MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI – 12

M.Sc. CHEMISTRY

SYLLABUS

FROM THE ACADEMIC YEAR 2023 - 2024

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI - 600 005

MANONMANIAM SUNDARANAR UNIVERSITY,

TIRUNELVELI – 12

PG - COURSES – AFFILIATED COLLEGES

M.Sc. CHEMISTRY

(Choice Based Credit System)

For those who joined from 2023-2024 onwards

Course Structure For III and IV Semesters

Course Structure

Semester - III

Part	Courses	Credit	Hours per Week (L/T/P)
Part A	Core Courses 4 **(CC9, CC10, CC11, CC12)**	18	22
	Elective Course 1 (Generic / Discipline Specific) **EC5**	4	5
Part B	Skill Enhancement Course - **SEC 2**: Professional Competency skill	2	3
	Internship / Industrial visit / Field visit / Knowledge updating activities such as research institute visit	2	
	Total	**26**	**30**

Semester - IV

Part	Courses	Credit	Hours per Week(L/T/P)
Part A	Core Courses 2 **(CC13, CC14)**	10	12
	Project with Viva voce	6	8
	Elective Course 1 (Generic / Discipline specific) **EC6**	4	5
Part B	Skill Enhancement Course / Professional competency skill : **SEC3:** Chemistry for Advanced Research Studies / Research Techniques and Tools	2	5
Part C	Extension Activity	1	
	Total	**23**	**30**

Credit Distribution

Semester-III

Part	Title of the Paper	Credit	Hours per Week (L/T/P)
PartA	CC9– Organic synthesis and Photochemistry	5	6(5L + 1T)
	CC10 –Coordination Chemistry-I	5	6(5L + 1T)
	CC11– Inorganic Chemistry Practical-II	4	5(4P + 1T)
	CC 12– Analytical Chemistry Practical	4	5(4P + 1T)
	Elective- V (Generic / Discipline Specific) (One from Group E) Pharmacognosy and Phytochemistry/ Biomolecules and Heterocyclic compounds	4	5(4L + 1T)
PartB	**Skill Enhancement Course –SEC 2:** Forensic Chemistry	2	3(2L+1T)
	Internship / Industrial visit / Field visit / Knowledge updating activities such as research institute visit	2	
	Total	**26**	**30**

Semester-IV

Part	Title of the Paper	Credit	Hours per Week (L/T/P)
Part A	**CC13–**Coordination Chemistry-II	5	6(5L + 1T)
	CC14–Physical Chemistry-II	5	6(5L + 1T)
	CC15 - Project with viva voce	6	8
	Elective- VI (Generic / Discipline Specific) (One from Group F) Chemistry of Natural Products / Polymer Chemistry	4	5(4L+1T)
Part B	Skill Enhancement Course: **SEC 3:** Scientific Research Methodology	2	5(4L+1T)
PartC	Extension Activity	1	--------
	Total	**23**	**30**

Component wise Credit Distribution

PART	Courses	Sem I	Sem II	Sem III	Sem IV	Total
Part A	Core	**14**	**14**	**18**	**16**	**62**
	Elective	**6**	**6**	**4**	**4**	**20**
Part B	Skill Enhancement Course	**-------**	**2**	**2**	**2**	**6**
	Internship / Industrial visit / Field visit / Knowledge updating activities such as research institute visit	**--------**	**--------**	**2**	**---------**	**2**
Part C	Extension Activity	**-------**	**--------**	**-------**	**1**	**1**
Total		**20**	**22**	**26**	**23**	**91**

TEMPLATE FOR SEMESTER EXAMINATION

Code	Category	Title of the Paper	Marks (Max 100)		Duration for UE	Credits
			CIA	UE		
Semester –III						
Part A	**Core IX**	Organic synthesis and Photochemistry	25	75	3 Hrs	**5**
	Core X	Coordination Chemistry-I	25	75	3 Hrs	**5**
	Core XI	Inorganic Chemistry Practical-II	50	50	6 Hrs	**4**
	Core XII	Analytical Chemistry Practical	50	50	6 Hrs	**4**
	Elective -V	(Choose one from Group-E) Pharmacognosy and Phytochemistry **(OR)** Biomolecules and Heterocyclic compounds	25	75	3 Hrs	**4**
Part B	**Skill Enhancement Course – SEC II**	Forensic Chemistry :**SEC2**	25	75	3Hrs	**2**
	Internship / Industrial visit / Field visit / Research Institute Visit	A report should be submitted at the end of the III Semester by each student and viva voce will be conducted during practical examination.	50	50	--------	**2**
Total						**26**
Semester-IV						
Part A	**Core XIII**	Coordination Chemistry-II	25		3 Hrs	**5**
	Core XIV	Physical Chemistry-II	25		3 Hrs	**5**
	Core XV	Project with viva voce	50		-----	**6**
	Elective- VI	**Elective- VI** (Generic / Discipline Specific) Chemistry of Natural Products / Polymer Chemistry**(One from Group F)**	25		3 Hrs	**4**
Part B	**Skill Enhancement Course- SEC III**	Scientific Research Methodology : **SEC3:**	25		3 Hrs	**2**
Part C	**Extension Activity**	A report should be submitted at the end of the IV semester by each student,	50	50	----------	1
	Total					**23**

CIA = Continuous Internal Assessment UE= University Examinations

ELECTIVE COURSES

Courses grouped in Group E and Group F which include topics from Pure Chemistry (PC), Applied Chemistry (AC) and Industrial Components (IC) like Pharmaceutical Industries, Polymer labs courses for flexibility of choice by the stakeholders / institutions.

Semester III: Elective V

Elective V to be chosen from Group E

(PC/AC/IC)

1. Pharmacognosy and Phytochemistry
2. Biomolecules and Heterocyclic compounds

Semester IV: Elective VI

Elective V to be chosen from Group F

Group F: (PC/AC/IC)

1. Chemistry of Natural Products
2. Polymer Chemistry

SKILL ENHANCEMENT COURSES

Group G: Skill Enhancement Course:

Semester III : Skill Enhancement course II :**SEC II :**Forensic Chemistry

Semester IV : Skill Enhancement Course / Professional Competency Skill III : **SEC III:** Scientific Research Methodology

EXTENSION ACTIVITIES

Group H:

Outreach Activities

1) Preparation and creating the awareness of the usage of Sanitizer, Disinfectant, Dishwashing etc, in the nearby area of college.
2) To find and create awareness of food adulteration.
3) Testing the water samples and creating awareness of using the water samples
4) Testing the soil samples in the nearby field and give suggestions to farmers
5) Performing chemistry magic in the nearby schools and encourage the students to join the course

Computational software:

Stepwise approach to Chemdraw, ACD/Chemsketch, Argus Lab, AVOGADRO, Molinspiration, preADMET, SwissADME, SwissDock, 1 – Click online server, Autodock, and Crystal Explorer.

Conduct Virtual experiments in the nearby schools to encourage the students.

TESTING PATTERN

THEORY COURSE (25+75)

Internal Assessment: 25 Marks

For theory courses, there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

Components	Marks
The average of the best two tests from three	**15**
Assignment	**5**
Seminar	**5**
Total	**25**

Computer Laboratory Courses: For Computer Laboratory Oriented Courses, there shall be two tests in Theory part and two tests in Laboratory part. Choose one best from Theory part and other best from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

External Assessment: 75 marks

Written Examination: Theory Paper (Bloom's Taxonomy based)

Lower levels: K1: Remembering; K2: Understanding; K3: Applying; **Higher levels:** K4:Analyzing; K5: Evaluating; K6: Creating.

Maximum: 75 Marks Passing Minimum: 50% Duration: 3 Hours

Question Paper Model

Intended Learning skills	**PART**	**Pattern of Each Part**
Memory Recall / Example / Counter Example / Knowledge about the Concepts / Understanding	**Part A**	Questions 1 To 15. **(15 x 1 = 15 Marks)**. Answer **ALL** questions. Three questions from each Unit. Choose the correct answer among the four options **vice a,b,c & d. Each question carries 1 mark**
Descriptions / Application (Problems)	**Part B**	**Either-or –Type** **Questions 16 To 20 (5x4=20 Marks)** Answer **ALL** questions by choosing **either** (**a**) or (**b**). Each answer should not exceed 250 words. One question from each unit and both parts of each question (ie subdivisions a & b) should be from the same UNIT . **Each question carries 4 marks.**
Analysis / Synthesis / Evaluation	**Part C**	**Either-or –Type** **Questions 21 To 25 (5x8=40 Marks)** Answer **ALL** questions by choosing **either** (**a**) or (**b**) Each answer should not exceed 600 words.One question from each unit and both parts of each question (ie subdivisions a & b) should be from the same UNIT . **Each question carries 8 marks.**

Each question should carry the course outcome and cognitive level.For instance,

1. [CO1: K2] Question xxxx
2. [CO3: K1] Question xxxx

PRACTICAL COURSE (50 +50)

The practical examination and viva voce of practical will be conducted at the end of the III semester by two external examiners. The break up of mark details for internal is given below whereas for external examination the scheme of valuation will be decided by the respective board of Question setters.

Component	Marks	Internal : 50 Marks, Break up details	
Internal	50	**Components**	**Marks**
External	50	Number of Experiments	30
Total	100	Record	10
Passing Minimum	50%	Model Test Average	10
		Total	50
There is no minimum pass mark **in internal. But** if it is **less than 50% it should be compensated in the external.**			

III semester : Report for Internship / Industrial Visit / Field Visit / Research Institute Visit **& IV Semester :** Project and Extension Activity

Internal :50 marks

III Semester : Internship / Industrial Visit / Field Visit / Research Institute Visit

Students should submit a report for internship / industrial visit / field visit / research institute visit at the end of third semester. The report should contain **Title, Declaration, Certificate, Contents, Introduction**(General information, Purpose etc) , **Discussion**(about the organization /institute, the things learned, the manufacturing processes, instrument operation, the relevant pictures etc.,) **Summary** (The strength and weakness of the visit, recommendation for the improvement of the organization / institute, evidence of the visit etc.,)These processes should be assessed by the coordinator (the professor who accompanied with the students in the visit) to award the internal mark.

The duration of internship should be 30 to 40 hours. Along with the report, the students undergoing internship should affix the certificate of attendance from the industry he visits whereas the other students should affix an evidence for their visit.

IV Semester: Project

Students will do the project work on a title approved by the respective project supervisor. Students should maintain daily records and present oral reports while doing project preparation. All the above processes will be duly assessed by the project supervisor to award the internal mark.

IV Semester: Extension Activity :

The sample list of Extension Activities are given in the Group H. Each student may select any one of the extension activity given in the Group H or the similar chemistry related extension activity. The activity of each student should be assessed by a supervisor to award internal mark.

External: 50 marks

The **Internship/ Industrial Visit / Field Visit/ Research Institute Visit report and its Viva voce examination** will be evaluated by **two external examiners** at the end of the III Semester.

The **Project and Extension Activity report and their viva voce examinations** will be evaluated by **two external examiners** at the end of IV Semester.

The break up of mark details for these examinations is as follows:-

Component	**Marks**	**External : 50 Marks, Break up details**	
Internal	50	**Components**	**Marks**
External	50	Report of Internship/ Industrial visit/ Field visit/ Research institute visit report **(III Semester)** & Project Report & Extension Activity Report **(IV Semester)**	30
Total	100	Viva voce	20
Passing Minimum	50%	Total	50
There is no minimum pass mark **in internal. But** if it is **less than 50% it should be compensated in the external.**			

Course Structure
II M.Sc. Chemistry :Semester -III

Title of the Paper	**ORGANIC SYNTHESIS AND PHOTOCHEMISTRY**						
Paper No.	**Core IX**						
Category	**Core**	**Year**	II	**Credits**	5	**Course Code**	
		Semester	III				
Instructional hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	5	1	-			6	
Prerequisites	Basic knowledge of organic chemistry						
Objectives of the course	To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions. To study various synthetically important reagents for any successful organic synthesis. To apply disconnection approach and identifying suitable synthons to effect successful organic synthesis. To learn the concepts of pericyclic reaction mechanisms. To gain the knowledge of organic photochemical reactions.						
Course Outline	**UNIT-I: Planning an Organic Synthesis and Control elements:** Preliminary Planning – knowns and unknowns of the synthetic system studied, analysis of the complex and interrelated carbon framework into simple rational precursors, retrosynthetic analysis, alternate synthetic routes, key intermediates that would be formed, available starting materials and resulting yield of alternative methods. Linear Vs convergent synthesis based on umpolung concepts of Seeback, regiospecific control elements. Examples on retrosynthetic approach, calculation of yield, advantages of convergent synthesis, synthesis of stereochemistry-controlled products.						
	UNIT-II: Organic Synthetic Methodology: Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Key intermediates, available starting materials and resulting yields of alternative methods. Convergent and divergent synthesis, Synthesis based on umpolung concepts of Seebach. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Control elements: Regiospecific control elements. Use of protective groups, activating groups, and bridging elements. Stereospecific control elements. Functional group alterations and transposition.						
	UNIT-III: Pericyclic Reactions: Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4, Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. ; Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and peri selectivity in pericyclic reactions.						

	UNIT-IV: Organic Photochemistry-I: Photochemical excitation: Experimental techniques; electronic transitions; Jablonskii diagrams; intersystem crossings; energy transfer processes; Stern Volmer equation. Reactions of electronically excited ketones; $\pi \rightarrow \pi^*$ triplets;

	Norrish type-I and Norrish type-II cleavage reactions; photo reductions; Paterno-Buchi reactions;
	UNIT-V: Organic Photochemistry-II: Photochemistry of α,β-unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to 3,4-diphenyl phenols; Barton's reactions.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. F. A. Carey and Sundberg, Advanced Organic Chemistry, 5th ed, Tata McGraw-Hill, New York, 2003. 2. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and sons, 2007. 3. R. E. Ireland, Organic synthesis, Prentice Hall India, Goel publishing house, 1990. 4. Clayden, Greeves, Warren, Organic Chemistry, Oxford University Press, Second Edition, 2016. 5. M. B. Smith, Organic Synthesis 3rd edn, McGraw Hill International Edition, 2011.
Reference Books	1. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974. 2. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2004. 3. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007. 4. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972. 5. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.
Website and e-learning source	**1. https://rushim.ru/books/praktikum/Monson.pdf**

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:

CO1: To recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.

CO2: To understand the versatility of various special reagents and to correlate their reactivity with various reaction conditions.

CO3: To implement the synthetic strategies in the preparation of various organic compounds.
CO4: To predict the suitability of reaction conditions in the preparation of tailor-made organic compounds.
CO5: To design and synthesize novel organic compounds with the methodologies learnt during the course.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

<table>
<tr><td>Title of the Paper</td><td colspan="7">COORDINATION CHEMISTRY – I</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core X</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>III</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Basic knowledge of Coordination Chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">To gain insights into the modern theories of bonding in coordination compounds.
To understand and construct correlation diagram and predict the electronic transition that are taking place in the complexes and magnetic properties of complexes.
To learn various methods to determine the stability constants of complexes
To describe various substitution and electron transfer mechanistic pathways of reactions in complexes
To study the reactions of octahedral and tetrahedral complexes.
To analyze different types photochemical reaction and their application in coordination complexes</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="7">UNIT-I: Modern theories of coordination compounds: Crystal field theory splitting of d orbitals in octahedral, tetrahedral and square planar symmetries, factors affecting 10Dq , crystal field stabilisation energy for high spin and low spin Oh and Td complexes, Applications CFSE, Jahn Teller distortions and its consequences. Ligand filed theory-.Molecular Orbital Theory and energy level diagrams: Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.</td></tr>
<tr><td colspan="7">UNIT-II: Spectral and Magnetic characteristics of coordination compounds: Spectral Characteristics: Microstate and Term symbol for d ions Characteristics of d-d transitions, charge transfer spectra, selection rules for electronic spectra - Orgel diagrams for d^1 to d^9 configurations - Tanabe Sugano diagram for octahedral d^6 complexes, nephelauxetic effect- Racha parameter and calculation of β and 10Dq octahedral d^2 and d^8 complexes
Magnetic characteristics: Basic terminology – Types of magnetic behavior- Determination of magnetic susceptibility by Guoy Balance and Faraday methods -Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments- Spin -state cross over - Magnetic properties of complexes with A , E and T terms. Magnetic properties of Lanthanides and Actinides – Comparison of magnetic properties of Oh, Td and square planar complexes of Fe (II),Co(II),Ni(II) and Cu(II).</td></tr>
</table>

	UNIT-III: Stability of Coordination of complexes Kinetic and thermodynamic stability - Inert and Labile complexes - Factors affecting stability of complexes, Stepwise and overall formation constants, Stability correlations - statistical factors, Irving William series,

	Macrocyclic and chelate effect. Determination of stability constant and composition of complex ions: Solubility method, Electrochemical method, Potentiometric method, Spectrophotometric method, Polorographic method and Continuous variation method (Job's method).
	UNIT-IV: Kinetics and mechanisms of substitution reactions in coordination complexes: Classification of inorganic reaction and reaction mechanism- Associative S_N2, Dissociative S_N1,interchange, $S_N{}^1CB$ mechanistic pathways for substitution reactions in octahedral complexes; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Eigen-Wilkins mechanism; Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.
	UNIT-V: Electron Transfer reactions and Photochemistry of coordination complexes: **Electron Transfer reactions** in octahedral complexes: Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions - nature of the bridging ligand in inner sphere electron transfer reactions. Complementary and Non Complementary electron transfer reactions. **Photochemistry:** Photochemical excitation in the transition metal complexes: Properties of THEXI states- Photophysical processes: bimolecular deactivation and energy transfer, Photochemical processes: Photo-redox, photo-substitution and photo-isomerisation reactions of Cr (III) and Co (III) complexes- Photophysical and photochemical properties of $[Ru(bpy)_3]^{2+.}$ Applications of inorganic photochemistry: photochemical conversion and storage of solar energy-photochemical conversion of N_2 to NH_3. – TiO_2 as a green photocatalyst in removing air and water pollutants.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.

Recommended Text	1. J.E. Huheey, E.A Keiter, R.L Keiter and O.K Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006

	2. G L Meissler and D A.Tarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008 3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993. 4. B. N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd, 1976. 5. F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988. 6. Asim K Das and Mahua Das, Fundamental concepts of inorganic chemistry,1st eBook edition, Volume 4, CBS publishers and distributors PVT Ltd,2019. 7. B.R.Puri,L.R.Sharma and K.C.Kalia,Principles of inorganic chemistry,Vishal publications,33rd edition,2016. 8. S.K.Agarwal and Keemti Lal, Advanced inorganic chemistry, Pragati Prakashan Educational publication,5th edition,2016. 9. R.L.Carlin,Magnetochemistry,Springer erlag,Berlin,Germany,1986. 10.A.Earnshaw, Introduction to Magneto-chemistry, Acdamic Press, Newyork, USA, 1968.
Reference Books	1. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977. 2. Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010. 3. , F. A. Cotton, G. Wilkinson, P. L. Guas, Basic Inorganic Chemistry John Wiley, 2002, 3rd edition. 4. B. Douglas, D. McDaniel, J. Alexander, Concepts and Models of Inorganic Chemistry,John Wiley, 1994, 3rd edition. 5. Asim K Das and Mahua Das, Fundamental concepts of inorganic chemistry,1st eBook edition, Volume 5, CBS publishers and distributors PVT Ltd,2019. 6. Ajai Kumar, Coordination chemistry, Aaryush Educations publications, 1st edition, 2014. 7. D.M.Roudhill, Photochemistry and Photophysics of metal complexes, Springer science + Business, media New York, 1st edition 1994. 8. R.Gopalan and V.Ramalingam, Concise Coordination chemistry, Vikas publishing house PVT Ltd 1st edition,2001.
Website and e-learning source	1.https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/ 2.https://teachmint.storage.googleapis.com/public/555766642/StudyMaterial/4730da7d-1f2a-4a70-a473-0cc7cd84dc13.pdf
Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able to: **CO1:**Understand and comprehend various theories of coordination compounds. **CO2:**Understand the electronic spectroscopic and magnetic properties of coordination complexes. **CO3:**Explain the stability of complexes and various experimental methods to determine the stability of complexes. **CO4:**Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes. **CO5:**To understand the versatility of electron transfer reactions and photochemistry of coordination complexes.	

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

<table>
<tr><td>Title of the Paper</td><td colspan="7">INORGANIC CHEMISTRY PRACTICAL-II</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core XI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>III</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>1</td><td colspan="3">4</td><td colspan="2">5</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Basic principles of gravimetric and qualitative analysis</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">To understand and enhance the analytical tool for the quantitative estimation of ions.
To recall the principle and theory in preparing standard solutions.
To train the students for improving their skill in estimating the amount of ions accurately present in the solution
To estimate metal ions, present in the given solution accurately without using instruments.
To determine the amount of ions, present in a binary mixture by volumetric and gravimetric methods.</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="7">UNIT-I: Preparation and analysis of metal complexes by titrimetric analysis :
1. Preparation of tris(thiourea)copper(I)sulphate dihydrate
2. Preparation of potassium tris(oxalato)chromate(III) trihydrate
3. Preparation of tetramminecopper(II) sulphate
4. Preparation of hexa(thiourea)copper(I) chloride dihydrate
5. Preparation of potassium tris(oxalato)ferrate(III) trihydrate</td></tr>
<tr><td colspan="7">Unit- II. Quantitative estimation of a mixture containing two metal ions (Volumetric and Gravimetric Estimations)
1. Estimation of mixture of Cu^{2+}(V) and Ni^{2+}(G)ions.
2. Estimation of mixture of Fe^{2+}(V)and Cu^{2+}(G)ions.
3. Estimation of mixture of Fe^{2+}(V) and Ni^{2+}(G)ions.
4. Estimation of Cu^{2+}(V) and Ba^{2+}(G) ions.
5. Estimation of Cu^{2+}(V)and Zn^{2+}(G) ions.</td></tr>
<tr><td>Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)</td><td colspan="7">Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved
(To be discussed during the Tutorial hours)</td></tr>
<tr><td>Skills acquired from this course</td><td colspan="7">Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.</td></tr>
<tr><td>Recommended Text</td><td colspan="7">1.Mounir A. Malati, Experimental Inorganic/Physical Chemistry - An Investigative, Integrated Approach to Practical Project Work, Woodhead Publishing Limited, Reprint, 2010.
2.G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, Revised 5th edition, ELBS, 1989.</td></tr>
</table>

	3.Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole-Thomson Learning, USA, **2004.**
Reference Books	1. G. Pass, and H. Sutcliffe, *Practical Inorganic Chemistry*; Chapman Hall, 1965. 2. W. G. Palmer, Experimental *Inorganic Chemistry*; Cambridge University Press, Reprint 1970. 3.I.M.Kolthoff and V.A.Stenger, Volumetric Analysis ,2nd Edition, Interscience Publishers, New Delhi,1947 4. *Vogel's Text book of Quantative Analysis*, 5th ed., London.
Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able: **CO1**: To recall the principle of titrimetric analysis. **CO2**: To acquire knowledge about the synthesis of coordination of complexes. **CO3**: To correlate the quantitative technique and the purity of the complex. **CO4**: To understand the separation techniques of bimetals in a solution. **CO5**:To develop the gravimetric skill.	

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO'sCO /PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

<table>
<tr><td>Title of the Paper</td><td colspan="8">ANALYTICAL CHEMISTRY PRACTICAL</td></tr>
<tr><td>Paper No.</td><td colspan="8">Core XII</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>II</td><td>Credits</td><td>4</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Semester</td><td>III</td><td colspan="4"></td></tr>
<tr><td>Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td></td><td>-</td><td>1</td><td colspan="3">4</td><td colspan="3">5</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Basic principles of potentiometry, colorimetry and cyclic voltametry</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">To design chromatographic for identification of species.
To analyze different constituents through instrumental methods of analysis.
To evaluate different contaminants in materials using spectrophotometry.
To design experiments for analysis of inorganic and organic materials.
To analyze constituents in materials using potentiometry and cyclic voltammetry.</td></tr>
<tr><td>Course Outline</td><td colspan="8">UNIT-I:
1. Potentiometric titration of HCl Vs NaOH
2. Determination of pK_a of weak acid by EMF method.
3. Potentiometric titration of FAS Vs $K_2Cr_2O_7$
4. Potentiometric titration of KI Vs $KMnO_4$.
5. Potentiometric titration of a mixture of Chloride and Iodide Vs $AgNO_3$.
6. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode.
7. Study of the inversion of cane sugar in the presence of acid by Polarimetric method.</td></tr>
<tr><td></td><td colspan="8">UNIT-II:
1. Estimation of Fe and Ni by colorimetric method.
2. Determination of spectrophotometrically the mole ratio of the ferrithiocyanate complex and equilibrium constant for the complex formation.
3. Determination of the amount (mol/L) of ferricyanide present in the given solution using cyclic voltammetry.
4. Determination of the standard redox potential of ferri-ferrocyanide redox couple using cyclic voltammetry.
5. Estimation of the amount of nitrate present in the given solution using spectrophotometric method.
6. Analysis of water quality through COD, DO, BOD measurements.
7. Assay of Riboflavin and Iron in tablet formulations by spectrophotometry
8. Estimation of chromium in steel sample by spectrophotometry
9. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography.
10. Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry.</td></tr>
</table>

	UNIT-III: Interpretation and identification of the given spectra of various organic compounds arrived at from the following spectral techniques. 1.UV-Visible 2.IR 3.NMR 4.ESR
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003. 2. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*; 6th ed., ELBS, 1989. 3. J. D. Woollins, *Inorganic Experiments*; VCH: Weinheim, 1995. 4. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi,2009. 5. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
Reference Books	1. N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Labmanual, S. Viswanathan Co. Pvt. Ltd, 2009. 2. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011. 3. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001. 4. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009. 5. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.
Website and e-learning source	1. https://bit.ly/3QESF7t 2. https://bit.ly/3QANOnX

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the principles associated with various inorganic organic and physical chemistry experiments

CO2: To scientifically plan and perform all the experiments

CO3: To observe and record systematically the readings in all the experiments

CO4: To calculate and process the experimentally measured values and compare with graphical data.

CO5: To interpret the experimental data scientifically to improve students efficiency for societal developments.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

<table>
<tr><td>Title of the Paper</td><td colspan="8">PHARMOCOGNOSY AND PHYTOCHEMISTRY</td></tr>
<tr><td>Paper No.</td><td colspan="8">Elective V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td>Credits</td><td>4</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="3">-</td><td colspan="3">5</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Basic knowledge of chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">To develop the knowledge of natural products, biological functions and pharmacological uses.
To develop knowledge on primary and secondary metabolites and their sources.
To understand the concepts of isolation methods and separation of bioactive compounds.
To provide the knowledge on selected glycosides and marine drugs.
To familiarize the guidelines of WHO and different sampling techniques.</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="8">UNIT-I:Pharmacognosy and Standardization of Herbal drugs: Introduction, definition, development classification and Source of Drugs: Biological, mineral, marine,and plant tissue cultures. Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture Ash value. Phytochemical investigations-General chemical tests.</td></tr>
<tr><td colspan="8">UNIT-II:Extraction Techniques: General methods of extraction, types – maceration, Decoction, percolation, Immersion and soxhlet extraction. Advanced techniques- counter current, steam distillation, supercritical gases, sonication, Microwave assisted extraction. Factors affecting the choice of extraction process.</td></tr>
<tr><td colspan="8">UNIT-III:Drugs containing Terpenoids and volatile oils: Terpenoids: Classification, Isoprene rule, Isolation and separation techniques, General properties of Camphor, Menthol, Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations, Classifications of Volatile oils, Camphor oil, Geranium oil, Citral- Structure and uses. Pentacyclic triterpenoids: amyrines; taraxasterol: Structure and pharmacological applications.</td></tr>
<tr><td colspan="8">UNIT-IV:Drugs containing alkaloids: Occurrence,function of alkaloids in plants, pharmaceutical applications. Isolation, Preliminary Qualitative tests and general properties. General methods of structural elucidation. Morphine, Reserpine, papaverine - chemical properties, structure and uses.</td></tr>
<tr><td colspan="8">UNIT-V: Plant Glycosides and Marine drugs: Glycosides: Basic ring system, classification, isolation, properties, qualitative analysis. Pharmacological activity of Senna glycosides, Cardiac glycosides- Digoxin, digitoxin, Steroidal saponins glycosides- Diosgenin, hecogenin. Plant pigments: Occurrence and general methods of structure determination, isolation and synthesis of quercetin and cyanidin chloride. Marine drugs -Selected Drug Molecules:</td></tr>
</table>

	Cardiovascular active substances, Cytotoxic compounds, antimicrobial compounds, antibiotic compounds, Anti-inflammatory agents. Marine toxins.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. Gurdeep R Chatwal (2016), Organic chemistry of Natural products, Volume I&II, 5th edition, Himalaya publishing House. 2. S.V.Bhat, B.A. Nagasampagi, M.Sivakumar (2014), Chemistry of Natural Products, Revised edition, Narosa Publishers.
Reference Books	1. Jeffrey B. Harborne (2012), Phytochemical methods: A Guide to Modern Techniques of Plant Analysis, 4th edition, Indian reprint, Springer. 2. Ashutoshkar (2007), Pharmacognosy and Pharmaco biotechnology, 2nd edition, New age international (P) limited, New Delhi. 3.Biren N.Shah and A.K.Seth, A text book of Pharamacognosy and Phytochemistry, ELSEVIER, First Edition,2010
Website and e-learning source	1. https://www.kobo.com/gr/en/ebook/phytochemistry-2 2. https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H 3. https://www.amazon.in/Computational-Phytochemistry-Satyajit- Dey-Sarker-ebook/dp/B07CV96NZJ 4. https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/ 5. https://www.worldcat.org/title/textbook-of-pharmacognosy-and- phytochemistry/oclc/802053616 6. https://www.worldcat.org/title/phytochemistry/oclc/621430002
Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able: **CO1:**To recall the sources of natural medicines and analysis of crude drugs. **CO2:** To understand the methods of evaluation based on various parameters. **CO3:**To analyze the isolated drugs **CO4:**To apply various techniques to discover new alternative medicines. **CO5:**To evaluate the isolated drugs for various pharmacological activities	

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

<table>
<tr><td>Title of the Paper</td><td colspan="8">BIOMOLECULES AND HETEROCYCLIC COMPOUNDS</td></tr>
<tr><td>Paper No.</td><td colspan="8">Elective V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td>Credits</td><td>4</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="3">-</td><td colspan="3">5</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Basic knowledge of biomolecules and heterocyclic com heterocyclic compounds.</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">To learn the basic concepts and biological importance of biomolecules .
To explain various functions of carbohydrates, proteins, nucleic acids, steroids and hormones.
To elucidate the structure determination of biomolecules
To extract and construct the structure of new steroids , hormones, proteins and nucleic acids.</td></tr>
<tr><td rowspan="4">Course Outline</td><td colspan="8">UNIT-I: Chemistry and metabolism of carbohydrates: Definition, classification and biological role of carbohydrates. monosaccharides: Linear and ring structures (Haworth formula) of ribose, glucose, fructose and mannose (structure determination not required), physical and chemical properties of glucose and fructose. Disaccharides: Ring structures (Haworth formula) –occurrence, physical and chemical properties of maltose, lactose and sucrose. Polysaccharides: Starch, glycogen and cellulose – structure and properties, glycolysis of carbohydrates.</td></tr>
<tr><td colspan="8">UNIT-II: Steroids and Hormones: Steroids-Introduction, occurrence, nomenclature, configuration of substituents. Diels’ hydrocarbon, stereochemistry, classification, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene. Hormones-Introduction, classification, functions of sex hormones- androgens and estrogens, adrenocortical hormones-cortisone and cortisol structure and functions of non-steroidal hormones-adrenaline and thyroxine.</td></tr>
<tr><td colspan="8">UNIT-III: The Criteria for Aromaticity and Hückel’s Rule Classification of Heterocycles- Nomenclature of Heterocyclic Compounds Hantzsch-Widman rules- Preparation and properties of Aziridine, Oxirane, azetines, azetidines, oxetanes and thietanes- Preparation and properties of triazole and tetrazoles. Six-membered heterocycles with heteroatom: Synthesis and reactions of pyrylium salts and pyrones, coumarins, chromones, pyridine, pyrimidine etc.</td></tr>
<tr><td colspan="8">UNIT-IV: Fused Ring Heterocyclic Compounds:Benzo fused five membered rings: Indole, isoindole, benzofuran and benzo thiophene, Preparation and properties. Benzo fused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions, Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.</td></tr>
</table>

	UNIT-V: Proteins and nucleic acids: Separation and purification of proteins – dialysis, gel filtration and electrophoresis. Catabolism of amino acids - transamination, oxidative deamination and decarboxylation. Biosynthesis of proteins: Role of nucleic acids. Amino acid metabolism and urea cycle. Structure, methods for the synthesis of nucleosides - direct combination, formation of heterocyclic base and nucleoside modification, conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA, Watson-Crick model, solid phase synthesis of oligonucleotides.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1.T. K Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, Wiley VCH,North America,2007. 2.I. L. Finar, Organic Chemistry Vol-2, 5th edition,Pearson Education Asia, 1975. 3.V. K. Ahluwalia and M. Goyal, Textbook of Heterocyclic compounds, Narosa Publishing, New Delhi,2000. 4.M. K. Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., Jalandhar, Delhi, 2014. 5.V. K. Ahluwalia, Steroids and Hormones, Ane books pub., New Delhi,2009.
Reference Books	1. Acheson, R.M. (1976). An Introduction to the Chemistry of Heterocyclic Compounds, Wiley India Pvt. Ltd. 2. I. L. Finar, Organic Chemistry Vol-1, 6th edition, Pearson Education Asia,2004. 3. Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co,2000. 4. Shoppe, Chemistry of the steroids, Butterworthes,1994. 5. I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad,2004. 6. M. P. Singh. and H. Panda, Medicinal Herbs with their formulations, Daya Publishing House, Delhi,2005.

Website and e-learning source	1.ps://www.organic-chemistry.org/ 2.ps://www.studyorgo.com/summary.php 3.ps://www.clutchprep.com/organic-chemistry

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To understand the basic concepts of biomolecules and natural products.

CO2: To integrate and assess the different methods of preparation of structurally different biomolecules and natural products.

CO3: To illustrate the applications of biomolecules and their functions in the metabolism of living organisms.

CO4: To analyse and rationalise the structure and synthesis of heterocyclic compounds.

CO5: To develop the structure of biologically important heterocyclic compounds , proteins and nucleic acids, steroids and hormones by different methods.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Skill Enhancement Course

<table>
<tr><td>Title of the Paper</td><td colspan="8">FORENSIC CHEMISTRY</td></tr>
<tr><td>Paper No.</td><td colspan="8">Skill Enhancement Course II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement course</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>2</td><td>1</td><td colspan="3">-</td><td colspan="3">3</td></tr>
<tr><td>Prerequisites</td><td colspan="8">To gain basic knowledge of Forensic Chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">To understand the knowledge of forensic science and biometric methods.
To acquire knowledge of finger printing.
To learn the concepts of forensic analysis.
To help the students to study forensic toxicology.
To gain the knowledge of cyber crimes.</td></tr>
<tr><td>Course Outline</td><td colspan="8"><u>UNIT I : ELEMENTARY FORENSIC SCIENCE</u>
Definition of Forensic science, The role of Forensic laboratory, Biometrics in Personal Identification- Introduction, Concepts of Biometric Authentication, Role in person Identification, - Face Recognition, IRIS, Retina Geometry, Hand Geometry, Speaker Recognition, Signature Verification.</td></tr>
<tr><td></td><td colspan="8"><u>UNIT II : FINGER PRINTING AND FORENSIC SEROLOGY</u>
Fingerprinting - General principles of Finger Printing, Fingerprint Detection - Powder tests: – dry powder method, detection using cellophane tape,- Chemical tests: – silver nitrate test, iodine fuming, ninhydrin, superglue (cyanoacrylate)and ruthenium oxide tests.
Forensic Serology – Blood types, Characterization of Blood stains, Blood stains patterns. Testing of Saliva .</td></tr>
<tr><td></td><td colspan="8"><u>UNIT III: FORENSIC ANALYSIS</u>
Forensic Drug Analysis: How drugs work - analysis of selected drug classes –Gamma hydroxybutyric acid (GHB), Gamma butyro lactone (GBL), Marijuana, Anabolic steroids, Heroin, Cocaine, Amphetamines.
Forensic analysis of Inks and paints :Questioned documents – Physical analysis, chemical analysis of inks and paper – analytical methods – Optical microscopy, fluorescent techniques, TLC, FT-IR.</td></tr>
<tr><td></td><td colspan="8"><u>UNIT IV: FORENSIC TOXICOLOGY</u>
Forensic Toxicology: Overview - Sample types – Blood and Plasma, Urine, Vitreous fluid, Hair. Types of Forensic Toxicology – Alcohol, Postmortem toxicology, Sport Toxicology. Analytical methods in Forensic Toxicology – Breath alcohol test (BrAC).
An introduction to DNA, Forensic DNA typing - methods of DNA typing - RFLP and PCR methods – Procedures for DNA typing, Applications of DNA testing.</td></tr>
</table>

	UNIT V : CYBER CRIME TECHNOLOGY AND FORENSIC SCIENCE **Use of computers in Forensic science:** Forensic Databases, Image Databases, DNA Database. Forensic Archiving of X-Ray Spectra, Video Image Processing and Animation Software, Use of Networks in Forensic Science. **Computer related crime:** Definitions and types - Framework for Investigating Computer- Related Crime, Human Aspects of Computer-Related Crime.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. Anil K. Jain, Arun A. Ross and Karthik Nandakumar, *Introduction to Biometrics*, Springer, 2011. 2. David E. Newton, *Forensic Chemistry*, Fact on File, Inc, 2007. 3. Suzanne Bell, *Forensic Chemistry*, Pearson International, Second Edition, 2014. 4. Edited by Stuart H. James and Jon J. Nordby, *Forensic Science - An Introduction to Scientific and Investigative Techniques*, CRC Press, 2003.
Reference Books	1. Saferstein R, Criminalistics: An introduction to Forensic Science: Prentice Hall, Eaglewood cliffs, New Jersey, 2001. 2. Editor – G.R. Sinha, *Advances in Biometrics - Modern Methods and Implementation Strategies*, Springer, 2019. 3. Editor – Jay A. Siegel, *Forensic Chemistry -Fundamentals and applications*, Wiley- Blackwell, First edition, 2016**.** 4. Max M. Houck**,** *Forensic Science-Modern methods of solving crime*, Praeger Publishers, 2007. 5. Kelly M. Elkins, *Introduction to Forensic chemistry***,** CRC Press, 2019. 6. Matthew Johll, *Investigating Chemistry: A Forensic Science Perspective*, W.H. Freeman & Co, Second Edition, 2008.
Website and e-learning source	1. https://drive.uqu.edu.sa/_/rajastania/files/Forensic/simpson-forensic-medicine.pdf 2. https://www.gutenberg.org/ebooks/19022 3. https://www.gutenberg.org/ebooks/44552 4. https://drive.google.com/file/d/1-VFFDM8iGlcFjI2yr8wDEhjTxJ7Q7tQ0/view

	5. https://drive.google.com/file/d/1plhu7lZnjJpPiYg05lWl4BL1v-XMvMcC/view 6. https://archive.org./details/forensicchemistr0000davi 7. https://www.bg.ac.rs/wp-content/uploads/2021/01/Forensic-chemistry-Handbook-by -Lawrence-Kobilinsky.pdf

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic principles of forensic chemistry.

CO2: To understand the versatility of finger printing and forensic serology.

CO3: To implement the concept of forensic analysis.

CO4: To predict the suitability of forensic toxicology.

CO5: To design the data bases for cyber crime technology.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

SEMESTER -IV

<table>
<tr><td>Title of the Paper</td><td colspan="7">COORDINATION CHEMISTRY – II</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core XIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Advanced knowledge of coordination of complexes.</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">To recognize the fundamental concepts and structural aspects of organometallic compounds.
To learn reactions of organometallic compounds and their catalytic behaviour.
To identify or predict the structure of coordination compounds using spectroscopic tools.
To understand the structure and bonding in coordination complexes.
To evaluate the spectral characteristics of selected complexes.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT-I: Chemistry of organometallic compounds: 18 and 16 electron rule; Structure and Bonding in Metal – olefin complexes (example: Ziese’s salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples. Synthesis, Structure bonding and reaction of ferrocenes - structure and bonding of beryllocene-covalent versus ionic bonding of beryllocene ; Metal Carbonyl complexes: Structure, bonding modes - MO approach of M-CO bonding, π-acceptor nature of carbonyl group, synergistic effect (stabilization of lower oxidation states of metals); Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters – Structures based on polyhedral skeleton electron pair theory or Wade’s rule. Zintl ions.</td></tr>
<tr><td></td><td colspan="7">UNIT-II: Reactions and catalysis of organometallic compounds: Agostic interaction - Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction and metathesis reaction. Organometallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt and rhodium catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, water gas shift reaction, cyclooligomerisation of acetylenes using Reppe's catalysts and Monsonto’s acetic acid process. Fischer Tropsch process and synthetic gasoline - Ziegler-Natta polymerization and mechanism of stereoregular polymer synthesis.
Hybrid Catalysis: Cluster compounds in catalysis - polymer-supported and phase-transfer catalysis-biphasic-systems.</td></tr>
<tr><td></td><td colspan="7">UNIT-III: Inorganic spectroscopy -I: IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, `Complexes; Determination of the structure of metal carbonyl Complexes.

NMR Spectroscopy: ^{1}H, ^{19}F and ^{31}P – NMR – applications in structural problems based on number of signals, multiplicity, anisotropy (like H_3PO_3, H_3PO_2, $[HNi(PPh_3)_4]^+$, SF_4, TiF_4, PF_5, HPF_2, H_2PF_3, $PF3(NH_2)_2$, P_4S_3,</td></tr>
</table>

	$P_4N_4Cl_6(NHC_6H_5)_2$, $P_3N_3(CH_3)_2Cl_4$, NF_3,NF_2, NH_3 – mer- and fac-$Rh(PPh_3)_3Cl_3$. B^{11} NMR of $B_3H_8^-$. Fluxional molecules (including organometallic compounds) and study of fluxionality by NMR technique - NMR of paramagnetic molecules - contact shifts. Evaluation of Rate constants - monitoring the course of reaction using NMR.
	UNIT-IV: Inorganic spectroscopy-II: EPR spectroscopy: Hyperfine splitting –Factors affecting magnitude of g-values - Zero field splitting and Kramers' degeneracy - Application of EPR in the study of transition metal complexes based on number of signals, multiplicity, anisotropy $[Cu(bpy)3]^{2+}$, $[Cu(Phen)Cl_2]$, $[(NH3)5Co\text{-}O2\text{-}Co(NH3)5]^{5+}$ Co3(CO)9Se, Co3(CO)9Rh, $[CoF6]^{4-}$, $[CrF6]^{3-}$, VO(acac)2, $[VO(H2O)6]^{2+}$, $[Fe(CN)5NO]^{2-}$, $[Ni(H_2O]^{2+}$, and $CuCl_2.2H_2O$. (bis(salicylaldimine)copper(II),$[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$. Applications in predicting the covalent character of M-L bond and Jahn-Teller distortion in Cu(II) complexes. EPR spectroscopy of metallo biomolecules: copper and iron proteins. Mossbauer spectroscopy – Mossbauer effect, Recoil energy, - Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds/complexes, Structural elucidation and bioinorganic application of iron-sulfur protein.
	UNIT-V: Photoelectron Spectroscopy: Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2, CH_4, NH_3). Koopman's theorem- applications and limitations. Shake-up and Shake-off process. Optical Rotatory Dispersion – Principle of CD, MCD and ORD; Δ and λ isomers in different Cobalt (III) complexes, Assignment of absolute configuration using CD and ORD techniques.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006

	2. G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008 3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993. 4. B D Gupta and A K Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University Press, 2013. 5. F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6thed.; Wiley Inter-science: New York, 1988. 6. H. Kaur Spectroscopy, Pragati Prakashan,8th edition,2023. 7. B.P. Straughan and S. Walker, Spectroscopy, Chapman and Hall Ltd,1st edition 1976. 8. S. F. A. Kettle ,Physical inorganic chemistry A Coordination chemistry approach, Springer-Verlag Berlin Heidelberg GmbH,1st edition 1996. 9. Asim K Das and Mahua Das, Fundamental concepts of inorganic chemistry,1st eBook edition, **Volume 4, 5 & 7**, CBS publishers and distributors PVT Ltd,2019. 10. Jagdamba Singh, Mrituanjay D Padey,Jaya Singh, Spectroscopy of Inorganic compounds, New age international publishers,1st edition ,2021.
Reference Books	1. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. 3rd ed. New York, NY: John Wiley, 2000. 2. P Gütlich, E Bill, A X Trautwein, Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications, 1st edition, Springer-Verlag Berlin Heidelberg, 2011. 3. B. Douglas, D. McDaniel, J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley, 1994, 3rd edn. 4. K. F. Purcell, J. C. Kotz, Inorganic Chemistry; Saunders: Philadelphia, 1976. 5. R. S. Drago, PhysicaI Methods in Chemistry; Saunders: Philadelphia, 1977. 6. Ajai Kumar, Coordination chemistry, Aaryush Educations publications, 1st edition, 2014 7. S.K.Agarwal and Keemti Lal, Advanced inorganic chemistry, Pragati Prakashan Educational publication,5th edition,2016. 8. Kazuo Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds Part B: Applications in Coordination, Organometallic, and Bioinorganic Chemistry, A John Wiley & Sons, Inc., Publication,6t edition 2009. 9. R.V.Parish, NMR, NQR. ESR, Mossbauer spectroscopy of inorganic chemistry,Ellis harwood Ltd,1st edition 1990. 10. F.Albert Cotton, Progress in Inorganic chemistry, Interscience Publishers, 1st edition ,1968.
Website and e-learning source	https://archive.nptel.ac.in/courses/104/101/104101100/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: Understand and apply 18 and 16 electron rule for organometallic compounds

CO2: Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds

CO3: Understand the reactions of organometallic compounds.

CO4: Familiarize the catalytic cycles

CO5: Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, Mossbauer and optical rotatory dispersion studies to interpret the structure of molecules by various spectral techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

<table>
<tr><td>Title of the Paper</td><td colspan="7">PHYSICAL CHEMISTRY-II</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core XIV</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>II</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td></td><td></td><td>Semester</td><td>IV</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td>Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td>6</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Basic knowledge of physical chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">To understand the essential characteristics of wave functions and need for the quantum mechanics.
To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator.
To apply the quantum mechanics to hydrogen and polyelectronic systems.
To familiarize the symmetry in molecules and predict the point groups.
To predict the vibrational modes, hybridization using he concepts of group theory.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT-I: Wave particle duality, Uncertainty principle, Particle wave and Schrodinger wave equation, wave function, properties of wave function. Properties of wave function, Normalized, Orthogonal, orthonormal, Eigen values, Eigen functions, Hermitian properties of operators. Introduction to quantum mechanics-black body radiation, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent and time dependent</td></tr>
<tr><td></td><td colspan="7">UNIT-II: Quantum models: Particle in a box-1D, two dimensional and three-dimensional, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules.</td></tr>
<tr><td></td><td colspan="7">UNIT-III: Applications to Hydrogen and Poly electron atoms: Hydrogen atom and hydrogen like ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions. Approximation methods –variation methods: trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hatrefock self-consistent field method, Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, Pauli exclusion principle and Slater determination.</td></tr>
<tr><td></td><td colspan="7">UNIT-IV: Group theory: Groups, sub groups, symmetry elements, operations, classification-axial and non-axial. Dihedral point groups- C_n,C_{nh}, D_n, D_{nh}, D_{nd}, Tdand Oh. Matrix representation and classes of symmetry operations, reducible irreducible and direct product</td></tr>
</table>

	representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for C_{2v}, C_{2h}, C_{3v} and D_{2h} point groups.
	UNIT-V: Applications of quantum and group theory: Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. R.K. Prasad, Quantum Chemistry, New Age International Publishers, New Delhi, 2010, 4th revised edition. 2. F. A. Cotton, Chemical Applications of Group Theory, John Wiley & Sons, 2003, 2nd edition. 3. A. Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy & Sons Ltd., 2013, 2nd Edition. 4. T. Engel & Philip Reid, Quantum Chemistry and Spectroscopy, Pearson, New Delhi, 2018, 4th edition. 5. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd. 2001. 6. D.A. McQuarrie, Quantum Chemistry, Viva Books PW. Ltd, 2013, 2nd edition.
Reference Books	1. N. Levine, Quantum Chemistry, Allyn& Bacon Inc, 1983, 4th edition. 2. D.A. McQuarrie and J. D. Simon, Physical Chemistry, A Molecular Approach, Viva Books Pvt. Ltd, New Delhi, 2012. 3. R. P. Rastogi & V. K. Srivastava, An Introduction to Quantum Mechanics of Chemical Systems, Oxford & IBH Publishing Co., New Delhi, 1999. 4. R.L. Flurry. Jr, Symmetry Group Theory and Chemical applications, Prentice Hall. Inc, 1980 5. J. M. Hollas, Symmetry in Molecules, Chapman and Hall, London, 2011, Reprint.

Website and e-learning source	1. https://nptel.ac.in/courses/104101124 2. https://ipc.iisc.ac.in/~kls/teaching.html
Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able: CO1: To discuss the characteristics of wave functions and symmetry functions. CO2: To classify the symmetry operation and wave equations. CO3: To apply the concept of quantum mechanics and group theory to predict the electronic structure. CO4: To specify the appropriate irreducible representations for theoretical applications. CO5: To develop skills in evaluating the energies of molecular spectra.	

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

<table>
<tr><td>Title of the Paper</td><td colspan="8">CHEMISTRY OF NATURAL PRODUCTS</td></tr>
<tr><td>Paper No.</td><td colspan="8">Elective VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Basic knowledge of general chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">To learn the basic concepts and biological importance of biomolecules and natural products.
To understand the functions of alkaloids, terpenoids, annthocyanins, flavones and vitamins
To elucidate the structure determination of biomolecules and natural products.
To extract and construct the structure of new alkaloids and terpenoids from different methods.
To understand the functions natural dyes</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="8">UNIT-I: Alkaloids: Introduction, occurrence, classification, isolation and functions of alkaloids. Classification, general methods of structural elucidation. Chemical methods of structure determination of Coniine, Piperine, Nicotine, Atropine, Quinine, Belladine, Cocaine, Heptaphylline, Papaverine and Morphine.</td></tr>
<tr><td colspan="8">UNIT-II: Terpenoids: Introduction, occurrence, Isoprene rule, classification. General methods of determining structure.
Structure determination of Camphor, Abietic acid, Cadinene, Squalene, Zingiberine. Carotenoids: Introduction, geometrical isomerism, Structure, functions and synthesis of β-carotene and vitamin-A.</td></tr>
<tr><td colspan="8">UNIT-III: Anthocyanines and flavones: Anthocyanines: Introduction to anthocyanines. Structure and general methods of synthesis of anthocyanines. Cyanidine chloride: structure and determination. Flavones: Biological importance of flavones. Structure and determination of flavone and flavonoids. Quercetin: Structure determination and importance.</td></tr>
<tr><td colspan="8">UNIT-IV: Vitamins : Water soluble Vitamins - thiamine, riboflavin, niacin, pyridoxine, folic acid, ascorbic acid sources, structure, biochemical functions, deficiency diseases, daily requirements; Fat soluble Vitamins - vitamin A, vitamin D2, vitamin E and vitamin K - sources, structure, biochemical functions, deficiency diseases, daily requirements.</td></tr>
<tr><td colspan="8">UNIT-V: Natural Dyes: Occurrence, classification, isolation, purification, properties, colour and constitution. Structural determination and synthesis of indigoitin and alizarin.</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 1, Himalaya Publishing House, Mumbai, 2009. 2. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 2, Himalaya Publishing House, Mumbai,2009. 3. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 1, Goel Publishing House, Meerut,1997. 4. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 2, Goel Publishing House, Meerut,1997. 5. I. L. Finar, Organic Chemistry Vol-2, 5th edition,Pearson Education Asia, 1975.
Reference Books	1.I. L. Finar, Organic Chemistry Vol-1, 6th edition, Pearson Education Asia,2004. 2.Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co,2000. 3,Shoppe, Chemistry of the steroids, Butterworthes,1994. 4.I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad,2004.
Website and e-learning source	https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic

Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able:

CO1: To understand the biological importance of chemistry of natural products.

CO2: To perform the isolation and characterization of synthesized natural products.

CO3: To elucidate the structure of alkaloids, terpenoids, carotenoids, flavonoids and anthocyanins.

CO4: To study the structure of phytochemical constituents by chemical and physical methods.

CO5: To interpret the experimental data scientifically to improve biological activity of active components.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

<table>
<tr><td>Title of the Paper</td><td colspan="7">POLYMER CHEMISTRY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td>Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Basic knowledge of general chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">To learn the basic concepts and bonding in polymers.
To explain various types of polymerization reactions and kinetics.
To understand the importance of industrial polymers and their synthetic uses.
To determine the molecular weight of polymers.
To predict the degradation of polymers and conductivities.</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="7">UNIT-I: Characterization, Molecular weight and its Determination: Primary and secondary bond forces in polymers; cohesiveenergy, molecular structure, chemical tests, thermal methods, Tg, molecular distribution, stability. Determination of Molecular mass of polymers: Number Average molecular mass (M_n)and Weight average molecular mass (M_w) of polymers. Molecular weight determination of high polymers by physical and methods.</td></tr>
<tr><td colspan="7">UNIT-II:Mechanism and kinetics of Polymerization: Chain growth polymerization: Cationic, anionic, free radical polymerization, Stereo regular polymers: Ziegler Natta polymerization. Reaction kinetics. Step growth polymerization, Degree of polymerization.</td></tr>
<tr><td colspan="7">UNIT-III: Techniques of Polymerization and Polymer Degradation: Bulk, Solution, Emulsion, Suspension, solid, interfacial and gas phase polymerization. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photodegradation, Photostabilizers, Solid and gas phase polymerization.</td></tr>
<tr><td colspan="7">UNIT-IV: Industrial Polymers: Preparation and Properties of fibre forming polymers, elastomeric material. Thermoplastics: Polyethylene, polystyrene, Polyacrylonitrile, Polyvinyl Chloride, Poly tetrafluoro ethylene, nylon and polyester. Thermosetting Plastics: Phenol formaldehyde epoxide resin. Elastomers: Natural rubber and synthetic rubber - Buna - N, Buna-S and neoprene. Conducting Polymers: Elementary ideas, polymeric sulphur nitriles and polyacetylene. Polymethyl methacrylate, polyimides, polyamides, polyurethanes, polyurea, and polyethylene</td></tr>
<tr><td colspan="7">UNIT-V: Polymer Processing: Compounding: Polymer Additives: Fillers, Plasticizers, antioxidants, thermal stabilizers, fire retardants and colourants. Processing Techniques: Calendaring, die casting, compression moulding, injection moulding, blow moulding and reinforcing. Film</td></tr>
</table>

	casting, Foaming, Thermofoaming. **Catalysis and catalysts**: Polymerization catalysis, catalyst support, clay compounds, basic catalyst, auto-exhaust catalysis, vanadium, heterogeneous catalysis.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1.V.R. Gowariker, *Polymer Science*, Wiley Eastern,1995. 2.G.S. Misra, *Introductory Polymer Chemistry*, New Age International (Pvt) Limited,1996. 3.M.S. Bhatnagar, A Text Book of Polymers, vol-I & II, S.Chand& Company, New Delhi, 2004.
Reference Books	1. F. N. Billmeyer, *Textbook of Polymer Science*, Wiley Interscience,1971. 2. A. Kumar and S. K. Gupta, *Fundamentals and Polymer Science and Engineering*, Tata McGraw-Hill,1978.
Website and e-learning source	1. https://archive.nptel.ac.in/courses/104/105/104105039/ 2. https://archive.nptel.ac.in/courses/113/105/113105077/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To understand the bonding in polymers.

CO2: To scientifically plan and perform the various polymerization reactions.

CO3: To observe and record the processing of polymers.

CO4: To calculate the molecular weight by physical and chemical methods.

CO5: To interpret the experimental data scientifically to improve the quality of synthetic polymers.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 - Low

Skill Enhancement Course

<table>
<tr><td colspan="2">Title of the Paper</td><td colspan="7">Scientific Research Methodology</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">Skill Enhancement Course III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement course</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>IV</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">-</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="7">Students should know about the fundamental concepts scientific research methodology.</td></tr>
<tr><td colspan="2" rowspan="5">Objectives of the course</td><td colspan="7">To choose scientific research problems.</td></tr>
<tr><td colspan="7">To enable student to comprehend the survey for literature and chemical abstract.</td></tr>
<tr><td colspan="7">To teach how to publish scientific writing of research papers, presentations and research proposal .</td></tr>
<tr><td colspan="7">To learn Plagiarism and Intellectual Property Rights.</td></tr>
<tr><td colspan="7">To introduce the basic principles, working and applications of Instrumental techniques like Surface Probe Microscopy.</td></tr>
<tr><td>Course Outline</td><td colspan="8"><u>UNIT I</u> : TO SCIENTIFIC RESEARCH:
Objectives of research – Types of research – Significance of research. Research methods versus methodology – Research and scientific method – Criteria of good research – Problems encountered by researchers in India. Problem selection – Selection of research problem, sources of research problems, criteria/characteristics of a good research problem, errors in selecting a research problem -project proposal – funding agencies.</td></tr>
<tr><td></td><td colspan="8"><u>UNIT II:</u> LITERATURE SURVEY:
Sources of information, Primary, Secondary, Tertiary sources, Journals, Journal abbreviations, Abstracts – Beilstein - Compendia and tables of information – Reviews –Current titles – Textbooks – Current contents - General treatises – Monographs and treatises on specific areas - Literature search – Information about a specific compound – Science citation index – Box to locate journals. Introduction to Chemical Abstracts. Online searching, Database, Scifinder, Scopus, Citation Index, Impact Factor.</td></tr>
<tr><td></td><td colspan="8"><u>UNIT III</u> : WRITING OF RESEARCH REPORT:
Format of the research report- style of writing the report- references and bibliography. Research paper writing: Types of research papers – Structure of research papers – Research paper formats - Different formats for referencing – ways of communicating research paper – organizing a poster display, giving an oral presentation in seminars/conferences – Making effective presentations using Power Point and Beamer. Research Proposal: Format of research proposal, individual research proposal and institutional proposal.</td></tr>
<tr><td></td><td colspan="8"><u>UNIT IV:</u> PLAGIARISM AND INTELLECTUAL PROPERTY RIGHTS:
Plagiarism - Introduction, Reason for plagiarism, Types of plagiarism - Plagiarism of words, Patchwork plagiarism, Self-plagiarism, Cyber and Digital plagiarism,</td></tr>
</table>

	Accidental plagiarism, Plagiarism of Authorship, Plagiarism of Ideas. Plagiarism policies - IEEE, Springer, Elsevier. Software used for identifying plagiarism. Techniques to avoid plagiarism - Referencing, Paraphrasing. Significance of Intellectual Property Rights. Forms of IPR - Patents, Copyright, Trademarks, Collective marks, Industrial Design. Valuation of IPR, IPR and licensing.
	UNIT V : ADVANCED INSTRUMENTAL TECHNIQUES: Principles, techniques and applications: Surface probe microscopy: Atomic force microscopy, Scanning tunnelling microscopy, Scanning electron microscopy, Transmission electron microscopy, HRTEM, Energy Dispersive X-ray analysis (EDX), X-ray photo electron spectroscopy. X-ray diffraction techniques - Powder and single crystal XRD, principle, techniques and applications.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET/ UGC-CSIR / GATE /TNPSC others to be solved (To be discussed during the Tutorial hours)
Course out comes	**On completion of this course, the students will be able to:**

CO1: Select research problems.
CO2: Do literature survey.
CO3: Write relevantly and coherently the research report.
CO4: Apply the concepts of plagiarism and to get patents..
CO5: Develop the skills of using instrumental technologies.

Recommended Text:

1. Dr.C.R. Kothari, Research Methodology: Methods and Techniques, New Age International Publishers, 2 nd Edition, New Delhi. 2014.
2. Ranjit kumar, Research Methodology: A Step by Step Guide for Beginners, Pearson Education; 2 nd Edition, 2005.
3. Tanmoy Chakraborty and Lalita Ledwani, Research Methodology in Chemical Sciences: Experimental and Theoretical Approach, Apple Academic Press; 1 st Edition, 2016.
4. Dr. N. Arumugam, Research Methodology, Saras Publication, First Edition, 2016.
5. Vinayak Bairagi and Mousami V. Munot, Research Methodology - A Practical and Scientific approach, CRC Press, 2019.
6. R. Gopalan, P. S. Subramanian and K. Rengarajan, Elements of Analytical Chemistry, Sultan Chand and Sons, New Delhi, 2005.
7. S. M. Khopkar, Basic concepts of analytical chemistry, New age international, third edition 2008.

8. Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch, Fundamentals of Analytical Chemistry, ninth edition, 2013.
9. Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Analytical Chemistry, John Wiley & Sons, seventh edition, 2013.
10. G.R. Chatwal and S.K. Anand, Instrumental Method of Chemical Analysis, Himalaya Publishing house, fifth Reprint, 2016.
Text Books
11. A. Joseph, Methodology for Research; Theological Publications, Bangalore, 1986.
12. B. E. Cain, The Basis of Technical Communicating, ACS., Washington, D.C., 1988.

Reference Books:

1. M.D. Barbara Gastel and Robert A. Day, How to Write and Publish a Scientific Paper, Greenwood Publishing Group Inc, 8 th Edition, 2016.
2. R. Gopalan, Thesis writing, Vijay Nicole Imprints Private Ltd., 2005.
3. D.G Peters, J.M. Hayes and G.M. Hefige, A brief introduction to Modern chemical analysis, Saunders, 1976.
4. R.A Day and A.L. Underwood, Quantitative analysis, Prentice Hall, 1999.
5. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, 5 th Edition, Bangalore, 2005.
6. Anthony R. West, Solid state chemistry and its applications, second edition, Aberdeen, March 1994.
7. R. L. Dominoswki, Research Methods, Prentice Hall of India, New Delhi, 1981.
8. Fink, A. *Conducting Research Literature reviews*: *From the internet to the Paper*. Sage 2009.

Website and e-learning source

1. https://pubs.acs.org
2. https://link.springer.com
3. https://www.cas.org
4. https://www.chemmethod.com
5. https://science-education- research.com

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

3 – Strong, 2 – Medium, 1 - Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2 – Medium, 1 – Low

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