UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A ++' GRADE' UNIVERSITY)
Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

Academic Section
Email: academicsectionju14@gmail.com

NOTIFICATION
(25/June/Adp./10)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the syllabi and courses of studies for **Post Graduate Programme in Chemistry under NEP-2020** as per details given below:-

Two Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Chemistry	Semester-I	December 2025, 2026 and 2027
	Semester-II	May 2026, 2027 and 2028
	Semester-III	December 2026, 2027 and 2028
	Semester-IV	May 2027, 2028 and 2029

One Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Chemistry	Semester-I	December 2026, 2027 and 2028
	Semester-II	May 2027, 2028 and 2029

The Syllabi of the courses are also available on the University website: www.jammuuniversity.ac.in

DEAN ACADEMIC AFFAIRS

No. F. Acd/II/25/8401-20
Dated: 19/6/25
Copy for information and necessary action to:

1. Dean, Faculty of Science
2. Convener, Board of Studies in **Chemsitry**
3. Director, Centre for IT Enabled services and Management, University of Jammu for information and for uploading on University Website.
4. All members of the Board of Studies
5. Joint Registrar (Evaluation/P.G. Exam.)
6. Programmer, Computer Section, Examination Wing

Syllabus of

Post Graduation (CHEMISTRY)

For two years

(as per NEP-2020)

PROGRAMME SPECIFIC OUT COMES (PSO)

The courses are designed in such a manner that the student feels an essence of studying the specialized courses of Chemistry in various semesters with a keen interest. The curriculum of Post-Graduation in Chemistry as per NEP-2020 is designed to motivate Post Graduate students to achieve the following program specific outcomes:

1. To enable the students to modulate, simulate and validate the advanced concepts related to different branches of Chemistry.
2. To practice and solve numerical problems and also to understand the mechanism of advanced organic/inorganic reactions and various theories associated with the latest developments.
3. To develop communication and other skills for use in a wide range of industrial areas.
4. To give a practical training with the sophisticated instruments/equipments.
5. To create an awareness and the impact of chemistry on the environment, society and development outside the scientific community.
6. To inculcate the scientific temperament in the students and outside the scientific community.
7. To understand good laboratory practices and safety measures and to develop research oriented skills.

For Two Year PG (Total Credits: 92)

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
1.	P2CHTC101	Inorganic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC102	Quantum Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC103	Organic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC104	Principles of Spectroscopy	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC105	Practical Course in Inorganic, Organic & Physical Chemistry-I	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
6.	P2CHTC201	Inorganic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
7.	P2CHTC202	Chemical Dynamics, Surface and Electro Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
8.	P2CHTC203	Organic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
9.	P2CHTC204	Applications of Spectroscopy in Organic Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
10.	P2CHPC205	Practical Course in Inorganic, Organic & Physical Chemistry-II	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
11.	P2CHVC251	Vocational Course	4	6.5	26	Core	-	100	Global	-	-	-	-	Vocational Course	-
12.	P2CHTC301	Environmental Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
13.	P2CHTC302	Nano-Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
14.	P2CHTC303	Bioorganic and Medicinal Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
15.	P2CHTE304	Analytical Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
16.	P2CHTE305	Spectroscopy and Photochemistry in Inorganic Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
17.	P2CHTE306	Heuristic Approach to Organic Synthesis	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
18.	P2CHTE307	Chemistry of Natural Products	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
19.	P2CHTE308	Thermodynamics and Statistical Mechanics	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
20.	P2CHTE309	Chemistry of Materials and Liquids	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
21.	P2CHPE310	Practical Course in Inorganic Chemistry	4	6.5	26	Elective	-	100	Global	-	-	Skill	-	-	-
22.	P2CHPE311	Practical Course in Organic Chemistry	4	6.5	26	Elective	-	100	Global	-	-	Skill	-	-	-
23.	P2CHPE312	Practical Course in Physical Chemistry	4	6.5	26	Elective	-	100	Global	-	-	Skill	-	-	-
24.	P2CHMO351	MOOC/SWAYAM Course	4	6.5	26	Elective	100	-	Global				SWAYAM/ MOOC	-	-
25.	P2CHTE401	Organotransition Metal Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
26.	P2CHTE402	Bioinorganic and Supramolecular Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
27.	P2CHTE403	Chemistry of Heterocyclic Compounds	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
28.	P2CHTE404	Catalysis in Organic Synthesis	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
29.	P2CHTE405	Solid State Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
30.	P2CHTE406	Polymer Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
31.	P2CHPE407	Project in Inorganic Chemistry	16	6.5	104	Elective	-	400	Global	-	-	Skill	-	-	Project
32.	P2CHPE408	Project in Organic Chemistry	16	6.5	104	Elective	-	400	Global	-	-	Skill	-	-	Project
33.	P2CHPE409	Project in Physical Chemistry	16	6.5	104	Elective	-	400	Global	-	-	Skill	-	-	Project

COURSE STRUCTURE FOR TWO YEAR PG (FOR EXIT AFTER ONE YEAR)

S. No.	Course No.	Course Title	No. of Credits	Credits Level	Credit Point	Course Type Core/Elective/ Any Other	Marks Theory	Marks Practical	Nature of Course Global	National	Regional	Skill	SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
Semester-I															
1.	P2CHTC101	Inorganic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC102	Quantum Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC103	Organic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC104	Principles of Spectroscopy	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC105	Practical Course in Inorganic, Organic & Physical Chemistry-I	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-I)	**20**				**500**								
Semester-II															
1.	P2CHTC201	Inorganic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC202	Chemical Dynamics, Surface and Electro Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC203	Organic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC204	Applications of Spectroscopy in Organic Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC205	Practical Course in Inorganic, Organic & Physical Chemistry-II	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
6.	P2CHVC251	Vocational Course	4	6.5	26	Core	-	100	Global	-	-	-	-	Vocational Course	-
		Total Credits (Semester-II)	**24**				**600**								
		Total Credits (Semester-I & II)	**44**				**1100**								

COURSE STRUCTURE FOR TWO YEAR PG

[Students have to choose one specialization from Inorganic/Organic/Physical Chemistry, in IIIrd and IVth Semester]

INORGANIC CHEMISTRY

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
Semester-I															
1.	P2CHTC101	Inorganic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC102	Quantum Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC103	Organic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC104	Principles of Spectroscopy	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC105	Practical Course in Inorganic, Organic & Physical Chemistry-I	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-I)	**20**				**500**								
Semester-II															
1.	P2CHTC201	Inorganic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC202	Chemical Dynamics, Surface and Electro Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC203	Organic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC204	Applications of Spectroscopy in Organic Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC205	Practical Course in Inorganic, Organic & Physical Chemistry-II	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-II)	**20**				**500**								
Semester-III															
1.	P2CHTC301	Environmental Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC302	Nano-Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC303	Bioorganic and Medicinal Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTE304	Analytical Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
5.	P2CHTE305	Spectroscopy and Photochemistry in Inorganic Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
6.	P2CHPE310	Practical Course in Inorganic Chemistry	4	6.5	26	Elective	-	100	Global	-	-	Skill	-	-	-
7.	P2CHMO351	MOOC/SWAYAM Course	4	6.5	26	Elective	100	-	Global				SWAYAM/ MOOC	-	-
		Total Credits (Semester-III)	**28**				**700**								
Semester-IV															
1.	P2CHTE401	Organotransition Metal Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
2.	P2CHTE402	Bioinorganic and Supramolecular Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
3.	P2CHRE407	Project in Inorganic Chemistry	16	6.5	104	Elective	-	400	Global	-	-	Skill	-	-	Project
		Total Credits (Semester-IV)	**24**				**600**								
		Total Credits (Semester-I, II, III & IV)	**92**				**2300**								

COURSE STRUCTURE FOR TWO YEAR PG

[Students have to choose one specialization from Inorganic/Organic/Physical Chemistry, in IIIrd and IVth Semester]

ORGANIC CHEMISTRY

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
Semester-I															
1.	P2CHTC101	Inorganic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC102	Quantum Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC103	Organic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC104	Principles of Spectroscopy	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC105	Practical Course in Inorganic, Organic & Physical Chemistry-I	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-I)	**20**				**500**								
Semester-II															
1.	P2CHTC201	Inorganic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC202	Chemical Dynamics, Surface and Electro Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC203	Organic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC204	Applications of Spectroscopy in Organic Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC205	Practical Course in Inorganic, Organic & Physical Chemistry-II	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-II)	**20**				**500**								
Semester-III															
1.	P2CHTC301	Environmental Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC302	Nano-Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC303	Bioorganic and Medicinal Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTE306	Heuristic Approach to Organic Synthesis	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
5.	P2CHTE307	Chemistry of Natural Products	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
6.	P2CHPE311	Practical Course in Organic	4	6.5	26	Elective	-	100	Global	-	-	Skill	-	-	-

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
		Chemistry													
7.	P2CHMO351	MOOC/SWAYAM Course	4	6.5	26	Elective	100	-	Global				SWAYAM/ MOOC	-	-
		Total Credits (Semester-III)	**28**				**700**								
Semester-IV															
1.	P2CHTE403	Chemistry of Heterocyclic Compounds	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
2.	P2CHTE404	Catalysis in Organic Synthesis	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
3.	P2CHRE408	Project in Organic Chemistry	16	6.5	104	Elective	-	400	Global	-	-	Skill	-	-	Project
		Total Credits (Semester-IV)	**24**				**600**								
		Total Credits (Semester-I, II, III & IV)	**92**				**2300**								

COURSE STRUCTURE FOR TWO YEAR PG

[Students have to choose one specialization from Inorganic/Organic/Physical Chemistry, in IIIrd and IVth Semester]

PHYSICAL CHEMISTRY

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
Semester-I															
1.	P2CHTC101	Inorganic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC102	Quantum Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC103	Organic Chemistry-I	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC104	Principles of Spectroscopy	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC105	Practical Course in Inorganic, Organic & Physical Chemistry-I	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-I)	**20**				**500**								
Semester-II															
1.	P2CHTC201	Inorganic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC202	Chemical Dynamics, Surface and Electro Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC203	Organic Chemistry-II	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTC204	Applications of Spectroscopy in Organic Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
5.	P2CHPC205	Practical Course in Inorganic, Organic & Physical Chemistry-II	4	6.5	26	Core	-	100	Global	-	-	Skill	-	-	-
		Total Credits (Semester-II)	**20**				**500**								
Semester-III															
1.	P2CHTC301	Environmental Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
2.	P2CHTC302	Nano-Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
3.	P2CHTC303	Bioorganic and Medicinal Chemistry	4	6.5	26	Core	100	-	Global	-	-	-	-	-	-
4.	P2CHTE308	Thermodynamics and Statistical Mechanics	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
5.	P2CHTE309	Chemistry of Materials and Liquids	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-

S. No.	Course No.	Course Title	No. of Credits			Course Type	Marks		Nature of Course				SWAYAM/ MOOC	Vocational Course	Research Project/ SummerInternship/Dissertation
				Credits Level	Credit Point	Core/Elective/ Any Other	Theory	Practical	Global	National	Regional	Skill			
6.	P2CHPE312	Practical Course in Physical Chemistry	4	6.5	26	Elective	-	100	Global	-	-	Skill	-	-	-
7.	P2CHMO351	MOOC/SWAYAM Course	4	6.5	26	Elective	100	-	Global				SWAYAM/ MOOC	-	-
		Total Credits (Semester-III)	**28**				**700**								
Semester-IV															
1.	P2CHTE405	Solid State Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
2.	P2CHTE406	Polymer Chemistry	4	6.5	26	Elective	100	-	Global	-	-	-	-	-	-
3.	P2CHRE409	Project in Physical Chemistry	16	6.5	104	Elective	-	400	Global	-	-	Skill	-	-	Project
		Total Credits (Semester-IV)	**24**				**600**								
		Total Credits (Semester-I, II, III & IV)	**92**				**2300**								

COURSE SPECIFIC OUTCOMES (CSO)

S. No.	Course No.	Course Title	Course Outcome
4.	P2CHTC101	Inorganic Chemistry-I	This course will enable the students to learn the concept of group theory and its applications, stereochemistry and bonding, theories of bonding, metal-ligand equilibria as well as electronic spectra of transition metal complexes. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
5.	P2CHTC102	Quantum Chemistry	This course will help to understand the various aspects of quantum mechanics. In addition, the students will gather knowledge about angular momentum, approximation methods, chemical bonding, HMO methods and its applications. This course also offers employability in the research institutes and academics.
6.	P2CHTC103	Organic Chemistry-I	This course is focussed on nature of bonding in organic molecules, stereochemistry, reaction mechanism, aliphatic nucleophilic substitution and free radical reactions. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
7.	P2CHTC104	Principles of Spectroscopy	By studying this course, the students are able to concentrate on physical aspects of various techniques of spectroscopy, namely, microwave, vibrational, Raman, NMR. Information about X-ray and neutron diffraction techniques will also be dealt. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
8.	P2CHPC105	Practical Course in Inorganic, Organic & Physical Chemistry-I	This course will help the students to learn how the rare analysis of metals is analyzed and simultaneously to prepare and characterize coordination complexes. After completing this course, students will be employable in R&D divisions of Industries Research and Academic Institutes. The organic synthesis of various compounds with characteristic functional groups will be carried out. IR spectra will be used to identify various functional groups. Error analysis and statistical analysis data will be analyzed by the students before proceeding to the actual performance of various experiments as mentioned in the following details.
9.	P2CHTC201	Inorganic Chemistry-II	By studying this course, the students will come to know the mechanism of reactions in inorganic complexes, magnetic properties of complexes and metal clusters framework of complexes. After completing this course, students will be employable in R&D divisions of Industries Research and Academic Institutes.
10.	P2CHTC202	Chemical Dynamics, Surface and Electro Chemistry	This course will help to understand chemical kinetics using various theories of bimolecular and unimolecular reactions. Polymer Chemistry, Micelles and Advanced Electrochemistry details will be imparted to the students. A brief idea of nano materials is also introduced. This course also offers employability in the Research and Development sector, research institutes and academics.
11.	P2CHTC203	Organic Chemistry-II	The contents of this course are focussed on electrophilic, nucleophilic substitution, addition, elimination reactions from their mechanistic point of view. Rearrangement and pericyclic reactions will also be dealt in this course. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
12.	P2CHTC204	Applications of Spectroscopy in Organic Chemistry	The course is designed from application point of view. The different spectroscopic techniques used in organic chemistry will be considered and number of examples will be put before the students to solve making use of different spectroscopic techniques. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
13.	P2CHPC205	Practical Course in Inorganic, Organic & Physical Chemistry-II	This course will help the students to learn how the rare analysis of metals is analyzed and simultaneously to prepare and characterize coordination complexes. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

S. No.	Course No.	Course Title	Course Outcome
14.	P2CHVC251	Vocational Course	This course is designed to equip students with practical skills in analytical methodologies, preparing them for a range of career opportunities. The course emphasizes hands-on expertise and real-world application, fostering both entrepreneurship and employability in the rapidly advancing field of analytical science.
15.	P2CHTC301	Environmental Chemistry	This course will enable the students to learn about the chemistry atmosphere, biosphere, hydrosphere, lithosphere and will to gain knowledge on air, water, soil, marine and solid waste management as well as environmental toxicology. This course will also familiarize with the green chemistry, environmental issues and analytical techniques.
16.	P2CHTC302	Nano-Chemistry	The aim of this course is to inculcate the knowledge among students related to the basics of Nano-materials, their synthesis, characterization, properties and applications. The course will have employability in the industry, research and academic fields.
17.	P2CHTC303	Bioorganic and Medicinal Chemistry	The aim of this course is to let the students understand enzymatic action, coenzymes, chemistry of vitamin B complex, co-crystals, carbohydrates metabolism, drug design, chemistry of antibiotics, mechanism of action of vitamins etc. This paper has scope of employability in medicinal chemistry and as scientist in research laboratories.
18.	P2CHTE304	Analytical Chemistry	This course is aimed to have an insight of various analytical techniques in analyzing the chemicals quantitatively. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
19.	P2CHTE305	Spectroscopy and Photochemistry in Inorganic Chemistry	This course is aimed to have an insight of various spectroscopic tools in analyzing the inorganic molecules/complexes. The ligand field photochemistry is also a part of the course. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
20.	P2CHTE306	Heuristic Approach to Organic Synthesis	On successful completion of this course, the students will gain knowledge about disconnection approach, planning the synthesis of organic compounds and natural products, photochemistry and asymmetric cycloaddition reactions. The learning from this course will help the students to get jobs in R &D laboratories, pharmaceutical industry and academics.
21.	P2CHTE307	Chemistry of Natural Products	After successful completion of this course, the student will gain knowledge about various natural products such as terpenoids, carotenoids, alkaloids, steroids, plant pigments and marine natural products, and their biosynthetic pathways.
22.	P2CHTE308	Thermodynamics and Statistical Mechanics	This course will be useful in understanding the non-equilibrium thermodynamics, transport phenomenon, thermodynamics of mixtures, statistical mechanics / thermodynamics and their applications.
23.	P2CHTE309	Chemistry of Materials and Liquids	Students will acquaint knowledge about chemistry of different materials like alloys, ceramics, composites and liquid crystals. The properties of liquids along with the various theories of liquids also form a part of discussion in this course. This course also offers employability in the field of research and development, research institutes besides academics.
24.	P2CHPE310	Practical Course in Inorganic Chemistry	This course aims to develop an understanding of synthesis, quantitative and qualitative analysis, separation of cations by Paper, Thin layer and Column chromatography. The students will also be trained to prepare and characterise the compounds using the available techniques.
25.	P2CHPE311	Practical Course in Organic Chemistry	In this course, students will be trained to employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment and, society. This paper has scope of employability in academics and in research institution and pharmaceutical industries.
26.	P2CHPE312	Practical Course in Physical Chemistry	Students will employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment, society, and other cultures outside the scientific community. There will also be a course based on review of literature on any modern scientific topic.
27.	P2CHMO351	Title of the	**Course Objectives:**

S. No.	Course No.	Course Title	Course Outcome
		MOOC/SWAYAM course opted by students	• To provide the students high quality learning experience using multimedia on anytime, anywhere basis. • To acquaint the students with online mode of learning using ICT platform. • To diverse the knowledge of students through open learning and help them to access different disciplines online and thus promoting interdisciplinary knowledge. • To provide the students a hybrid model of learning that adds to the quality of classroom teaching.
28.	P2CHTE401	Organotransition Metal Chemistry	This course will enable the students to learn basic concepts, different bonding behaviour, synthetic and structural aspects of transition metal-carbon bond. Students will also gain the knowledge of applications of these compounds in various fields as catalyst with full understanding of their mechanism.
29.	P2CHTE402	Bioinorganic and Supramolecular Chemistry	The focus of this course is to enable the students to learn about the bioinorganic and molecular recognition and design of molecules for the beneficial of society.
30.	P2CHTE403	Chemistry of Heterocyclic Compounds	An exhaustivestudy of heterocyclic chemistry will be presented which will help the students to grasp its chemistry. This paper includes the different types of reaction mechanism in the preparation of different ring size heterocyclic compounds and also their biological importance. This will help students to get employability in Research and Development.
31.	P2CHTE404	Catalysis in Organic Synthesis	On successful completion of this course, the students will gain knowledge about asymmetric catalysis including organocatalysis and metal catalysis. This will train the students to perform asymmetric organic transformations. In addition, the learning from this course will help the students to get employment in industry and academia.
32.	P2CHTE405	Solid State Chemistry	The students will have an understanding of general principles of solid state reactions, preparation, methods and crystal symmetry, defects/structure of solids and their electronic, ionic conduction and magnetic properties.
33.	P2CHTE406	Polymer Chemistry	Basic aspects of polymer chemistry and their characterization, structure and properties of polymers, polymer processing and properties of commercial polymers are discussed in this course work.
34.	P2CHRE407	Project in Inorganic Chemistry	The Projects have been designed so as to provide exposure to students in various experimental aspects of Inorganic Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
35.	P2CHRE408	Project in Organic Chemistry	The Projects have been designed so as to provide exposure to students in various experimental aspects of Organic Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.
36.	P2CHRE409	Project in Physical Chemistry	The Projects have been designed so as to provide exposure to students in various experimental aspects of Physical Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

Exit Point Policy for the 2-Year PG Programme:

- There will be **one exit point** in the 2-year PG programme — at the **end of the 1st year** (after Semester-II).
- Students who choose to exit at this stage will be awarded a **Postgraduate Diploma**.
- The **PG Diploma** will be specifically titled: **Postgraduate Diploma in Spectroscopic Techniques**.
- To qualify for the diploma, students must complete an **additional 4-credit work-based vocational course** in **Analytical Techniques** during the **summer term** (Duration: **8 weeks**).
- This additional course is **mandatory** for students intending to exit early with the diploma.

SCHEME OF EXAMINATION FOR THEORY COURSES

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have**06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

In addition, there shall be a MOOC course through SWAYAM Portal which the students have to study in Semester III.

SCHEME OF EXAMINATION FOR PRACTICALS

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
Internal Examination	100%	8 hours	50

	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
External Examination	100%	8 hours	50
Total			100

Distribution of Marks in Practical Courses in 1st and 2nd Semesters

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 05 Marks each) **Total Marks = 15**

Practical Examination (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 10 Marks each) **Total Marks = 30**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and<80 % = 02 Marks

External Practical Examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 14 Marks each) **Total Marks = 42 Marks**

Viva-voce Examination =08 Marks

Distribution of Marks in Practical Course in 3rdSemester

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment (Inorganic Chemistry /Organic Chemistry / Physical Chemistry: **15 Marks**

Practical Examination (Inorganic Chemistry / Organic Chemistry / Physical Chemistry) :**30 Marks**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and < 80 % = 02 Marks

External Practical examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination (Inorganic Chemistry / Organic Chemistry / Physical Chemistry) :**42 Marks**

Viva-voce Examination = 08 Marks

SCHEME OF EXAMINATION FOR RESEARCH (DISSERTATION/PROJECT)

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

	Time allotted for the examination	**% Weightage (Marks)**		
Mid Term Appraisal	4 hours	25%		
External Examination	4 hours	75%	50%	Project Report
			25%	Viva-Voce
Total				100

Distribution of Marks in Research (Dissertation/Project) in 4th Semester

Total Credits = 16, Total Marks = 400

Internal Evaluation = 100 Marks, External Evaluation = 300 Marks

Internal Research (Dissertation/Project) Evaluation

Assessment of Research (Dissertation/Project) shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of the Department and concerned teacher who shall evaluate/assess dissertation of the students.

External Research (Dissertation/Project) Evaluation

Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of concerned Department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess dissertation of the students.

Course Code: P2CHTC101 **Nature of Course: Core**
Title: Inorganic Chemistry-I
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *This course will enable the students to learn the concept of group theory and its applications, stereochemistry and bonding, theories of bonding, metal-ligand equilibria as well as electronic spectra of transition metal complexes.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Concept of Group theory in Chemistry and its Applications (12 hours)
Symmetry elements and symmetry operations, Definitions of group, Subgroup, Point symmetry groups, Schonfilies symbols, Symmetry operations as group elements, Multiplication table, Conjugacy relation and classes, Representation of symmetry operations by matrices, Character of a representation, Reducible & irreducible representation, Derivation of Character tables for C_{2v}, C_{3v}, C_{2h}, Simple applications of Character Table

UNIT-II: Stereochemistry and Bonding in Main Group Compounds (12 hours)
VSEPR, Walsh diagram for triatomic molecules, Bent rule and energetics of hybridization, $d\pi$-$p\pi$ bonds, Chemistry of inorganic rings and cages, Borazines, Phosphazenes, Polyhedral boranes, Carboranes, Metalloboranes and Metallocarboranes.

UNIT-III: Theories of Bonding in Transition Metal Complexes (12 hours)
Shortcomings in Valence Bond Theory, Crystal field splitting in Octahedral, Tetrahedral, Square planar, Square Pyramidal and Trigonal Bipyramidal complexes, Structural effects of crystal field splitting, Variation of hydration energies and ionic radii of metal ions, site selection of cations in spinal and inverse spinals, Lattice energy, Molecular orbital theory, MO energy level diagrams for octahedral, tetrahedral and square planar complexes, π bonding and M.O theory, Variation of Δ_o with the π acceptor and σ donor ligand.

UNIT-IV: Metal-Ligand Equilibria in Solution (12 hours)
Stepwise and overall formation constants and their interaction, Trends in stepwise constants, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Determination of binary formation constants by pH-metry, Formation of colored complexes in solution in different metal to ligand ratios, Calculation of stability constant of a complex formed in 1:1 metal to ligand ratio by spectrophotometric method, Determination of ε.

UNIT-V: Electronic Spectra of Transition Metal Complexes (12 hours)
Spectroscopic ground states, Term symbol, Splitting of terms by ligands, Rules for electronic transitions, Correlation diagrams, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 –d^9), Calculation of Dq, B and β Parameters, Nephelauxetic effect and Jahn-Teller Effect, Charge transfer spectra

BOOKS RECOMMENDED

1. Analytical applications of complex equilibria, J. Inczedy, Halsted Press: New York, NY (1976).
2. Solution Equilibria, F. R. Hartley, C. Burgess & R. M. Alcock, Prentice-Hall: Europe (1980).

3. Complexation in Analytical Chemistry, A. Ringbom, Wiley: New York (1963).
4. Chemical Applications of Group Theory, F.A. Cotton.
5. Group Theory and Symmetry in Chemistry Lowell H. Hall.
6. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
7. Inorganic Chemistry, J.E. Huhey, Harpes& Row.
8. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley.
9. Advanced Inorganic Chemistry, J. D. Lee.
10. Comprehensive Coordination Chemistry, G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
11. Group Theory and Chemistry, D. M. Bishop, Clarendon Press: Oxford, U.K. (1973).
12. Symmetry in Chemistry, H. H. Jaffe & M. Orchin, Dover Publications (2002).
13. Electronic Spectra of Transition Metal Complexes, D. Sutton, McGraw-Hill: New York (1968).
14. Ligand Field Theory and its Applications, Brian N. Figgis and Michael A. Hitchman, Wiley-VCH.
15. Inorganic Solids: An Introduction to Concepts in Solid-State Structural Chemistry, D. M. Adams, John Wiley & Sons, London (1974).
16. Inorganic Chemistry by Catherine Housecroft and A G Sharpe Prentice Hall; 2nd edition (2004-11-18).
17. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.
18. Concepts and Models of Inorganic Chemistry, Bodie Douglas, DarlMcdaniel, John Alexander, Wiley; 3rd edition (2006).
19. Inorganic Chemistry, A.G. Sharpe, Pearson, India, 3rd edition, (2002).

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II.** Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B. Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.*

Course No.: P2CHTC102 **Nature of Course: Core**
Title: Quantum Chemistry
Credits: 04 **Maximum Marks: 100**
No.of hours: 60

Course Outcome: *This course will help to understand the various aspects of quantum mechanics. In addition, the students will gather knowledge about angular momentum, approximation methods, chemical bonding, HMO methods and its applications.*
This course also offers employability in the research institutes and academics.

UNIT-I: Exact quantum mechanical results **(15 hours)**

Schrodinger equation and the postulates of quantum mechanics, Operator concept, Some properties of quantum mechanical operators, Linear, Hermitian and Unitary operators, Commutator and their properties, Operators for different observables, Schrodinger wave equation for Hydrogen and Hydrogen like atoms in spherical polar coordinates, Separation into three equations, Quantum numbers and their importance, Radial and Angular wave functions (Spherical Harmonics).
Complete solution of Schrodinger equation for the following model systems: Particle in a box (1 and 3 dimensional), Concept of degeneracy, One dimensional Simple Harmonic Oscillator & the Rigid Rotator, Calculation of various average values for the above systems, Concept of Tunneling, Numericals.

UNIT-II: Angular momentum and Electronic structure of atom **(12 hours)**

General theory of angular momentum, Eigen functions and Eigen values of angular momentum operators, Ladder operators, Commutation relations,Spin angular momentum, Anti-symmetry and Pauli's principle.
Electronic configuration, Russell-Saunders and jj-coupling schemes,Slater determinant, Vector model of the atom, Atomic term symbols, Term separation of p^n configurations, Spin-orbit coupling, Zeeman splitting, Virial theorem, Numericals.

UNIT-III: Approximation methods **(10 hours)**

Approximation methods, The Variation method, Linear variation principle, Perturbation method–postulates and calculation of first order perturbation (non-degenerate), Application of variation method and perturbation method to Helium atom (Ground state energy), Numericals.

UNIT-IV: Chemical Bonding **(13 hours)**

Molecular orbital theory (Homonuclear and Heteronucleardiatomics), LCAO-MO approximation, Molecular orbital treatment of H_2^+molecular ion and H_2 molecule, Calculation of energy levels from wave functions, Comparison of experimental and theoretical results, Physical picture of bonding and anti-bonding wave function, Brief introduction to H_2. Valence bond treatment of H_2 molecule, Comparison of MO and VB methods, Numericals.

UNIT-V: HMO method and its applications **(10 hours)**

Huckel's MO theory of conjugated systems; Application to Ethylene, Butadiene, Cyclobutadiene, Allyl systems (Allyl cation, Allyl radical and Allyl anion), Cyclopropenyl systems (Cyclopropenylcation, Cyclopropenylradical and

Cyclopropenylcarbanion).Calculation of properties- Delocalization energy, Electron density and Bond order, Numericals.

BOOKS RECOMMENDED

1. Physical Chemistry, P. W. Atkins, J. de Paula, Oxford, Tenth Edition, 2014.
2. Introduction to Quantum Chemistry, A. K. Chandra, McGraw Hill, Fourth Edition, 2001.
3. Quantum Chemistry, Ira. N. Levine, Pearson, Seventh Edition, 2016.
4. Molecular Quantum Mechanics, P. W. Atkins and R. S. Friedmann, Oxford, Fifth Edition, 2012.
5. Quantum Chemistry and Spectroscopy by T. Engel and P. Reid, Pearson, Third Edition, 2018.
6. Quantum Chemistry, J. P. Lowe and K. A. Peterson, Academic Press, Third Edition, 2005.
7. Physical Chemistry by R. J. Silby, R. A. Alberty and M. G. Bawendi, Wiley, Fourth Edition, 2004.
8. Quantum Chemistry by D. A. McQuarrie, Viva Books Pvt. Ltd, New Delhi, 2011.
9. Mathematics for Physical Chemistry, R. G. Mortimer, Third Edition, Elsevier, 2005.
10. Elementary Quantum Chemistry, F. L. Pilar, Second Edition, Dover Publication Inc., New York, 2001.
11. Physical Chemistry: A Molecular Approach, D. A McQuarrie and J. D. Simon, Univ. Science Books, Third Edition 2001.

PATTERN OF EXAMINATION

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MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
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Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall*

have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

Course Code: P2CHTC103 **Nature of Course: Core**
Title: Organic Chemistry-I
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *This course is focussed on nature of bonding in organic molecules, stereochemistry, reaction mechanism, aliphatic nucleophilic substitution and free radical reactions.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Nature of bonding in organic molecules **(12 hours)**
Delocalized chemical bonding-conjugation, Cross-conjugation, Resonance, Hyperconjugation, Tautomerism, Aromaticity in benzenoid and non-benzenoid compounds, Alternant and non-alternant hydrocarbons,Huckel's rule, Energy level of molecular orbitals, Annulenes, Antiaromaticity, Homo-aromaticity, Crown ether complexes and cryptands, Inclusion compounds, Cyclodextrins.

UNIT–II: Stereochemistry **(12 hours)**
Elements of symmetry, Molecular Chirality, Absolute configuration, Molecules with more than one chiral center, Threo- and erythro- isomers, Properties of enantiomers (Carvone & Limonene) & birth of chiral drugs (examples Nicotine, Thyroxine and Thalodimide). Methods of resolution, Optical purity, Enantiotopic and diastereotopic atoms, Groups and faces, Chirality in Biphenyls, Allenes and SpiranesConformational analysis of cyclohexanes, Decalins, Effect of conformation on reactivity.

UNIT–III: Reaction Mechanism: Structure and Reactivity **(12 hours)**
Types of mechanisms, Kinetic and thermodynamic control, Curtin-Hammett principle, Potential energy diagrams, Transition states and intermediates, Methods of determining mechanisms, Isotope effects, Structure, stability and reactions of carbenes and nitrenes, Effect of structure on reactivity-Resonance and field effects, Steric effect, Qualitative treatment. The Hammett equation and linear free energy relationship, Substituent and reaction constants.

UNIT–IV: Nucleophilic Substitutions **(12 hours)**
The S_N2, S_N1, Mixed S_N1 and S_N2 and SET mechanisms, The neighbouring group mechanism, Neighbouring group participation by σ and π bonds, Classical and non-classical carbocations, Phenonium ions, Norbornyl system, The S_Ni mechanism.
Nucleophilic substitutions at an allylic, aliphatic trigonal and a vinylic carbon, Reactivity effects of substrate structure, Attacking nucleophile, Leaving group and reaction medium,Phase transfer catalysis and ultrasound, Ambident nucleophile and regioselectivity.

UNIT–V: Free Radical Reactions **(12 hours)**
Mechanism of free-radical reactions, Neighbouring group assistance, The effect of solvent and attacking radicals on reactivity, Allylic halogenations (NBS), Oxidation of aldehydes to carboxylic acids, Auto-oxidation, Coupling of alkynes [Cadiot-Chodkiewicz coupling] and arylation of aromatic compounds by diazonium salts, Sandmeyer, Barton and Hunsdiecker reactions. Alkylation and acylation of N-hetrocycles.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry, Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Corell University Press.
6. Organic Chemistry, R.T. Morrison & R.N. Boyd, Prentice Hall.
7. Stereochemistry of Organic Compounds, D. Nasipuri (3rd Edition), New Age International (P) Limited, New Delhi (2014).
8. Organic Synthesis, Michael B. Smith, McGraw Hill Education.
9. Steric and Stereoelectronic Effect in Organic Chemistry, V. K. Yadav, Springer Singapore (2016).
10. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham,Cambridge University Press (4th edition, 2015).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition, 2007).

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
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Total			100

Test I and Test II

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Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

Course Code: P2CHTC104 **Nature of Course: Core**
Title: Principles of Spectroscopy
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *By studying this course, the students are able to concentrate on physical aspects of various techniques of spectroscopy, namely, microwave, vibrational, Raman, NMR. Information about X-ray and neutron diffraction techniques will also be dealt.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Unifying Principles **(10 hours)**

Electromagnetic Radiation, Characterization, Quantization of energy, Regions of emr, Interaction of emr with matter, Molecular spectra, General features for emission or absorption of electromagnetic radiation, Representation of spectra, Signal-to-Noise ratio, Resolving power, Width of spectral lines: Collision broadening, Doppler broadening, Heisenberg's uncertainty principle, Intensity of spectral lines: Transition probability, Population of states and Path length of sample, Stimulated (Induced) absorption, Stimulated and spontaneous emission, Einstein coefficients, Numericals

UNIT–II: Microwave Spectroscopy **(10 hours)**

The classification of molecules on the basis of moment of inertia, Interaction of radiation with rotating molecule, Rotational spectra of diatomic molecules: the rigid diatomic molecule, the intensities of spectral lines, the effect of isotopic substitution, determination of bond length and/or atomic masses from microwave data, the non-rigid rotator, the spectrum of non-rigid rotator, Energy levels and spectra of linear polyatomic molecules, Chemical analysis by microwave spectroscopy, The microwave Oven, Numericals

UNIT–III: Vibrational Spectroscopy **(12 hours)**

Vibrating diatomic molecule: the energy of a diatomic molecule, the simple Harmonic oscillator, the Anharmonic oscillator, Selection rules, overtones and combination bands, dissociation energies from vibrational spectra, Vibrational-rotational spectra, P, Q and R branches, Breakdown of Born-Oppenheimer approximation, Vibrations of polyatomic molecules: Fundamental vibrations and their symmetry, Influence of rotation on the spectra of polyatomic molecules: linear molecules, the influence of nuclear spin, Numericals

UNIT–IV: Raman Spectroscopy and Nuclear Magnetic Resonance Spectroscopy **(14hours)**

Raman Spectroscopy: Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra of linear molecules, Vibrational Raman spectra: Raman activity of vibrations, Rule of Mutual exclusion, Vibrational Raman spectra, Rotational fine structure, Selection rules, Structure determination from Raman and Infra-Red spectroscopy, Numericals.

Nuclear Magnetic Resonance Spectroscopy: Nuclear spin and an applied field, Larmor frequency, Basic idea about NMR instrument,Nuclear Magnetic resonance, Saturation, Chemical shift and its measurements, Factors affecting chemical shift, Shielding and Deshielding, Spin-spin coupling, FT NMR, Advantages of FT NMR.

UNIT–V: Diffraction Techniques **(14 hours)**

***X-ray diffraction*:** X-rays and their generation,Diffraction of X-rays, Crystal systems and Bravais lattice, Lattice planes, Miller indices and directions, d-spacing formulae, index reflections, Identifications of unit cells from systematic absences in diffraction pattern, Debye-Scherrer method of X-ray structural analysis of crystals, Intensities of X-ray reflections: Scattering of X-rays by an atom and by a crystal, Structure factor and its relation to intensity and electron density, Uses of Powder X-ray diffraction, Numericals

Neutron diffraction: General introduction, Magnetic structure analysis, Uses of Neutron diffraction

BOOKS RECOMMENDED

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
2. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill.
4. Solid State Chemistry and its applications, A.R. West, John Wiley & Sons.
5. Solid State Chemistry: An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd., UK.
6. Atomic and molecular spectroscopy- Basic concepts and applications. Rita Kakkar, Cambridge Press, 2017.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

Course Code: P2CHPC105 **Nature of Course: Core**
Title: Practical Course in Inorganic, Organic and Physical Chemistry-I
Credits: 04 **Maximum Marks: 100**
No. of hours: 120

INORGANIC CHEMISTRY

Course Outcome: *This course will help the students to learn how the rare analysis of metals is analyzed and simultaneously to prepare and characterize coordination complexes.*
After completing this course, students will be employable in R&D divisions of Industries Research and Academic Institutes.

1. Prepare $[Ni(NH_3)_6]Cl_2$ and carry out its ligand exchange reactions with bidentate ligands like Oxalate (ox), Glycine(gly), acetylacetone (acac) and dimethyl glyoxime(dmg) by substitutionmethod.
2. Preparation of $[Ni(dmg)_2]$, $[Co(NH_3)_6]$ $[Co(NO_2)_6]$, $Hg[Co(SCN)_4]$, $Na[Cr(NH3)_2(SCN)_4]$ and $[Co(py)_2Cl_2]$ complexes
3. Prepare $[Ni(NH_3)_6]Cl_2$, $[Ni(en)_3]Cl_2.2H_2O$ and $[Ni(en)_2]Cl_2.2H_2O$. Record electronic spectra of nickel(II) chloride hexahydrate and these complexes and determine energies of transition and spectrochemical order of ligands H_2O, NH_3 and en.
4. Prepare two copper oxalate hydrate complexes; $K_2[Cu(C_2O_4)_2].4H_2O$ and $K_2[Cu(C_2O_4)_2].2H_2O$ by controlling experimental conditions: Kinetic vs Thermodynamic factors
5. Prepare *cis*and*trans*-$[Co(en)_2Cl_2]Cl$ complexes.
6. Prepare *cis, trans*-$K[Cr(C_2O_4)_2(H_2O)_2].2H_2O$ and $K_3[Cr(C_2O_4)_3].3H_2O$ complexes.
7. Prepare $Cu(acac)_2$, $Mn(acac)_3$, $Fe(acac)_3$ and $VO(acac)_2$ Complexes
8. Prepare Bis(ethylenediammine)dioxolatocobolt(III) chloride dihydrate
9. Determine wavelength of maximum absorption (λ_{max}) of the complex formed between Fe^{2+} and 1,10-phenanthroline and determine concentration of ferrous ion in a sample from calibration curve.
10. Determine composition of Fe^{3+}- salicylic acid complex in solution by Job's Method.
11. Determine composition of Fe^{3+}- NCS^- complex in solution by Job's Method.
12. Estimation of 10Dq for $[Ti(H_2O)_6]^{3+}$ by spectrophotometric method

Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education Ltd
2. Synthesis and Characterization of Inorganic Compounds, William L. Jolly, Prentice Hall.
3. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge
4. Inorganic Synthesis, MC Graw Hill.
5. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic press.
6. Standard methods of chemical analysis by W.W. Scaff, Technical Pres

ORGANIC CHEMISTRY

Course Outcome: *The organic synthesis of various compounds with characteristic functional groups will be carried out. IR spectra will be used to identify various functional groups.*

Quantitative Analysis
Separation, purification and identification of compounds of binary mixture (two solids) using TLC, chemical tests, IR spectra to be used for functional group identification.

Organic Synthesis
Acetylation: Acetylation of $-NH_2$ and –OH groups.
Synthesis of oximes of carbonyl compounds.
Aldol condensation: Dibenzal acetone and benzylidene acetone from benzaldehyde.
Cannizaro reaction: Benzyl alcohol and benzoic acid from benzaldehyde.
Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M.Miller, Prentice Hall.
2. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
3. Systematic Qualitative Organic Analysis, H. Middlenton, Adward Arnold.
4. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
5. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
6. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

PHYSICAL CHEMISTRY

Course Outcome:*Error analysis and statistical analysis data will be analyzed by the students before proceeding to the actual performance of various experiments as mentioned in the following details.*

Number of hours for each experiment: 3-4 hours
A list of experiments under different headings is given below. Typical experiments are to be selected from each type. Students are required to perform at least 25 experiments.

Error Analysis and Statistical Data Analysis
Errors, types of errors, minimization of errors, error distribution curves, precision, accuracy and combination; statistical treatment for error analysis, student 't' test, null hypothesis, rejection criteria, F&Q test; linear regression analysis, curve fitting, calibration of volumetric apparatus, burette, pipette and standard flask.

Phase Equilibria
To construct the phase diagram for three component system (e.g. Chloroform-acetic acid-water, ethanol-benzene-water, ethanol-ethyl acetate-water, acetic acid-benzene-water).

Chemical Kinetics
i) Determination of the effect of (a) change of temperature (b) change of concentration of reactants and catalyst and (c) ionic strength of media on the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.

ii) Determination of velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
iii) Determination of the rate constant for the oxidation of iodine ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.
iv) Flowing clock reactions.
v) Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulaphate ion).

Solutions

i) Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.
ii) Determination of the degree of disassociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

Viscosity

i) Determination of molecular weight of high polymer (polystyrene) from viscosity measurements.

Surface-Tension

Study of variation of surface tension of solution with concentration and determination of surface excess, Study of interfacial tension between two immiscible liquids, CMC from surface-tension measurements

Any other practical introduced by the teacher

BOOKS RECOMMENDED

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry, Viswanathan and Raghavan.
6. Advanced Physical Chemistry, J.B. Yadav, Goel Publishing House.

SCHEME OF EXAMINATION FOR PRACTICALS

	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
Internal Examination	100%	8 hours	50
External Examination	100%	8 hours	50
Total			100

Distribution of Marks in Practicals

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 05 Marks each) **Total Marks = 15**

Practical Examination (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 10 Marks each) **Total Marks = 30**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and<80 % = 02 Marks

External Practical Examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 14 Marks each) **Total Marks = 42 Marks**

Viva-voce Examination =08 Marks

Course Code: P2CHTC201 **Nature of Course: Core**
Title: Inorganic Chemistry-II
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *By studying this course, the students will come to know the mechanism of reactions in inorganic complexes, magnetic properties of complexes and metal clusters framework of complexes.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Mechanism of Substitution Reactions in Octahedral Transition Metal complexes (12 hours)

Energy profile of a substitution reaction, Inert and labile complexes, Factors affecting the inert and labile nature, Calculation of CFAE (Crystal field activation energy), Intimate and Stoichiometric Mechanism, Rate Laws for Different Stoichiometric Mechanisms, Different factors reaction rate and reaction mechanisms, Acid hydrolysis of octahedral Co(III)-ammine complexes, Base hydrolysis of octahedral Co(III)-ammine complexes, Evidence of SN1 CB mechanism, Anation reaction, Substitution reaction without breakage of metal to ligand bond.

UNIT–II: Mechanism of Substitution Reactions in Square Planar Complexes and Electron Transfer (or Oxidation-Reduction) Reaction (12 hours)

Mechanism of substitution reactions in Pt(II) complexes, Factors effecting the reactivity of square planar complexes, Trans-effect, Theories of trans-effect-Grinberg's electrostatic polarization theory and Chatt and Orgel pi-bonding theory, Application of trans-effect to synthesis of complexes, Reductions -oxidation reaction, One electron transfer reaction, Outer sphere, Marcus equation for outer-sphere cross reactions, Inner sphere redox reaction, steps of inner sphere redox reaction, Types of inner sphere electron transfer reactions.

UNIT–III: Magnetic Properties of Transition Metal Complexes (12 hours)

Elements of magnetic properties and Terminology, Spin-orbit coupling constants and splitting of energy levels, Lande splitting rule, Paramagnetism and thermal energy, multiplet width, Curie equation and Van-Vleck equation, Quenching of orbital contribution to magnetic moment by crystal field, orbital contribution from excited state through spin-orbit coupling, magnetic properties of complexes of first transition metal ions, magnetic properties of lanthanides, magnetic moments of metal complexes with crystal field terms of A, E and T symmetry, T.I.P, anomalous magnetic moments, high and low spin equilibrium, Intramolecular effects, Antiferromagnetism and ferromagnetism of metal complexes, Magnetic exchange coupling.

UNIT–IV: Metal Carbonyls, Nitrosyls, Dinitrogen and Oxygen Complexes (12 hours)

Metal carbonyls, Structure and bonding, Vibrational spectra of metal carbonyls for bonding and structural elucidation, Important reactions of metal carbonyls, Preparation, Bonding, Structure and important reactions of transition metal nitrosyls, Dinitrogen and oxygen complexes, Tertiary phosphine as ligand.

UNIT-V: Metal Clusters (12 hours)

Introduction, dinuclear clusters, multiple metal-metal bonds, multinuclear clusters, low nuclearity carbonyl clusters, high nuclearity carbonyl clusters, electron counting schemes for high nuclearity carbonyl clusters, capping rule, limitations & exceptions, polyhedral skeletal

electron pair approach or Mingo's rules, isolobal analogy, Isolobal main-group and transition-metal fragments, examples of applications of analogy, clusters having interstitial main group elements, carbide clusters.

BOOKS RECOMMENDED

1. Inorganic Reaction Mechanism, F. Basolo& G. Pearson.
2. Inorganic Reaction Mechanism, J. O. Edwards.
3. Selected Topics in Inorganic Chemistry, Malik, Madan&Tuli.
4. Mechanism of Inorganic Reactions, D.Katakis&G.Gordon, John Wiley & Sons: N.Y. (1987).
5. Ligand Substitution Processes, H. Langford &H.B.Gray, W.A. Benjamin, Inc. New York.
6. Magnetochemistry by R.L. Carlin, Springer Verlag.
7. Magnetism and Transition Metal Complexes, F. E. Mabbs& D. J. Machin, Chapman and Hall: U.K. (1973).
8. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley.
9. Inorganic Chemistry, J.E. Huhey, Harpes& Row.
10. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
11. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J. A. McCleverty, Pergamon.
12. Inorganic Chemistry – Principles of Structure & Reactivity, J. E.Huheey, Elllen A Keiter& Richard L Keiter, IV Edition (2005).
13. Introduction to metal pi-complex chemistry, M. Tsutsui, M. N. Levy, A. Nakamura, Springer
14. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.
15. Concepts and Models of Inorganic Chemistry, Bodie Douglas, DarlMcdaniel, John Alexander, Wiley; Third edition (2006).
16. Inorganic Chemistry by A. G. Sharpe, Pearson India; 3rd Edition (2002).
17. Basic Organometallic Chemistry: Concepts, Syntheses and Applications 2nd Edition, B. D. Gupta and A. J. Elias, 2nd Edition, Universities Press.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.*

Course No.: P2CHTC202 **Nature of Course: Core**
Title: Chemical Dynamics, Surface and Electro Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *This course will help to understand chemical kinetics using various theories of bimolecular and unimolecular reactions. Different theories, equations and concepts related to the units of Surface Chemistry, Advanced Electrochemistry and Micelles will be imparted to the students.*
This course also offers employability in the research and development sector, research institutes and academics.

Unit-I: Chemical Dynamics – I **(14 hours)**
Collision theory of reaction rates, Steric factor, Activated complex theory, Arrhenius equation and Collision theory; Ionic reactions, Kinetic salt effects: Primary and Secondary salt effects, Steady state kinetics, Photochemical and thermal reaction between hydrogen and bromine, Photochemical reaction between hydrogen and chlorine, Pyrolysis of acetaldehyde, Decomposition of ethane and nitrogen pentoxide, Formation and decomposition of phosgene, Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, Kinetics of enzyme reactions, Numericals.

Unit–II: Chemical Dynamics – II **(10 hours)**
General features of fast reactions, Study and kinetics of fast reactions by flow method, Relaxation method (Kinetics of first order reaction reversed by a first order, second order reaction reversed by first order and first order reaction reversed by a second order reaction) and Flash Photolysis method, Theories of unimolecular reactions: Lindemann-Christiansen, Hinshelwood and Rice-Ramsperger-Kassel (RRK) theories, Kinetics of complex reactions: Opposing/Reversible reactions and Consecutivereactions, Combination and Disproportionation Reactions, Numericals.

Unit-III: Surface Chemistry **(12 hours)**
Surface tension and surface free energy, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Adsorption and its types, Adsorption isotherms, Freundlich and Langmuir adsorption isotherms, BET equation, Determination of surface area, Gibbs adsorption equation, Surface films on liquids, Catalytic activity at surfaces, Numericals.

Unit–IV: Electrochemistry-I **(12 hours)**
Debye-Huckel limiting law, Debye-Huckel-Onsager treatment and its extension, Debye-Huckel-Bjerrum equation, Thermodynamics of electrified interfaces, Lippman equation, Method of determination of surface excess, Structure of electrified interfaces: Helmholtz-Perrin, Guoy-Chapman and Stern models, Over potential, Exchange current density, Butler-Volmer equation, Tafel plot, Electrocatalysis, Numericals.

Unit–V: Electrochemistry-II and Micelles **(12 hours)**
Analogies between semiconductor and electrolyte, Structure of semiconductor-electrolyte interface, The diffuse charge region inside an intrinsic semiconductor (The Garrett-Brattain Space), Differential capacity due to space charge.
Polarography:Theory and working of polarography, Ilkovic equation, Half wave potential and its significance, Overvoltage.

Micelles

Surface active agents, Classification of surfaceactive agents, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting the CMC of surfactants, Counter ion binding of micelles, Solubilisation, Micro emulsion, Reverse micelles.

BOOKS RECOMMENDED

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Chemical Kinetics, K.J. Laidler, Pearson, 3rd Edition.
3. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley and sons, 5th Edition.
4. Micelles, Theoretical and Applied Aspects, V.Moroi, Plenum.
5. Modern Electrochemistry Vol. 1, Vol. 2A and Vol. 2B, J.O.M. Bockris and A.K.N. Reddy, Plenum.
6. Nanomaterials, B. Viswanathan, Narosa Publishing House.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II.** Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.*

Course Code: P2CHTC203 **Nature of Course: Core**
Title: Organic Chemistry-II
Credits: 04 **Maximum Marks: 100**
No.of hours: 60

Course Outcome: *The contents of this course are focussed on electrophilic, nucleophilic substitution, addition, elimination reactions from their mechanistic point of view. Rearrangement and pericyclic reactions will also be dealt in this course.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Aromatic Electrophilic & Nucleophilic Substitutions **(12 hours)**

The arenium ion mechanism, orientation and reactivity in substituted benzenes, energy profile diagrams, The ortho/para ratio, ipso attack, Orientation in other ring systems (hydrocarbons and heterocyclic compounds), Friedel-Crafts reaction of alkenes and alcohol substrates, Vilsmier reaction.

The S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophiles,The Smiles and Sommelet-Hauser rearrangements.

UNIT-II: Addition of Carbon-Carbon Multiple Bonds **(12 hours)**

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, Regio- and chemoselectivity, Orientation and reactivity, Addition to cyclopropane ring, Regioselective hydroboration of asymmetric olefins, Michael reaction, Sharpless asymmetric epoxidation.

Elimination Reactions

The E2, E1 and E1cB mechanisms,Regioselectivity of E1 and E2 eliminations, Base and stereoelectronic effect on E2/S_N2 competition; Orientation of the double bond, Reactivity: Effects of substrate structures, Attacking base, the leaving group and the reaction medium, Mechanism and orientation in pyrolytic eliminations, Peterson olefination.

UNIT-III: Addition to Carbon-Hetero Multiple Bonds **(12 hours)**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles [LAH, $NaBH_4$, BH_3, DIBAL-H], Addition of Grignard, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, The Wittig reaction, Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel and Claisen Condensations, Hydrolysis of esters and amides.

UNIT–IV: Pericyclic Reactions **(12 hours)**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene and 1,3,5-hexatriene system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams, FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, 4n and 4n+2 systems, Cycloadditions: Antrafacial and suprafacial additions, 4n and 4n+2 systems, 1,3-dipolar cycloadditions, Sigmatropic rearrangements-suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, Claisen, Cope and Ene reaction.

UNIT–V: Rearrangements **(12hours)**

General mechanistic considerations-Nature of migration, Migratory aptitude, Memory effects.

A detailed study of the following rearrangements:

Wagner-Merrwein Shifts, Pinacol-Pinacolone, Tiffeneau-Demjanov, Favorskii, Stevens, Arndt-Eistert synthesis, Neber,Hofman, Curtius, Schmidt and Baeyer-Villiger.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentic-Hall.
6. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
7. Advanced Organic Chemistry: Reaction Mechanisms, Reinhard Bruckner, Academic Press, USA.
8. Pericyclic reactions by Ian Flemmings, University Oxford Press (2015, 2nd Edition).
9. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham, Cambridge University Press (4th edition, 2015).
10. Polar rearrangements, Laurence M. Harwood, Oxford Science Publications, Oxford University Press (1992).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition, 2007).

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

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Major test (after 90 days)	100%	3 hours	60
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Test I and Test II

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Major Test

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have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

Course Code: P2CHTC204 **Nature of Course: Core**
Title: Applications of Spectroscopy in Organic Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *The course is designed from application point of view. The different spectroscopic techniques used in organic chemistry will be considered and number of examples will be put before the students to solve making use of different spectroscopic techniques.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT–I: Ultraviolet and Visible Spectroscopy **(12 hours)**
Various electronic transitions (185-800 nm), Beer-Lambert law, Effect of solvent on electronic transitions, Ultraviolet bands for carbonyl compounds, Unsaturated carbonyl compounds, Dienes, Conjugated polyenes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds, Ultraviolet spectra of aromatic compounds, Steric effect in biphenyls.
Principle of Circular Dichorism (CD) and Optical Rotatory Dispersion (ORD)exciton chirality, Methods and applications.

UNIT–II: Infrared Spectroscopy **(12 hours)**
Basic principles, Characteristic vibrational frequencies of Alkanes, Alkenes, Alkynes, Aromatic compounds, Alcohols, Ethers, Phenols and Amines, Detailed study of vibrational frequencies of carbonyl compounds (Ketones, Aldehydes, Esters, Amides, Acids, Anhydrides, Lactones, Lactams and Conjugated carbonyl compounds), Effect of hydrogen bonding and solvent effect on vibrational frequencies, Overtones, Combination bands and Fermi resonance.

UNIT–III: Nuclear Magnetic Resonance Spectroscopy **(14 hours)**
General introduction and definition, Excitation &Relaxation, Pulsed Experiments, Chemical shift, Spin-spin Coupling,Shielding mechanism, Chemical shift values and correlation for protons bonded to carbon and other nuclei. Complex spin-spin interaction between two, three, four and five nuclei (first order spectra), Virtual coupling,Hindered rotation, Karplus curve-variation of coupling constant with dihedral angle,Chemical exchange, Effect of deuteration. Simplification of complex spectra: Nuclear magnetic double resonance, Contact shift reagents, Solvent effects, Fourier transform techniques, Nuclear overhauser effect (NOE).

UNIT-IV: Carbon-13 NMR Spectroscopy **(10 hours)**
General considerations, Factors influencing carbon shifts, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), DEPT, APT.
Two dimensional NMR spectroscopy
Proton-Proton Correlation through coupling [COSY], Proton-Heteronucleus Correlation [HETCOR and H, C COSY], Carbon-Carbon Correlation [2D-INADEQUATE and C,C COSY].

UNIT-V: Mass Spectrometry **(12hours)**
Introduction, Ion production – EI, CI, FD and FAB, Factors affecting fragmentation of organic compounds, Common functional groups, Molecular ion peak, Metastable peak, McLafferty rearrangement, Nitrogen rule, High resolution mass spectrometry, Examples of

mass spectral fragmentation of organic compounds with respect to their structure determination, Introduction to modern MS techniques (MALDI, ESI).

BOOKS RECOMMENDED

1. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
2. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley & Sons (2005).
3. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley (1992).
4. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, (6th Edition) Tata McGraw Hill Education (2011).
5. Organic Spectroscopy, William Kemp; Palgrave USA (2008).
6. Introduction to spectroscopy 94th edition, Donald L. Pavia, Gary M. Lampman, George S. Kriz and James R. Vyvyan, Brooks/Cole, Cangage Learning (2009).
7. Comprehensive chiroptical spectroscopy: Applications in stereochemical analysis of synthetic compounds, natural products and biomolecules, Vol. 2, John Wiley & sons (2012).
8. Application of Mass spectrometry to Organic Chemistry, R. I. Reed, Academic Press London & New York.
9. Organic Structural Spectroscopy, J.B. Lambert, H.F. Shurvell, D.A. Lightner & R.G. Cooks, Prentice-Hall International, UK (1998).

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.*

Course Code: P2CHPC205 **Nature of Course: Core**
Title: Practical Course in Inorganic, Organic and Physical Chemistry-II
Credits: 04 **Maximum Marks: 100**
No. of Hours: 120

Course Outcome: *This course will help the students to learn how the rare analysis of metals is analyzed and simultaneously to prepare and characterize coordination complexes.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

INORGANIC CHEMISTRY

1. Determination of Boric acid in borax.
2. Determine total alkalinity in water sample from different sources.
3. Determination of dissolvedoxygen(DO) in water sample Iodometrically.
4. Determination of chlorine in Commercial sample of bleaching powder Iodometrically.
5. Determination of total, temporary and permanent hardness of water complexometrically using Eriochrome Black-T as indicator
6. Determination of strength of Ca^{2+} ions present in a given milk sampleby EDTA back titration.
7. Determination of strength of Al^{3+} ions by EDTA back titration.
8. Determination of strength of Mg^{2+} and Al^{3+} ions present in the mixture by titrating against EDTA using masking agent.
9. Determination of strength of sodium chloride solution using Mohr's Method.
10. Determination of strength of silver nitrate solution using Volhard's Method.
11. Determination of strength of sodium chloride solution using Fajan's Method.
12. Estimation of Ca^{2+} and Mg^{2+}ions content present in a sample of cement.
13. Estimation of Ag gravimetrically and Cu volumetrically in a mixture solution containing Ag^{+} and Cu^{2+} ions
14. Estimation of Cu^{2+} and Ni^{2+} in a mixture solution by gravimetric method
15. Estimation of Cu^{2+} and Zn^{2+} in a mixture solution by gravimetric method
16. Estimation of Zn^{2+} and Ni^{2+} in a mixture solution by gravimetric method
17. Determination of ascorbic acid in packed juice/freshjuice/vitamin-c tablet by titration with potassium iodate
18. Determination of hydrazine by titration with potassium iodate
19. Determination of iodine content in Iodized salt.
20. Determinationof phosphate content in a soft drink.

Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education Ltd.
2. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edn., Longman Group Limited, London.
3. Standard methods of chemical analysis by W.W. Scaff, Technical Press.

ORGANIC CHEMISTRY

Course Outcome: *The students will be trained in synthesising the starting materials which may be of useful in the synthesis of more compounds. They will also get training as to how the two components can be separated from each other. The quantitative analysis will also form the part of the experimental course.*

a. **Organic Synthesis:** Sandmeyer reaction: p-Chlorotoluene from p-toluidine. Knoevenagel Condensation: Synthesis of cinnamic acid.
b. Friedel Crafts Reaction: β-Benzoyl propionic acid from succinic anhydride and benzene. Aromatic electrophilic substitutions: Synthesis of 4-nitroaniline and 4-bromoaniline. Beckmann rearrangement of acetophenone and benzophenone oximes.
   The products may be characterized by spectral techniques.
c. Separation and identification of organic compounds from two component mixture. The products may be characterized by spectral techniques.
d. **Quantitative Analysis:** Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method. Estimation of amines/phenols and glucose using bromated bromide solution/acetylation method. Determination of iodine and saponification values of an oil sample.

Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M.Miller, Prentice Hall.
2. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
3. Systematic Qualitative Organic Analysis, H. Middlenton, Adward Arnold.
4. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
5. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
6. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

PHYSICAL CHEMISTRY

Course Outcome: *The aim of this course is to develop the experimental skill to the students by taking instrumentation tools and also physical tools to evaluate the various properties of solutions.*

Heat of solution:
Study the heat of solution of benzoic acid/oxalic acid by solubility method at different temperatures and the effect of electrolyte on it.

Adsorption:
Study the adsorption of oxalic acid on charcoal and hence check the validity of Langmuir adsorption isotherm and classical adsorption isotherm.

Critical solution temperature:
Determine the mutual solubility curve of phenol and water and hence find its consolute temperature and the effect of electrolyte on the system.

Abbe's refractometer:
Determine the refractive indices of given organic liquid at room temperature

pH meter and Conductivity meter:
Determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of acid.
Determine the strength of strong and weak acid and their mixture using pH metry.

Determine the strength of strong and weak acid and their mixture using conductivity meter.
Study of kinetics of second order reaction using conductivity –meter.

Phase-Equilibria

Phase diagram of two component eutectic systems (Naphthalene-benzoic acid; acetamide-benzoic acid; naphthalene-diphenyl).

Phase diagram of two component compound forming systems (salicylic acid – benzamide, acetamide-β-naphthol).

Any other practical introduced by the teacher.

BOOKS RECOMMENDED

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry by Viswanathan and Raghavan.
6. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.

SCHEME OF EXAMINATION FOR PRACTICALS

	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	8 hours	50
External Examination	100%	8 hours	50
Total			100

Distribution of Marks in Practical Courses in 1st and 2nd Semesters

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 05 Marks each) **Total Marks = 15**

Practical Examination (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 10 Marks each) **Total Marks = 30**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and<80 % = 02 Marks

External Practical Examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to

be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination (Inorganic Chemistry, Organic Chemistry and Physical Chemistry: 14 Marks each) **Total Marks = 42 Marks**

Viva-voce Examination =08 Marks

Course Code: P2CHVC251 **Nature of Course: Core**
Title: Vocational Course
Credits: 04 **Maximum Marks: 100**
No. of hours: 120

Course Outcome: The course is designed to equip students with practical expertise in advanced analytical tools.

Postgraduate Diploma in Spectroscopic Techniques

The Postgraduate Diploma in Spectroscopic Techniques is a specialized vocational Course designed to equip students with practical expertise in advanced analytical tools. To qualify for this diploma, students must successfully complete an additional 4-credit, work-based vocational course during the summer vacations (8 weeks). This hands-on course will focus on the application of various spectroscopic instruments, including:

- Nuclear Magnetic Resonance (NMR) Spectrometer
- UV-Visible-NIR Spectrophotometer
- Fluorescence Spectrophotometer
- Infrared (IR) Spectrophotometer

Career Relevance:
This diploma is designed to equip students with practical skills in analytical methodologies, preparing them for a range of career opportunities. Graduates will be well-positioned to:

- Launch their own start-ups in analytical services or materials testing
- Work in industrial quality assurance (QA) roles
- Serve as technical support personnel in government or private laboratories

The diploma emphasizes hands-on expertise and real-world application, fostering both entrepreneurship and employability in the rapidly advancing field of analytical science.

Course No: P2CHTC301 **Nature of Course: Core**
Title: Environmental Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *This course will enable the students to learn about the chemistry atmosphere, biosphere, hydrosphere, lithosphere and will to gain knowledge on air, water, soil, marine and solid waste management as well as environmental toxicology. This course will also familiarize with the green chemistry, environmental issues and analytical techniques.*

UNIT-I: Atmosphere **(12 hours)**

Earth's Atmosphere: Structure and chemical composition of atmosphere. Chemical and photo-chemical reactions, Formation of inorganic and organic particulate matter, Air quality standards, Air pollution–types and sources, Effects of NO_x, SO_2 and CO, depletion of stratospheric ozone, impact of chlorofluoro hydrocarbons, alternatives for CFC's, greenhouse effect (Global warming) and acid rains. Temperature measurements and controls: Vertical temperature and stability of atmosphere. Biogeochemical cycle of Carbon, Nitrogen, Oxygen and Sulfur.

UNIT–II: Lithosphere **(12 hours)**

Soil formation and composition, Soil physical properties: texture, colour, pore space, particle density; Chemical composition of Soil; Inorganic and organic constituents, Soil profile and composition of its horizons;Soil quality parameters; various micro and macro nutrients present in soil; Acid-base and ion exchange reactions in soils; NPK in soil; Sources of soil pollution: Industrial, Urban waste, Agricultural practice and solid waste (plastics and metals), Measures to control soil pollution; Soil analysis: Soil pH, total nitrogen, phosphorus, sulfur, potassium and magnesium.

UNIT–III: Hydrosphere **(12 hours)**

Water: Structure and bonding of water molecule, properties of water, Chemical composition of water bodies – lakes, streams and rivers; Hydrological cycle; Aquatic environment, complexation in natural water and waste water; Water pollution: Classification, types and sources, common sources, inorganic and organic pollutants and toxic metals; Effects of water pollutants on life and environment; Climate change impacts on water Cycle and water Demand; Water quality parameter and their analytical methods: Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demands (COD), solids, contents of chloride and chlorine demand and their determination.

UNIT–IV: Industrial Pollution **(12 hours)**

Environmental implications and abetment of cement industry, sugar mill, distillery, textile, paper and pulp mill, thermal power plant and polymer/plastic industry; Environment without plastic and plastic recycling techniques, Solid Waste Management:landfill, incineration, resource reduction, recycling and reuse, composting and organic farming. Treatment of sewage and industrial waste water and criteria of water quality.

UNIT-V: Environmental Toxicology **(12 hours)**

Hazardous waste: Introduction, listed hazardous wastes, origin, transport, effects and fates of hazardous wastes; Chemical solutions to environmental toxicity, biodegradability/bioremediation, principles of decomposition.

Bhopal gas tragedy: MIC and its impacts, Minamata disasters: mercury and its toxicity; Nuclear Hazards: Chernobyl and Three Mile Island.
Green chemistry: Principles and goals of green chemistry, Green chemicals, green catalysts, green solvents and green synthesis.

BOOKS RECOMMENDED

1. Environmental Chemistry, S. E. Manahan, Lewis Publishers
2. Environmental Chemistry, Sharma & Kaur, Krishna Publishers
3. Environmental Chemistry, A. K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S. M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F. J. Welcher, Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
8. Environmental Chemistry, C. Baird and W. H. Freeman.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

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Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

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Course Code: P2CHTC302 **Nature of Course: Core**
Title: Nano-Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *The aim of this course is to inculcate the knowledge among students related to the basics of nano-materials, their synthesis, characterization, properties and applications. The course will have employability in the industry, research and academic fields.*

UNIT-I: Fundamentals of Nanoscience and Nanotechnology **(12 hours)**
Solid materials and their strength, Perspective of length, Nanomaterials, Nanoscience and Nanotechnology, Nanostructures in nature, Prime materials, Carbon nanostructures viz. Carbon nanotube (Single-walled and multi-walled), Fullerenes, Surface effects of Nanomaterials, Surfaceplasmon resonance, Quantum size effects.

UNIT-II: Synthesis of Nanomaterials **(12 hours)**
Introduction, Nanomaterials synthesis, Top-Down and Bottom-Up Approaches, Solvothermal synthesis, Hydrothermal synthesis, Physical techniques: Arc discharge method, Laser Ablation, High energy ball milling, Reverse micellar/Micro-emulsion method, Reverse micellesworksasnanoreactor,Mechanismfornanoparticlesynthesisinsidethereversemicelles,Co-precipitation, Sol-Gel Method, Sono-chemical Methods. Theory, Experimental conditions, Kinetics of solid state reactions and molten–salt routes.

UNIT-III: Characterization of Nanomaterials **(12 hours)**
Electron Microscopic Techniques: Principles of electron microscopy, Scanning Electron Microscopy (SEM), Strengths and limitations of Scanning electron microscopy, Energy dispersive X-ray analysis (EDX), Transmission Electron Microscopy (TEM), Scanning Tunnelling Microscopy (STM) and Atomic Force Microscopy (AFM).

Dynamic Light Scattering (DLS) Studies: Principle, Theory and Methodology.

BET Surface Area Studies: Principle, Theory and Methodology.

Thermal techniques: Principles, Instrumentation data analysis and applications of DSC,TGA and DTA and their special features.

UNIT-IV: Properties of Nanomaterials **(12 hours)**
Introduction: Formation of Dangling bonds, Atom like behavior of Nanoparticles; Physicochemical Properties; Optical properties: Semi-conductor Nanoparticles, Metal Nanoparticles; Electrical and electronic properties: Electronic properties of carbon nanotubes; Redox properties: Semi-conductor nanoparticles; Mechanical properties: Elastic properties, Hardness and strength, Ductility and Toughness, Superplastic behavior; Magnetic properties: Magnetic properties of Fe_2O_3 nanoparticles, Superparamagnetism; Chemical sensing properties; Catalytic properties.

UNIT-V: Applications of Nanomaterials **(12 hours)**
Importance of Nanomaterials (Gold, Silver, Dielectric and Magnetic Oxide Nanoparticles), Some selected applications like, Nanomaterials in medicine, Nanomaterials for energy sector, Kinetic energy (KE) penetrators with enhanced lethality, High energy density batteries,

Nanomaterials in Next-Generation Computer, Nanomaterials in catalysis and sensors, Nanomaterials for water purification, Nanomaterials in communication sector, Nanomaterials in food, Nanomaterials for the environment, Nanomaterials in automobiles, Nanomaterials in ceramics industry.

BOOKS RECOMMENDED

1. Principals of Nanoscience and Nanotechnology, M.A. Shah and Tokeer Ahmad, Narosa Publications, 2010.
2. Nano Materials, B. Viswanathan, Narosa Publications, 2009.
3. Nano: The Essentials, T. Pradeep, Tata McgrawHill, 2009.
4. Chemistry of Nanomaterials: Synthesis, Properties and Applications by C.N.R. Rao, A. Muller and A. K. Cheetham (eds.),Wiley-VCH, Weinheim, 2004.
5. Nanoscale Materials by Luis M. Liz-Marzan and Prashant V. Kamat, Kluwer Academic Publishers (Boston), 2003.
6. "Nanomaterials Chemistry: Recent Developments and New Directions", ed. By C.N.R. Rao, A. Muller & A.K. Cheetham (Eds.), Wiley-VCH, 2007.
7. Solid State Chemistry and its applications, Anthony R. West, John Wiley & Sons.
8. Physical Principles of Electron Microscopy: An introduction to TEM, SEM and AFM by R.F. Eqerton, Springer, 2008.
9. Introduction to Atomic Force Microscopy, Paul E. West, Pacific Nanotechnology, USA.
10. Solid State Chemistry Techniques, A.K. Cheetham and Peter Day, Oxford Science Publications.
11. Scanning Probe Microscopy and Spectroscopy, Ronald Weisendanger, Cambridge University Press.
12. Nano Materials, A. K. Bandyopadhyay, New Age Internationals (P) Limited, Publishers.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

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Total			100

Test I and Test II

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Course Code: P2CHTC303 **Nature of Course: Core**
Title: Bio-Organic and Medicinal Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *The aim of this course is to let the students understand enzymatic action, coenzymes, chemistry of vitamin B complex, co-crystals, carbohydrates metabolism, drug design, chemistry of antibiotics, mechanism of action of vitamins etc. This paper has scope of employability in medicinal chemistry and as scientist in research laboratories.*

UNIT-I: Enzymes, Co-enzymes and Chemistry of Vitamin B-Complex (12 hours)

Introduction, Remarkable properties of enzymes, Reversible and irreversible inhibition, Fischer's lock and key and Koshland's induced fit hypothesis, Concept and identification of active site by the use of inhibitors, Enzyme modification by site-directed mutagenesis, Baker Yeast and its applications.

Functions and mechanism of action of thiamine, Riboflavin and Pantothenic acid, Cofactors as derived from vitamins, Coenzymes, Prosthetic groups, Apoenzymes, Structure and biological functions of coenzyme A, Thiamine pyrophosphate, Pyridoxal phosphate, NAD+, $NADP^+$, FMN, FAD, Lipoic acid.

UNIT-II: Carbohydrates Metabolism (12hours)

Introduction, classification, General properties with reference to mutarotation, Lobre-D-Bruyen Van Ekinstein rearrangement, Epimerization, Fischer Killani synthesis, Wohl's and Ruffs method.

Glycolysis, Gluconeogenesis, Glycogenolysis, Citric acid cycle (Krebs Cycle), Pentose phosphate pathway, Conversion of pyurvate to phosphoenolpyurvate, Conversion of glyceraldehyde-3-phosphate to Phosphoenolpyurvate.

Polysaccharides and disaccharides (Glycogen breakdown by glycogen phosphorylase), Conversion of fructose to glyceraldehyde-3-phosphate, galactose to glucose-1-phosphate.

UNIT-III: Drug-design and Co-crystals (12 hours)

Introduction, Concept of Lead compounds, Factors governing drug design and rational approach, Drug design through method of variations, Disjunction and conjunction, Bioisosteric replacement, Rigid analogs, Homologation of alkyl chains, Changes in ring size and ring position isomers, Alteration of stereochemistry, Fragments of lead molecules.

Co-crystals: General introduction, Designing and characterization techniques, Factors affecting designing of co-crystals and applications in pharmaceuticals.

UNIT-IV: Structure and mode of action (12 hours)

Cardiovascular drugs: Antihypertensive and hypotensive drugs:

Hydralazine (Apresoline hydrochloride), Methyldopa (Aldomet), Procainamide (Pronestyl), Antisympathetic drugs- Propanolol (Indral), Verapamil (Isoptin) and Prenylaminelactate (Synadrin), Rosuvastatin (Crestor)

Antiparkinsonian Agents: Biperiden hydrochloride (Akineton hydrochloride), Ethopropazine hydrochloride (Profenamine) and Levodopa (Bendopa).

Anticancer drugs: Texol, Tamoxifen.

Antihistaminic drugs: Cetrizine, Promethazine hydrochloride and Chloropheniraminemeleate (Alermine).

Antimalarials: Chloroquine phosphate (Resochin) and Mepacrine hydrochloride (Quinacrine).

Antidiabetic: Sitagliptin (Januvia), Metformin (Glucophage)

UNIT-V: Antibiotics and Vitamins **(12 hours)**

Antibiotics: Introduction, Classification, Isolation and chemistry of Pencillins, Chloramphenicol and Cephalosporin.

Vitamins: Occurrence, Chemistry, Functions and Mechanism of action of Ascorbic acid, α-Tocopherol and Vitamin K_1& K_2.

BOOKS RECOMMENDED

1. Bio-organic Chemistry: A Chemical Approach to enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Philip L.R. Bonner, 2nd edition.
3. Principles of Bio Chemistry, Lehninger, 4th edition.
4. Enzymatic Reaction Mechanism, C. Walsh and W.H. Greeman.
5. Enzyme Structure and Mechanism, A. Fersht and W.H. Freeman.
6. Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th Ed., Edited by R.F. Doerge, J.B. Lippincott Co., Philadelphia 1982.
7. Pharmaceutical Chemistry in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley and Sons., N.Y.
8. Principles of Medicinal Chemistry, Lea and Febiger, Philadelphia, USA.
9. Strategies of Organic Drug Synthesis and design, D. Lendnicer, John Wiley and Sons, N.Y.
10. Burger's Medicinal Chemistry, Drug Discovery and Development, John Wiley and Sons.
11. Crystal Engineering: Desiraju, World scientific publishing Singapore 2011.

PATTERN OF EXAMINATION

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Course Code: P2CHTE304 **Nature of Course: Elective**
Title: Analytical Chemistry-I
Credits: 04 **Maximum Marks: 100**
No. of Hours: 60

Course Outcome: *This course is aimed to have an insight of various analytical techniques in analyzing the chemicals quantitatively.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Gravimetric Analysis **(12 hours)**
Gravimetric analysis requirements; identify an insoluble form, separate the analyte from any constituent that may interfere, properties of precipitates. nucleation and crystal growth, factors influencing completion of precipitation, co-precipitation and post-precipitation, wash the precipitate free of impurities and co-precipitants (surface adsorption, inclusions and occlusions), convert precipitate to a reliable weighing form, organic and inorganic precipitating reagents.

UNIT-II: Potentiometric Titrations **(12 hours)**
Potentiometric titration; classical method, location of end point, experimental details forpotentiometric titrations involving neuralisation reactions, redox reactions, precipitationreactions, pH titrations using pH electrodes, precipitation titration using silver electrodes,redox titration using platinum electrodes, ion selective electrodes in potentiometric titrationsmeasuringpM, derivative titrations, applications

UMT-IV: Electron Spectroscopy **(12 hours)**
Definition of a solid surface, Types of surface measurements, X-Ray photoelectronspectroscopy (XPS/ESCA): Introduction, principle, chemical shifts as a function of oxidationstates, Instrumentation, Applications. Auger electron spectroscopy: Principle,instrumentation- Radiation source, Energy analyzer, Detector, Auxiliary system. Applications- Quantitative analysis.

UNIT-V: Electron Microscopy **(12 hours)**
Scanning electron microscopy (SEM):: Basics, Instrumentation, Applications, Transmissionelectron microscopy (TEM): Introduction, Basic theory, Electron gun, Electromagneticlenses, Imaging, Operating parameters- Magnification, Resolution, Depth of field, Samplepreparation, Specimen orientation and manipulation, Applications, Selected Area ElectronDiffraction, Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM)and Scanning Tunnelling microscopy (STM).

UNIT-V: Spectrochemical Methods **(12 hours)**
Survey of spectrochemical methods, quantitative principles of absorption; Beer's law, analytical use of Beer's law, mixtures of absorbing species, calculation of unknown from calibration curve, deviation from Beer's law, spectroscopic determination of pK value of the indicator(methyl red), Simultaneous spectroscopic determination (Cr and Mn), spectroscopic titrations.
Industrial applications, Environmental applications, Clinical applications.

BOOKS RECOMMENDED

1. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edition, The English Language Book Society & Longman
2. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson
3. Analytical Chemistry: Principles, John H. Kennedy, 2nd Edition, Saunders College Publishing.
4. Analytical Chemistry, Gary D. Christian, 6th Edition, Wiley
5. Instrumental Analysis, 2nd Ed., Bauer, Christian, O'Reilly, Allyn and Bacon, 1978.
6. Principles of Instrumental Analysis, 5th Ed- Indian Reprint, Skoog, Holler, Nieman, Harcourt Asia, 2001.
7. Instrumental Analysis, Skoog, Holler, Crouch, Brooks Cole- Cenage learning, 2003.
8. Transmission Electron Microscopy, Williams and Carter, Plenum Press, New York and London, 1996.
9. Nature and Science, 4(3), 2006, Ma, et al, Transmission & Scanning Electron Microscopy.
10. Instrumental Methods of Analysis, 7th edn. H.H. Willard, L.L. Merritt, Jr. and J.A. Dean and F.A. Settle, Jr. Publishers and Distributors, New Delhi, 1986.
11. Basic Concepts of Analytical Chemistry, S. M. Khopkar, 2nd Edition, New Age International (P)Limited, Publishers

PATTERN OF EXAMINATION

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Major Test

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Course Code: P2CHTE305 **Nature of Course: Elective**
Title: Spectroscopy and Photochemistry in Inorganic Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

***Course Outcome**: This course is aimed to have an insight of various spectroscopic tools in analyzing the inorganic molecules/complexes. The ligand field photochemistry is also a part of the course.*
After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Vibrational Spectroscopy **(12 hours)**
Symmetry and shape of AB2, AB3, AB4, AB5 and AB6 molecules, Mode of bonding of ambidentate ligands, nitro, thiocyanato, ethylenediamine and diketonato complexes, Raman Spectroscopy: Stokes and anti-stokes lines, Polarisability of ellipsoids, Rotational and vibrational Raman spectroscopy, Selection rules, Resonance Raman spectroscopy, Basic understanding and its applications particularly for study of active sites of metalloproteins.

UNIT–II: NMR of Paramagnetic Compounds and NQR Spectroscopy **(12 hours)**
Nuclear Magnetic Resonance of Paramagnetic Substances in Solution: The chemical shift in diamagnetic and paramagnetic molecules, The contact and Pseudocontactshifts, Factors affecting nuclear relaxation,
Nuclear Quadrupole Resonance (NQR) spectroscopy: Introduction, Quadrupole moment and field gradient, Quadrupole relaxation energies of quadrupole states, Effect of magnetic field on the NQR spectra, Applications and structural informations from NQR spectra.

UNIT-III: Electron Spin Resonance Spectroscopy **(12 hours)**
Basic Principle, Spin Hamiltonian, Hyperfine coupling, Spin polarization and McConnell relationship, Isotropic and anisotropic hyperfine coupling constants, Spin-orbit coupling and significance of g- tensor, Application to transition metal complexes (having one unpaired electron) including biological systems and inorganic free radical viz. BF_2, F_2 , PH_4, etc.

UNIT–IV: Mossbauer Spectroscopy **(12 hours)**
Basic Principles, Spectral parameters and spectrum display, Application of the technique to the studies of:
(a) Bonding and structure of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin,
(b) Sn^{2+} and Sn^{4+} compounds, Nature of M-L bond, Coordination number and structure, and
(c) Detection of oxidation state and inequivalent MB atoms.

UNIT-V: Ligand Field Photochemistry **(12 hours)**
Electronically excited states of metal complexes, Energy dissipation by radiative and non-radiative processes, Franck-Condon Principle, Mechanism of photo substitution reaction of Cr(III) complexes, Examples, Adamson's rule, Photo substitution and photo reduction reactions of Co(III) complexes, Photo substitution reactions of Rh(III) complexes.

BOOKS RECOMMENDED

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish,

Ellis Harwood.
3. Vibrational Spectroscopy- Modern Treheb, Barnes, A.J., and W.J. Orville-Thomas, Elsevier, 1977.
4. Chemical Applications of Group Theory, F.A. Cotton.
5. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
6. Fundamentals of Molecular Spectroscopy. C.N. Banwell, Tata McGrew Hill.
7. Concepts of Inorganic Photochemistry, A. W. Adamson and P. D. Fleischauer, Wiley.
8. Physical Methods for Chemistry, R. S. Drago, Saunders Company.
9. Infrared and Raman Spectra: Inorganic and coordination compounds, K. Nakamoto, Wiley.
10. Structural Methods in Inorganic Chemistry, E.A. V. Ebsworth, D. W. H. Rankin and S. Cradock, ELBS.
11. Progress in Inorganic Chemistry, Vol. 8, ed., F. A. Cotton, Vol. 15, ed. S.J. Lippard, Wiley.
12. Applications of physical methods to Inorganic and Bioinorganic Chemistry, Robert A. Scott, Charles M. Lukehart, Wiley.
13. Inorganic Reaction Mechanism F. Basolo& R.G. Pearson
14. Inorganic Reaction Mechanism J.O. Edwards.
15. Photochemistry – Rohatgi-Mukherjee.

PATTERN OF EXAMINATION

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Course Code: P2CHTE306 **Nature of Course: Elective**
Title: Heuristic Approach to Organic Synthesis
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *On successful completion of this course, the students will gain knowledge about disconnection approach, planning the synthesis of organic compounds and natural products, photochemistry and asymmetric cycloaddition reactions.*
The learning from this course will help the students to get jobs in R&D laboratories. pharmaceutical industry and academics.

UNIT-I: Disconnection Approach **(14 hours)**
An introduction to synthons and synthetic equivalents, Disconnection approach, Functional group inter-conversions, Importance of the order of events in organic synthesis, One group C-X and two group C-X disconnections (1,2 and 1,3-difunctionalised compounds), Chemoselectivity, Reversal of polarity.
Protecting Groups
Principle of protection of alcohol (Acetal, Acetyl and silyl ethers) and carbonyl groups.

UNIT-II: One Group C-C Disconnections **(10 hours)**
Alcohols and carbonyl compounds, Regioselectivity, Use of acetylenes and aliphatic nitro compounds in organic synthesis.
Two Group C-C Disconnections
Biological, Cope and Claisen reaction, Diels-Alder reaction, 1,3-difunctionalised compounds, α, β-unsaturated carbonyl compounds, 1,5-difunctionalised compounds, Michael addition and Robinson annelation.

UNIT-III: Retrosynthesis and Synthesis **(12 hours)**
Reserpine (Woodward synthesis)& Longifolene (Corey synthesis).
Biosynthesis of Terpenes (squalene and phytoene), Prostaglandins and Flavonoids (Acetate pathway and Shikimic acid pathway).

UNIT-IV: Photochemistry **(12 hours)**
General principles. Photochemistry of alkenes, dienes and polyenes: *cis-trans* isomerisation, photoisomerization of 1,3-butadiene; orbital symmetry considerations (alkenes and dienes). Photochemistry of carbonyl compounds, Hydrogen abstraction and fragmentation reactions; cycloaddition and rearrangement reactions of cyclic unsaturated ketones.Photochemistryof aromatic compounds.

UNIT-V: Cycloadditions **(12 hours)**
Diels-Alder reactions, Inverse electron demand Diels-Alder reactions, Hetero-Diels Alder reactions, 1,3-dipolar cycloaddition reactions, [2+2] Cycloadditions, Pauson-Khand type reactions.

BOOKS RECOMMENDED

1. Designing Organic Synthesis, S. Warren, John Wiley & sons.
2. Organic Synthesis– Concept, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, Verlage VCH (1997).
3. Progress in Total Synthesis Vol. 1, E. Danishetsky and S. Danishetsky, Appleton Centyrt Crafts, N.Y.

4. The Logic of Chemical Synthesis, E.J. Corey and X.M. Cheng, John Wiley and Sons, New York, N.Y.
5. Art in Organic Synthesis, Nitya Anand, Jasjit S. Bindra, S. Randanathan, Wiley-Blackwell.
6. Principles of Organic Synthesis, R.O.C. Norman and J. M. Coxon, CRC Press, Taylor & Francis (3rd Edition, 2017).
7. Greene's Protective Groups in Organic Synthesisby Peter G. M. Wuts, Theodora W. Greene, Fourth Edition. Wiley 2007
8. Catalysis in Asymmetric Synthesis; Vittoria Caprio and M.J. Williams, Wiley (2nd ed., 2008).
9. Advanced Organic Chemistry, Part-A – Str. & Mech., F.A. Carey and R.J. Sundberg, Springer (5th ed., 2007).
10. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B.Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Harlow, Essex, England (1994).
11. Chemistry of Natural Products, S.V. Bhat, B.A. Nagasampagi and M. Sivakumar, Narosa Publishing House, New Delhi.

PATTERN OF EXAMINATION

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Course Code: P2CHTE307 **Nature of Course: Elective**
Title: Chemistry of Natural Products
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *After successful completion of this course, the student will gain knowledge about various natural products such as terpenoids, carotenoids, alkaloids, steroids, plant pigments and marine natural products, and their biosynthetic pathways.*

UNIT-I: Terpenoids and Carotenoids **(12 hours)**

Classification, Occurrence and isoprene rule, General methods for the determination of structure of terpenoids; Structure determination, Stereochemistry and synthesis of the following representative molecules:
α–Terpineol, Menthol, Farnesol, Santonin, Carvone, β–Carotene and Squalene.

UNIT-II: Alkaloids **(12 hours)**

Definition, Physiological action, Occurrence and isolation, General methods for the structure determination of alkaloids; Structure elucidation, and synthesis of Quinine, Morphine, Atropine and Papaverine.

UNIT-III: Steroids and Plant pigments **(12 hours)**

Occurrence, Basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of Cholesterol, Testosterone, Estrone, Progestrone.

Occurrence and general methods of structure determination of anthocyanins.Synthesisof Apigenin, Quercetin, Cyanin, and Butein.

UNIT-IV: Marine natural products **(12 hours)**

General introduction, Isolation of marine natural products, Detailed study of following marine natural products:
Marine toxins (Saxitoxin and Tetrodotoxin), Nucleosides (pyrimidines and purines D-arabinosides and pyrimidines and purines 1-β-D-ribosides).

UNIT-V: Synthesis of Secondary Metabolites **(12 hours)**

Terpenes (squalene and phytoene), Prostaglandins (PGE_2 and PGI_2), Thromoboxane (A_2 and B_2) and Flavonoids (Catechin, Epicatechin and Quercetin).

BOOKS RECOMMENDED

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson,J.B.Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Harlow, Essex, England (1994).
2. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.
3. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M. I. Choudhary, Harwood Academic Publishers.
4. Chemistry of Natural Products, S.V. Bhat, B.A. Nagasampagi and M. Sivakumar, Narosa Publishing House, New Delhi.
5. Bioactive Marine Natural Products, D. S. Bhakuni and D. S. Rawat, Anamaya Publishers, New Delhi (2005).

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Course Code: P2CHTE308 **Nature of Course: Elective**
Title: Thermodynamics and Statistical Mechanics
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *This course will be useful in understanding the non-equilibrium thermodynamics, transport phenomenon, thermodynamics of mixtures, statistical mechanics / thermodynamics and their applications.*

Unit –I: Non-Equilibrium Thermodynamics **(12 hours)**

Thermodynamic criteria for non-equilibrium states, Entropy production and entropy flow, Entropy balance equations for different irreversible processes (e.g. heat flow, chemical reaction etc.),Transformation of the generalized fluxes and forces, Non equilibrium stationary states, Phenomenological equations, Microscopic reversibility and Onsager's reciprocity relations, Electro kinetics phenomena, Diffusion, Electric conduction, Irreversible thermodynamics for biological systems, Coupled reactions.

Unit –II: Transport Phenomenon **(12 hours)**

Mass Transport: Diffusion, Diffusion coefficient, Time evaluation of concentration gradient, Fick's first and second laws, Statistical view of diffusion, Einstein-Smoluchowski equation, Thermal conductivity, Viscosity of gases and fluids, Poiseuille's law, Einstein relation, Nernst-Einstein equation, Stokes-Einstein equation, Relation between flux and viscosity, Diffusion coefficient and mean free path, Thermal conductivity/viscosity and mean free path, Sedimentation and centrifugation, Ionic conduction, Strong and weak electrolytes.

Unit –III: Thermodynamics of Mixtures **(12 hours)**

Brief resume of classical concepts of thermodynamics including free energy, Chemical potential and entropies, Partial molar properties: Partial molar free energy, Partial molar volume and partial molar heat content and their significances, Determinations of these quantities, Concepts of fugacity and determination of fugacity.

Non ideal systems: Excess functions for non-ideal solutions, Activity, Activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions,Determination of activity and activity coefficients, Ionic strength.

Unit –IV: Statistical Mechanics **(12 hours)**

Role of statistical mechanics, Ensemble: Micro canonical, Canonical and Grand canonical, Postulates of ensemble averaging, Phase space, Stirling's approximation, Occupation number, Micro and macro states, Statistical weight factor, Probability, Concept of distribution, Thermodynamic probability, Types of statistics: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Most probable distribution of three types of statistics, Lagrange's determined multipliers, Evaluation of β, Comparison of three statistics, Molecular partition function and its significance, Thermodynamic properties in terms of partition function, Numericals.

Unit –V: Applications of statistical mechanics **(12 hours)**

Factorisation of molecular partition function, Canonical ensemble partition function (Independent and distinguishable molecules or particles; Independent and indistinguishable molecules or particles), Evaluation of translational, rotational, vibrational, electronic and nuclear partition functions, Contribution of translational, rotational and vibrational partition functions to thermodynamic functions, Effect of nuclear spin on diatomic molecules,

Equilibrium constant of ideal gas in terms of partition function. Heat capacities of solids: Einstein theory and Debye theory, Numericals.

BOOKS RECOMMENDED

1. Thermodynamics for Chemists: S. Glasstone.
2. Statistical Thermodynamics: M.C. Gupta.
3. Physical Chemistry: P.W. Atkins.
4. Chemical Thermodynamics: R.P. Rastogi and R.R. Misra.
5. Statistical Mechanics and Properties of Matter: E.S.R. Gopal.
6. Statistical Mechanics, D.A. McQuarrie.
7. Thermodynamics of Irreversible Processes, Rolf Haase.
8. Fundamental of Chemical Thermodynamics, E.N. Yeremin.
9. Introduction to Irreversible Thermodynamics, Prigogine.
10. Modern Thermodynamics, D. KondePudi and I. Prigogine.
11. Physical Chemistry, Engel and Reid.

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Course No.: P2CHTE309 **Nature of Course: Elective**
Title: Chemistry of Materials and Liquids
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *Students will acquaint knowledge about chemistry of different materials like alloys, ceramics, composites and liquid crystals. The properties of liquids along with the various theories of liquids also form a part of discussion in this course.*
This course also offers employability in the field of research and development, research institutes besides academics.

UNIT-I **(12 hours)**

Multipurpose Materials

Ferrous alloys and its classification, Fe-C phase transformations in ferrous alloys, Cast irons, Stainless steels, Non-ferrous alloys, Mechanical properties of ferrous and non-ferrous alloys and their applications.

Ceramics: Types and Applications

Ceramics, Classification of Ceramics; Glasses and glass ceramics, Clay products, refractories, Abrasives, Cements, Advanced ceramics; Piezoelectric ceramics, Microelectrochemical systems (MEMS), Optical fibers, Ceramic ball bearings, Properties of different types of ceramics and their applications.

UNIT-II **(14 hours)**

Fabrication and Processing of Ceramics

Fabrication and processing of glasses; Glass properties, Glass forming, Heat treatment of glasses; Annealing and glass tempering, Fabrication and processing of clay products; Characteristics of clay, Compositions of clay products, Fabrication techniques; Hydroplastic forming, Slip casting, Drying, Firing.

Liquid Crystals

Mesomorphic behavior, Classification of liquid crystals; Polymer, Discotic, Thermotropic and lyotropic liquid crystals, Nematic and smectic mesophases, Structure of nematic phase; Ordinary nematic and Twisted nematic (Cholesteric) structures, Molecular arrangement in smectic A and smectic C phases, Optical properties of liquid crystals, Dielectric susceptibility and dielectric constants.

UNIT-III **(10 hours)**

Composites

Particle-reinforced composites; Large particle composites and Dispersion strengthened composites, Fiber-reinforced composites, Influence of fiber length, Influence of fiber orientation, Fiber phase, Matrix phase, Polymer matrix composites; Glass fiber-reinforced polymer and Carbon fiber-reinforced polymer composites, Carbon-carbon composites, Hybrid composites, Processing of fiber-reinforced composites; Pultrusion and Filament winding, Structural composites; Laminar composites, Sandwich panels.

UNIT-IV

General Properties of Liquids **(12 hours)**

Liquids as dense gases, Critical constants, Comparison between van der Waals constants and critical constants, Some thermodynamic relations, Internal pressure and its significance in liquids, Various equations of state, Different types of intermolecular forces in liquids,

Different potential functions for liquids, Additivity of pair potential approximation, Configurational integral,Liquids as disordered solids.

UNIT-V **(12 hours)**

Theories of Liquids

Partition function method (model approach), Simple cell model, LJD model, Communal energy and entropy, Significant structure model (hole theory of liquids).

Methods of Structure Determination and Computational Techniques

Spectroscopic techniques for liquid dynamic structure studies; Neutron and X-ray scattering spectroscopy, Computation Techniques - Monte Carlo and Molecular dynamics methods.

BOOKS RECOMMENDED

1. Solid State Physics, N.W. Ashcroft and N.D. Mermin, Saunders Collage.
2. Materials Science and engineering, An Introduction, W.D. Callister, Wiley.
3. Principles of the Solid state, H.V. Keer, Wiley Eastern.
4. Materials Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
5. Thermotropic Liquid Crystals, Ed., G.W. Gray, John Wiley.
6. Handbook of Liquid Crystals, Kelker and Hatz, Chemie Verlag.
7. An Introduction to Liquid State, P.A. Egelstaff, Academic Press.
8. The Dynamic Liquid State, A.F.M. Barton, Longman.
9. The Liquid State, J.A. Pryde.
10. Significant Liquid Structures, H. Eyring and M.S. John.
11. The Liquid Phase, D.H. Trevena, WYKEHAM Publications.

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Course Code: P2CHPE310 **Nature of Course: Elective**
Title: Practical Course in Inorganic Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 120

Course Outcome: *This course aims to develop an understanding of synthesis, quantitative and qualitative analysis, separation of cations by Paper, Thin layer and Column chromatography. The students will also be trained to prepare and characterise the compounds using the available techniques.*
This paper has scope of employability in academics and in research institution and industries.

Preparation of selective inorganic compounds and their study by IR, electronic spectra, NMR and magnetic susceptibility measurement.Handling of air and moisture sensitive compounds involving vacuum lines.
Selection can be made from the following:

1. Preparation of sodiumhexanitritocobaltate(III), $Na_3[Co(NO_2)_6]$; record and interpret IR spectra; Handbook of Preparative Inorganic Chemistry. Vol. 1 (2nd ed.). New York, NY: Academic Press. p. 1541.
2. Synthesis of different nickel complexes; [Ni(salen)], $[Ni(PPh_3)_2Cl_2]$ and $Ni(NCS)_2(PPh_3)_2$,analysis of Ni, Cl and S and spectroscopic studies:Inorganic Chemistry Communications
   Volume 6, Issue 2, February 2003, Pages 154-156; J. Science of Synthesis Georg Thiene Verlag KG, Vol. 1, p 11; Polyhedron, Volume 5, Issue 9, 1986, Pages 1487-1488
3. Conversion of lead nitrate $[Pb(NO_3)_2]$to lead carbonate $[PbCO_3]$, lead(II)oxide [PbO] and then in to lead(IV) oxide $[PbO_2]$; Dagmar Sykorova, Inorganic Chemistry Lab Manual-II.
4. Preparation of tetraamminecarbonatocobalt(III) nitrate and its conversion to pentaamminecholorocobalt(III) chloride; Inorganic Syntheses; Wiley-Interscience: pp 103 (1983).
5. Preparation of pentaamminecholorocobalt(III) chloride and study of Linkage isomers by its conversion to pentaammminenitritocobalt(III) chloride and to nitro isomer followed by IR characterization; Inorganic Chemistry18, 1869 (1979).
6. Preparation of phosphine, Ph_3P, and its transition metal complexes; Inorg. Synth. 15, 45 (1974).
7. Reaction of Cr(III) with a multidentate ligand like EDTA: a kinetic experiment (visible spectra Cr-EDTA complex); J.A. C. S., 1953, 75, 5670.
8. Preparation of Chromium(III) complexes, $[Cr(H_2O)_6]NO_3.3H_2O$, $[Cr(H_2O)]_4Cl_2]Cl.2H_2O$, $[Cr(en)_3]Cl_3$and $Cr(acac)_3$, followed by IR characterisation; Inorg. Synth.,13, 184 (1972).
9. Synthesis and studies on Ligand Field Strength: Chromium Complexes
   $K_3[Cr(C_2O_4)_3]\cdot 3H_2O$ and $[Cr(H_2NCH_2CH_2NH_2)_3]_2(SO_4)_3$ with ligands of different Δo.Inorganic syntheses, 1979, Published by John Wiley & Sons, Inc. Page :127.
10. Solid phase synthesis of cis and *trans*-bisglycinatocopper(II); J. Chem. Educ. 1982, 59,1052.
11. Preparation of silver nano-particles using silver nitrate solution and their spectroscopic characterization using UV-Visible spectrophotometry; Int. J. Mol. Sci. 2016, 17, 1534
12. Isolation of Cu from copper sulphate$[CuSO_4]$ and the preparation of copper compounds Cu_2O, Cu(I)Cl and $[Cu(NH_3)_4]SO_4$ from copper sulphate;DagmarSykorova, Inorganic Chemistry lab manual-II.

Gravimetric/Volumetric analysis: Copper, Cobalt, Lead, Nickel, Chromium, Chloride (Volhard's method), Sulphur etc.

Separation by Paper/TLC/Column Chromatography:
Paper, Thin layer and Column chromatography: Principle, separation process, technique, design of mobile phase, methods of paper chromatography (Ascending, Descending and Radial, comparative mobile phase study of separating mixtures, chromatogram analysis and Interpretation. Chromatographic media coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, visualization methods and applications in the separation. Adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications.

1. Separation, identification and determination of R*f* value of two cations by paper chromatography (Ascending, Descending and Radial).
2. Separation, identification and determination of R*f* value of three cations by paper chromatography (Ascending, Descending and Radial).
3. Separation and determination of R*f* value of two cations by thin layer chromatography.
4. Determination of ionisable chloride in a complex by cation exchange column (separation followed by Mohr's titration of elute for estimation).
5. Separation of Cobalt(II) and Nickel(II) on anion exchange column followed by estimation through EDTA titrations.
6. Separation of Permanganate and Bichromate ions on Alumina column and their Estimation from Beer Law plots.

Any other practical introduced by the teacher.

BOOKS RECOMMENDED

1. Vogel's textbook of quantitative chemical analysis (5^{th} and 6^{th} edition).
2. G. R. Chatwal, Instrumental Methods for Chemical Analysis, 5^{th} ed., Himalaya Publications (India).
3. V. K. Ahluwalia and S. Dingra, Advanced experimental Inorganic Chemistry, Manakin Press Pvt. Ltd., 2016.
4. R. P. W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York.
5. M. N. Sastri, Separation methods,Himalaya Publishing Company, Mumbai.
6. E. Helfman, Chromatography, Van Nostrand, Reinhold, New York.
7. E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.
8. H.M Mc Nair and J. M. Miller, Basic Gas Chromatography, John Wiley, New York.
9. Microscale Inorganic Chemistry- A Comprehensive Laboratory Experience - Szafran, Zvi, Mono M. Singh and Ronald M. Pike,John Wiley & Sons, Inc. 1991.

SCHEME OF EXAMINATION FOR PRACTICALS

	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Internal Examination	100%	8 hours	50
External Examination	100%	8 hours	50
Total			100

Distribution of Marks in Practicals

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment:**15 Marks**

Practical Examination: **30 Marks**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and<80 % = 02 Marks

External Practical Examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination: **42 Marks**

Viva-voce Examination:**08 Marks**

Course Code: P2CHPE311 **Nature of Course: Elective**
Title: Practical Course in Organic Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 120

Course Outcome: *In this course, students will be trained to employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment and, society.*
This paper has scope of employability in academics and in research institution and pharmaceutical industries.

Two/three step synthesis of organic compounds
The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

Benzpinacolone from benzophenone, Benzilic acid from benzoin, Fischer-indole synthesis, dihydropyrimidinones and dihydropyridines.
Use of microwaves/ultrasounds for the synthesis of coumarins.

Extraction of organic compounds from natural sources

1. Isolation of casein from milk
2. Isolation of lactose from milk
3. Isolation of piperine from black pepper
4. Isolation of lycopene from tomatoes
5. Isolation of β-carotene from carrot.

Spectroscopy
Identification of some organic compounds by the analysis of available spectral data (UV, IR, PMR, CMR and MS).
Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Elementary Practical Organic Chemistry, Part-1, 2nd ed., Vogel.
2. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.
3. Spectrophotometric determination of amino acid by Michail A. Alterman, Peter Hunziker, Vol. 828, Print ISBN: 978-1-61779-444-5.
4. Microwave-assisted organic synthesis, Vol. 25, D. Bogdal, Elsevier Science, 2005.
5. Laboratory experiment using microwave heating, N.E. Leadbeater and C.B. McGowan, CRC Press, 2013.
6. Experiments in green and sustainable chemistry, H.W. Roesky and D. Kennepohl, Wiley-VCH, 2009.
7. Advanced Practical Chemistry by LDS Yadav, Pragati tenth edition 2022.

SCHEME OF EXAMINATION FOR PRACTICALS

	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
Internal Examination	100%	8 hours	50
External Examination	100%	8 hours	50
Total			100

Distribution of Marks in Practicals

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment: **15 Marks**

Practical Examination: **30 Marks**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and<80 % = 02 Marks

External Practical Examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination: **42 Marks**

Viva-voce Examination: **08 Marks**

Course Code: P2CHPE312 **Nature of Course: Elective**
Title: Practical Course in Physical Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 120

Course Outcome: *Students will employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment, society, and other cultures outside the scientific community.*
This paper has scope of employability in academics, research institution and industries.

1. Determination of Planck's constant by means of LED's method based on expression of diode current for $V<V_0$. The dependence of current with temperature is to be measured, keeping the V slightly below V_0 and material constant η to be obtained from V-I characteristics of the diode.
2. Four Probe set-up for measuring the resistivity of very low to highly resistive samples at temperature up to 200°C with PID controlled oven, having the following setup:
   (i) Four Probe Arrangement with built-in RTD sensor & PID controlled Oven
   (ii) D.C. Microvoltmeter
   (iii) Constant Current Source for low resistivity samples like thin films for metals and alloys
   (iv) Low Current Source
3. Measurement of Magentoresistance of Semiconductors with the apparatus consisting of:
   a) Four Probe Arrangement
   b) Sample: Ge Crystal (n-type)
   c) Magnetoresistance setup
   d) Electromagnet
   e) Constant Current Power Supply
   f) Digital Gaussmeter
4. Study of Dependence of Hall Coefficient on Temperature by the following setup:
   a) Hall Effect Setup
   b) Hall Probe (Ge: p-type) with a small oven
   c) Electromagnet
   d) Constant Current Power Supply
   e) Digital Gaussmeter
5. Study of the energy band-gap and diffusion potential of P-N Junctions.

X-ray diffraction studies

6. To the X-ray diffraction pattern of a given compound
   (i) Assign lattice planes to different peaks of XRD pattern
   (ii) Determine lattice parameters
   (iii) Determine crystallite size and lattice strain.

Magnetic measurements

7. To determine the magnetic susceptibility of a given compound using Faraday's method and hence determine different magnetic parameters.

Spectrophotometry

8. To determine the specific rate constant for the oxidation of ethanol by potassium dichromate using spectrophotometer.

9. To determine the critical micelle concentration of a surfactant using spectrophotometer.

Viscometric measurements

10. Determine the molecular mass of polystyrene from viscometric measurements.

Polarimetry

11. To determine the rate constant for the inversion of sucrose by polarimetry.

Ultrasonic interferometry

12. To find the velocity of sound in liquids using ultrasonic interferometer.

Thermogravimetry

13. To determine the transition temperature and the heat of transition of the given hydrated salt by differential thermal analyzer.

Chemical Kinetics

14. To Study the kinetics of bromination of phenol by bromide-bromate mixture in an acid medium as a clock reaction.
15. To find out the order of reaction between potassium bromate and potassium iodide.

Thermodynamics

16. To determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
17. Determination of temperature dependence of solubility of compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO-water mixture) and calculate the partial molar heat of solution.

Conductivity measurements

18. To determine the degree of hydrolysis and hydrolysis constant of (i) aniline hydrochloride (ii) sodium acetate and (iii) ammonium chloride by conductometric measurements.
19. Estimate the concentration of HCl, CH_3COOH and $CuSO_4.5H_2O$ in a given solution by carrying out conductometric titration with NaOH solution.
20. Determine the equivalent conductance of a strong electrolyte i.e. NaCl, KCl at several concentrations and hence verify Debye Huckel Onsager equation.
21. Determine the equivalent conductance of a weak electrolyte i.e. CH_3COOH at infinite dilution by Kohlrausch law.

pH metry

22. To determine the strength of unknown solution of HCl by titrating it with NaOH solution using pH meter.
23. To find the strength of unknown solution of NH_3 solution by titrating it with CH_3COOH solution.
24. To find the strength of unknown solution of Na_2CO_3 solution by titrating it with HCl solution.
25. To find out the dissociation constant of polybasic acid e.g. phosphoric acid by titrating it with NaOH solution.
26. Determine the degree of hydrolysis and hydrolysis constant of (i) aniline hydrochloride (ii) sodium acetate and (iii) ammonium chloride by conductometric measurements.

Any other practical introduced by the teacher.

BOOKS RECOMMENDED

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry by Viswanathan and Raghavan.

SCHEME OF EXAMINATION FOR PRACTICALS

	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
Internal Examination	100%	8 hours	50
External Examination	100%	8 hours	50
Total			100

Distribution of Marks in Practicals

Total Credits = 04, Total Marks = 100

Internal Examination = 50 Marks, External Examination = 50 Marks

Internal Practical Examination

Daily Assessment: **15 Marks**

Practical Examination: **30 Marks**

Attendance = **05 Marks**

≥ 90% = 05 Marks

≥ 80% and < 90 % = 03 Marks

≥ 75% and<80 % = 02 Marks

External Practical Examination

External Practical examination shall be conducted by Board of Examiners consisting of concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall assess final practical performance of the students.

Practical Examination: **42 Marks**

Viva-voce Examination: **08 Marks**

Course Code: P2CHMO351 **Nature of Course: Elective**
Title: Title of the MOOC/SWAYAM course opted by students
Credits: 04 **Maximum Marks: 100**

Course Description:

One 04 credit MOOC (Massive Open Online Course) selected from SWAYAM (Study Webs of Active-Learning For Young Aspiring Minds) UGC (University Grant Commission) portal. SWAYAM is a programme initiated by Government of India to achieve the three cardinal principles of Education policy viz., access, equity and quality.

Course Objectives:

- To provide the students high quality learning experience eusing multimedia on anytime, anywhere basis.
- To acquaint the students with online mode of learning using ICT platform.
- To diverse the knowledge of students through open learning and help them to access different disciplines online and thus promoting interdisciplinary knowledge.
- To provide the students a hybrid model of learning that adds to the quality of classroom teaching.

Course Selection Guidelines for Students:

- The students are required to enrol and qualify any one of the MOOC courses from SWAYAM (UGC) portal that should of 04 credits.
- The course can be selected from the SWAYAM platform depending upon the availability of courses as notified by UGC generally on predefined dates, 1st June or 1st November respectively, every year.
- The students are required to enrol for the SWAYAM course immediately after the commencement of 1st Semester as per notified dates by UGC for SWAYAM courses.
- The course should be completed before the completion of 3rd Semester of M.Sc.
- Student ideally should not select self-paced MOOCs, and the courses selected must be different from one offered in the course curriculum of semesters in order to duplication.
- The student must fill an undertaking form, as given in the brochure, and submit the same after duly filled form to their respective Departments/Colleges for future reviews and record purposes.
- SWAYAM Examination fees (if any), or any other fee prescribed, shall be borne by the students only.

Course Content:

To be provided by the Course Coordinator of SWAYAM Course through online mode.

Examination:

To be conducted by the host Institution offering SWAYAM course selected by the student. The students are required to submit the qualifying marksheet/certificate to the office of the Department of Chemistry.

Course Code: P2CHTE401 **Nature of Course: Elective**
Title: Organotransition Metal Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *This course will enable the students to learn basic concepts, different bonding behaviour, synthetic and structural aspects of transition metal-carbon bond. Students will also gain the knowledge of applications of these compounds in various fields as catalyst with full understanding of their mechanism.*

UNIT-I: σ–Bonded Transition Metal Complexes (Hydrocarbyls/aryls) (12 hours)
Definition, brief introduction, types and classification of σ–hydrocarbyls/aryls, nomenclature, bonding and structure of hydrocarbyls, routes of synthesis from group 3 (d^1) metal to group 10 (d^8) metals, Properties: stability factors, kinetic *vs* thermal stability of σ–hydrocarbyls;Decomposition pathways: hydride (α, β and γ) eliminations; Reductive elimination; characteristic chemical reactions.
Organo-copper compounds: Lithium dialkylcuprates and Lithium diarylcuprates (Gilman-type reagents), composition and structure of $LiCuR_2$, mechanism, Reactions with alkyl/aryl halides, ketones & α-haloketones, Acid chlorides, α, β-unsaturated carbonyls, disubstituted acetylenes, Primary and secondary amines, S-alkyl thioesters, epoxides. Introduction to alkenylcopper(I) reagents.

UNIT-II: Complexes of Transition Metal-Carbon Multiple Bonds (12 hours)
Alkylidenes and alkylidynes: Introduction, Low valent (Fischer) and high valent (Schrock) carbenes, singlet and triplet carbenes, nature of bonding and structures of metal carbenes, synthetic methods, spectral behaviour, electrophilicity and nucleophilicity of metal carbenes, reactivity and chemical reactions, reactive sites on metal carbenes, applications of metal carbenes.
Low valent (Fisher) and high valent (Schrock) carbynes: Doublet and quartet carbynes, Bonding model, synthetic methods and chemical reactions, Alkyne metathesis reactions and their mechanism, Grubb's and Schrock's olefin metathesis catalysts.

UNIT-III: Transition Metal – π Complexes (12 hours)
Transition metal-alkene complexes: Introduction, Bonding model, structure, types, synthesis, physical and chemical properties. Transition metal-alkyne complexes: Bonding model and structural features, synthesis, chemical reactions and alkyne metathesis reactions; Transition metal-allyl complexes: Types, bonding model and structural features, η^1-η^3 conversion, *syn*and*anti*conversion of protons, ^{1}H NMR analysis in metal-allyls,, synthesis and chemical reactions; Transition metal-butadiene complexes: Types, Bonding model, different extremes of bonding, synthesis and chemical properties; Metal-cyclobutadiene complexes; Metal-cyclopentadiene complexes: Bonding, synthesis and chemical reactions; Transition metal-arene and η(1-5)cyclohexadienyl complexes: Properties and structural features, synthesis and chemical reactions; Cycloheptatriene (CHT) and cyclooctatetraene (COT) metal complexes.

UNIT-IV: Organometallic compounds in Catalysis (12 hours)
Stoichiometric reactions for catalysis, activation of H-H and C-H bond; Homogeneous hydrogenation catalysis: Wilkinson's Catalyst, monohydride and dihydride hydrogenation, mechanism of catalytic cycle (CC), selected applications of Wilkinson's catalyst, Asymmetric hydrogenation using Chiral Catalyst; Polymerization of olefins: Zeigler-Natta catalyst and its possible mechanisms (Cosee-Arlman,, Alkylidene &Agostic hydrogen) of polymerization of

propene, stereo specific nature; Hydrocarbonylation of olefins (oxo reaction): Mechanism using Cobalt and Rhodium catalyst; Methanol carbonylation: Mechanism of catalytic cycle of Monsanto and Cativa process; Olefin oxidation of alkenes (Wacker process): Basic reactions involved and mechanism of catalytic cycle.

UNIT-V: Fluxional organometallic compounds and transition metal compounds with bonds to hydrogen **(12 hours)**

Basics and concepts of non-rigidity, Rate of rearrangements and techniques of study, Non-rigid molecules in different coordination geometries (4, 5 & 6), Berry's mechanism of pseudorotation, Hopping pattern, Classification and their fluxionality in alkenes and allyls (η^2 and η^3), σ-Bonded cyclic alkenes and π-Bonded cyclic alkenes, Rotation and scrambling of ligands on metals.

Transition metal hydrides: Types, Mononclearpolyhdrides, homoleptic polyhydride anions, carbonyl hydrides, molecular hydrogen compounds; synthesis, properties like spectral behaviour, acidity and chemical reactions; Open and closed M...H--C interactions, Transition metal-aluminohydrides and -borohydrides.

BOOKS RECOMMENDED

1. Principles and Applications of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegedus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-organic Chemistry, A.J. Pearson, Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
5. Basic Organometallic Chemistry, Concepts, Syntheses and Applications, B.D. Gupta and A.J. Elias, University Press.
6. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals., Wiley, New York,
7. A. Dedieu. Transition Metal Hydrides, Wiley-VCH.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03**

markseach. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.*

Course Code: P2CHTE402 **Nature of Course: Elective**
Title: Bioinorganic and Supramolecular Chemistry
Credit: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *The focus of this course is to enable the students to learn about the bioinorganic and molecular recognition and design of molecules for the beneficial of society.*

UNIT-I **(12 hours)**

Essential and trace metal ions in biology and their distribution, thermodynamic and kinetic factors for the presence of selected metal ions; special ligands systems- porphyrins, chlorin and corrin.

Transport and storage of dioxygen: Heme proteins and oxygen uptake, O_2 binding properties of heme (haemoglobin and myoglobin) and non-heme proteins hemocynin& hemerythrin), their coordination geometry and electronic structure, co-operativity effect and Bohr Effect, characterization of O_2 bound species by Raman and infrared spectroscopic methods.

Metal complexes in transmission of energy: Chlorophyll's, Photosystem I and II, oxygen evolving complex (OEC), 4Mn-cluster and O_2 evolution.

UNIT-II: Structure, function and biochemistry of enzymes containing following metals **(12 hours)**

a) Zinc: Zinc Fingers, Carboxy peptidase, Carbonic anhydrase.
b) Copper: Type I, Type II, Type III
Blue Proteins: Azurins, Plastocynins& Blue Oxidases, Model compounds of Blue copper proteins, Non Blue Proteins: Galactose oxidase, SOD.
c) Cobalt: Vitamin B12 co enzymes and model compounds, Actions of Cobalamines, Adenosylcobalamine as a coenzyme, Ribonucleotide reductase, Methylcobalamine as cofactor.

UNIT-III **(12 hours)**

Metal Storage, Transport and Biomineralization: Ferritin, Transferrin and Siderophores.
Structure and function of metalloproteins in electron transport processes – Cytochromes and Iron-Sulphur proteins: rubridoxin, ferridoxins.
Nitrogen fixation: Biological nitrogen fixation and its mechanism. Nitrogen-cycle enzymes: MoFe-cofactors. NOx reductases, nitrogenase and insights into N_2 binding, Chemical nitrogen fixation reduction to ammonia.
Molybdenum oxotransferase enzymes–Xanthine oxidase.

UNIT-IV **(12 hours)**

Iron enzymes – catalase, peroxidase and cytochrome P-450 and their mechanisms of action.
Applied bioinorganic chem–metals in medicine- therapeutic applications of cis-platin, transition metal radioisotopes (example: Tc, Co and Cu etc.) and MRI (Mn, Fe and Gd) agents. **Toxicity of metals** - Cd, Hg Pb, Asand Cr toxic effects with specific examples and chelation therapy.

UNIT-V **(12 hours)**

Definition of supramolecular chemistry. Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, halogen-bonding and van der Waals

interactions. Host-Guest interactions, lock and key analogy. Introduction to recognition, Molecular receptors- Design principles, Spherical recognition- Cryptates of metal cations, macrocyclic cryptands, Recognition of ammonium ions and related substrates, Recognition of neutral molecules, Recognition of anionic substrates (anionic coordination).
Molecular and Supramolecular devices: Supramolecular photochemistry, Supramolecular electronic devices, Supramolecular ionic devices.

BOOKS RECOMMENDED

1. Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, University ScienceBooks.
2. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine,University, Science Books.
3. Inorganic Biochemistry Vols. I and II ed., G. L. Eichhorn, Elsevier.
4. Progress in Inorganic Chemistry, Vols. 18 and 38 ed., J.J. Lippard, Willey.
5. Supramolecular Chemistry, J. M. Lehn, VCH.
6. Bioinorganic Chemistry: A Short Course-Rosette M.Malone, Wiley Interscience, 2002.
7. Biological Inorganic Chemistry-An Introduction, Robert Crichton, Elsevier Science,2007.
8. Supramolecular Chemistry: A Concise Introduction, J. L. Atwood and J. W. Steed,John Wiley & Sons, 2000.
9. Perspectives in Supramolecular Chemistry, G. R. Desiraju, Vol. 2, John Wiley & Sons.
10. Crystal Engineering, G. R. Desiraju, Cambridge university Press India Pvt. Ltd., 2011.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
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Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall

have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

Course Code: P2CHTE403 **Nature of Course: Elective**
Title: Chemistry of Heterocyclic Compounds
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *An exhaustivestudy of heterocyclic chemistry will be presented which will help the students to grasp its chemistry. This paper includes the different types of reaction mechanism in the preparation of different ring size heterocyclic compounds and also their biological importance. This will help students to get employability in Research and Development.*

UNIT-I: Nomenclature of Heterocycles **(12 hours)**
Replacement and systematic nomenclature (Hantzsch-Widmann system) for monocyclic, Fused and bridged heterocycles and simple spiroheterocycles, Carbocycles, Ring assemblies, Same repeating units, Different repeating units.

UNIT-II: Ring synthesis *via* different types of reactions **(12 hours)**
Introduction, Cyclization reactions (Displacement at tetrahedral carbon, Intramolecular nucleophilic addition to carbonyl group, intramolecular addition of nucleophiles to other double bond, cyclization onto triple bond, radical cyclization, carbene and nitrene cyclization, electrocyclic reactions). Cycloaddition reactions (1,3-Dipolar cycloaddition, Hetero Diels Alder reaction, [2+2] cycloaddition, cheletropic reactions, Ene reaction).

UNIT-III: Bicyclic and tricyclic ring systems with one heteroatoms **(10 hours)**
Synthesis and Chemical reactions including biological importance of quinoline, isoquinoline, acridine.
Bicyclic ring systems with two heteroatoms
Synthesis and Chemical reactions including biological importance of Cinnoline, Phthalazine, quinazoline, quinoxaline.

UNIT-IV: **(14 hours)**
Six-Membered Heterocycles with One heteroatom: Synthesis and reactions of pyridine,pyridine-*N*-oxide, pyriliumsalts.Biological importance, Synthesis and reactions of Coumarins (4-Hydroxy coumarin, 4-Methyl coumarin) and chromones.
Six Membered Heterocycles with two Heteroatoms: Synthesis and reactions of diazines (Pyrazines, Pyridazines, Pyrimidines and Barbiturates).
Seven- and Large-Membered Heterocycles: Synthesis and reactions of azepines, oxepines and thiepines.

UNIT-V **(12 hours)**
Four membered heterocyclic compounds with one heteroatom: Synthesis and chemical reactions of azetidines, Oxetanes, Thietanes
Five membered heterocyclic compounds with two heteroatoms: Biological importance, Synthesis and chemical reactions of pyrazole, imidazole, oxazole, thiazole.
Benzo-Fused Five Membered Heterocycles with one heteroatom: Synthesis and reactions including medicinal applications of benzopyrrole, Benzofuran and benzothiophene.

BOOKS RECOMMENDED

1. Heterocyclic Chemistry, Thomas L. Gilchrist, 3rd Edition, Addison Wesley Longman Limited 1997.

2. Chemistry of Heterocyclic Compounds, RakeshK. Prashar, Beena Negi,Anne Books Pvt. Ltd., 2022
3. Heterocyclic Compounds, Rashmi Jain, Alok Sahay, Usha Soni, Sandhya Pimplapure, Pragati Prakashan , 6th Edition , 2021.
4. Heterocylic Chemistry, J.A. Joule and K. Mills, Black well Publishing, 4th Edition, 2004.
5. Heterocyclic Chemistry, Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
6. The Chemistry of Heterocycles, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
7. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Pandler, Wiley Interscience.
8. An Introduction to Heterocyclic Compounds, R.M. Acheson, John Wiley and Sons.
9. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, Eds. Pergamon Press.
10. G. Solladie, J.D. Morrison (ed.), Asymmetric Synthesis, Academic Press.
11. Organic Synthesis, Michael B. Smith, McGraw Hill, International Edition.

PATTERN OF EXAMINATION

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	% Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, **Section-A** and **Section-B**. **Section-A** will have one compulsory question comprising of **08 parts** (minimum **01** from each unit) of **03 marks** each. Section B will have **06 questions of 12 marks** each to be set from the last three units (**02 from each unit**). Students are required to attempt 01 question from each unit of Section B. **In major test there should not be a gap of more than two days in between two tests.**

NOTE: *Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.*

Course Code: P2CHTE404 **Nature of Course: Elective**
Title: Catalysis in Organic Synthesis
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome:*On successful completion of this course, the students will gain knowledge about asymmetric catalysis including organocatalysis and metal catalysis. This will train the students to perform asymmetric organic transformations. In addition, the learning from this course will help the students to get employment in industry and academia.*

UNIT-I: Asymmetric Organocatalysis: A New Stream in Organic Synthesis (10 hours)
Introduction, historical background, catalysts, privileged catalysts, Proline, Cinchona Alkaloids, TADDOLs and derivatives, Binaphthol derivatives, reaction types, covalent catalysis, non-covalent organocatalysis.

UNIT–II: Aldol and Mannich-Type Reactions (14 hours)
Introduction, Aldol reactions of alkyl ketone donors, α-oxyketone donors, and aldehyde donors; Aldol reactions with ketone acceptors, Intramolecular aldol reactions.Mechanism and transition states of aldol reactions; effects of water on aldol reactions, catalyst recycling, and catalyst development strategies. Mannich-type reactions of aldehyde donors with glyoxylate imines, and with other preformed imines, Three-component Mannich reactions using aldehyde donors, Mannich-type reactions of ketone donors.

UNIT-III: Reduction of Alkenes (12 hours)
Asymmetric hydrogenation with Rhodium complexes, Ruthenium complexes, Titanium and Zirconium catalysts, Iridium catalysts, and with organocatalysts.

UNIT-IV: Reduction of Ketones and Imines (12 hours)
Hydrogenation of ketones, Hydrogenation and transfer hydrogenation of Imines and related compounds, Transfer hydrogenation of ketones, Heterogeneous hydrogenation, Reduction of ketones using enantioselective Borohydride reagents, Hydrosilylation of ketones, imines and nitrones.

UNIT-V: Catalytic Carbon-Carbon/Nitrogen Bond-Formation Reactions (12 hours)
General introduction to cross-coupling reactions, Metal-catalysed allylic substitutions, Alkyl metalation of alkenes.Suzuki, Heck, Sonogashira and Negishi couplings; Buchwald-Hartwig aminations.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry, PartA and B – Structure & Mechanism, F.A. Carey and R.J. Sundberg, Springer (5th ed., 2007).
2. Enantioselective Organocatalysis: Reactions and Experimental Procedures, Peter I. Dalko, Wiley (2007).
3. Catalysis in Asymmetric Synthesis; Vittoria Caprio and Jonathan M.J. Williams, Wiley (2nd ed., 2008).

PATTERN OF EXAMINATION

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Course Code: P2CHTE405 **Nature of Course: Elective**
Title: Solid State Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *The students will have an understanding of general principles of solid state reactions, preparation, methods and crystal symmetry, defects/structure of solids and their electronic, ionic conduction and magnetic properties.*

UNIT-I:Structure of Solids **(12 hours)**

Closed packed structures: cubic close packing and hexagonal close packing, Some important structure types: NaCl, ZnS, CsCl and perovskite ($SrTiO_3$),Crystal systems, Bravais lattice, Lattice planes, Symmetry: Point symmetry, Space symmetry and point groups, Representation of point groups and selected examples, Space groups.

UNIT-II: Crystal Defects, Solid Solutions and Organic Solid State Chemistry **(12 hours)**

Crystal defects - Perfect and imperfect crystals, Intrinsic and extrinsic defects, Point defects (Schottky and Frenkel defects), DerivationforSchottky and Frenkel defect concentration, Colour centres, Plane defects: Grain boundary and Staking faults, Solid solutions: Substitutional solid solutions, Interstitial solid solutions, More complex solid solutions mechanisms, Requirements for solid solutionformation.Topochemical control of solid state organic reactions: Conformational effects, Molecular packing effects,Electrically conducting organic solids: conjugated systems, organic charge transfer complexes (New superconductors).

UNIT-III: Preparative Methods **(12 hours)**

General Principles of Solid State Reactions: Reaction conditions, Structural considerations, Wagner reaction mechanism, Surface area of solids,Preparation of materials in solid state: Ceramic methodand its limitations, Precursor method, Sol-gel method, Hydrothermal method, Electrochemical reduction methods, Vapour phase transport and high pressure methods, Preparation of thin films, Growth of single crystals.

UNIT-IV: Electronic and Ionic Conduction **(12 hours)**

Metals, insulators and semiconductors, Electronic structure of solids-band theory (Chemical and Physical approaches), Band structure of metals, Insulators and Semiconductors, Intrinsic and extrinsic semiconductors, Doping of semiconductors, Controlled valency semi-conductors, Applications of semiconductors, Band structure of inorganic solids, Ionic conductivity in solids, Solid electrolytes- Fast ion conductors: α-AgI, β-Alumina, Oxide ion conductors.

UNIT-V: Magnetic and Dielectric Properties **(12 hours)**

Magnetic properties – Classification of materials, Behaviour of substances in a magnetic field, Effect of temperature: Curie and Curie-Weiss laws, Calculation of magnetic moments, Mechanisms of ferro and anti-ferromagnetic ordering, Super exchange and double exchange, Ferromagnetic domains and hysteresis, Soft and hard magnetic materials, Dielectric materials, Ferroelectricity, Pyroelectricity, Piezoelectricity, Applications of Ferro-, Piezo- and Pyroelectrics.

BOOKS RECOMMENDED

1. Solid State Chemistry and its applications, A.R. West, John Wiley, New York.
2. Principles of the Solid State, H.V. Keer, New Age International (P) Limited, India.
3. Solid State Chemistry, An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd, U.K.

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Course Code: P2CHTE406 **Nature of Course: Elective**
Title: Polymer Chemistry
Credits: 04 **Maximum Marks: 100**
No. of hours: 60

Course Outcome: *Basic aspects of polymer chemistry and their characterization, structure and properties of polymers, polymer processing and properties of commercial polymers are discussed in this course work.*

UNIT-I: General Aspects **(12 hours)**

Importance of polymers, Basic concepts: Monomers, Repeat units, Degree of polymerization, Linear branched and network polymers, Classification of polymers, Polymerization: Condensation, Addition, Radical chain-ionic, Co-ordination and co-polymerization, Polymerization conditions and polymer reactions, Polymerization in homogenous and heterogeneous systems.

UNIT-II: Polymer Characterization **(14 hours)**

a) Polydispersion – average molecular weight concept, Number and Weight average molecular weight, Molecular weight distribution, Measurement of molecular weights: viscosity, osmometric, light scattering, ultracentrifugation methods.

(b) Analysis and testing of polymers, Chemical analysis of polymers, Spectroscopic methods, X-ray diffraction study, Microscopy, Thermal analysis and physical testing, Tensile strength, Fatigue, Impact, Tear resistance, Hardness, Abrasion resistance.

UNIT-III: **(12 hours)**

(a) Thermodynamics of Solutions of High Polymers

Entropy of mixing of solvent and solute, Enthalpy of mixing of solvent and polymeric solute, Free energy of mixing of polymeric solute with solvent, Chemical potential and activity of solvent, Osmotic pressure of polymeric solutions.

(b) Structure and Properties

Morphology and order in crystalline polymers, Configurations of polymer chains, Crystal structures of polymers, Crystallization and melting, Polymer structure and physical properties: Crystalline melting point, T_m-melting points of homogeneous series, Effect of chain flexibility and other steric factors, Entropy and heat of fusion, Glass transition temperature, Effect of molecular weight, Diluents, Chemical structure, Chain topology, Branching and cross linking.

UNIT-IV: Polymer Processing **(10 hours)**

Property requirements and polymer utilization, Plastics, Elastomers and fibres, Processing techniques: Compounding, Calendaring, Die casting, Rotational casting, Film casting, Injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Foaming, Reinforcing and fibre spinning.

UNIT-V: Properties of Commercial Polymers **(12 hours)**

Polyethylene, Polyvinyl chloride, Polyamides, Polyesters, Phenolic resins, Epoxy resins and silicon polymers, Functional polymers, Fire retarding polymers and electrically conducting polymers, Biomedical polymers, Contact lens, Dental polymers, Artificial heart, Kidney, Skin and blood cells.

BOOKS RECOMMENDED

1. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.R. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.

PATTERN OF EXAMINATION

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Course Code: P2CHRE407 **Nature of Course: Elective**
Title: Project in Inorganic Chemistry
Credits: 16 **Maximum Marks: 400**
No. of hours: 480

Course Outcome: *The Projects have been designed so as to provide exposure to students in various experimental aspects of Inorganic Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.*

The students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

EVALUATION SCHEME

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Time allotted for the examination	%Weightage (Marks)		
Mid Term Appraisal	4 hours	25%		
External Examination	4 hours	75%	50%	Project Report
			25%	Viva-Voce
Total				100

Distribution of Marks in Research (Dissertation/Project)

Total Credits = 16, Total Marks = 400
Internal Evaluation = 100 Marks, External Evaluation = 300 Marks

Internal Research (Dissertation/Project) Evaluation

Assessment of Research (Dissertation/Project) shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of the Department and concerned teacher who shall evaluate/assess dissertation of the students.

External Research (Dissertation/Project) Evaluation

Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of the Department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess dissertation of the students.

Course Code: P2CHRE408 **Nature of Course: Elective**
Title: Project in Organic Chemistry
Credits: 16 **Maximum Marks: 400**
No. of hours: 480

Course Outcome: *The Projects have been designed so as to provide exposure to students in various experimental aspects of Organic Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.*

The students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

EVALUATION SCHEME

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Time allotted for the examination	% Weightage (Marks)		
Mid Term Appraisal	4 hours	25%		
External Examination	4 hours	75%	50%	Project Report
			25%	Viva-Voce
Total				100

Distribution of Marks in Research (Dissertation/Project)

Total Credits = 16, Total Marks = 400
Internal Evaluation = 100 Marks, External Evaluation = 300 Marks

Internal Research (Dissertation/Project) Evaluation

Assessment of Research (Dissertation/Project) shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of the Department and concerned teacher who shall evaluate/assess dissertation of the students.

External Research (Dissertation/Project) Evaluation

Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of the Department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess dissertation of the students.

Course Code: P2CHRE409 | **Nature of Course: Elective**
Title: Project in Physical Chemistry
Credits: 16 | **Maximum Marks: 400**
No. of hours: 480

Course Outcome: *The Projects have been designed so as to provide exposure to students in various experimental aspects of Physical Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.*

The students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

EVALUATION SCHEME

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Time allotted for the examination	% Weightage (Marks)		
Mid Term Appraisal	4 hours	25%		
External Examination	4 hours	75%	50%	Project Report
			25%	Viva-Voce
Total				100

Distribution of Marks in Research (Dissertation/Project)
Total Credits = 16, Total Marks = 400
Internal Evaluation = 100 Marks, External Evaluation = 300 Marks

Internal Research (Dissertation/Project) Evaluation
Assessment of Research (Dissertation/Project) shall be conducted by Board of Examiners consisting of Head of the Department, one/two Professors of the Department and concerned teacher who shall evaluate/assess dissertation of the students.

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