaction (preparation of ethyl cinnamate from benzaldehyde), Cannizzaro's reaction (on benzaldehyde) Asymmetric reduction, Phase transfer catalyst isolation of natural products (like Eugenol from cloves, Limonene from orange peels, Trimyristin from nutmeg etc.), photochemical reaction, Peracid and lead tetra acetate oxidation, rearrangement reactions, synthesis of heterocyclic compounds like Hydantoin, thiohydantoin, pyrazolone, Biginelli reaction (synthesis of 4-aryl-3,4-dihydropyrimidinone).