



**Sarvodaya Kelavani Samaj Managed
Shri Manibhai Virani & Smt. Navalben Virani Science College, Rajkot**

(An autonomous College affiliated to Saurashtra University, Rajkot)

Reaccredited at the “A” Level (CGPA 3.28) by NAAC

“STAR” College Scheme & Status by MST-DBT

A College with Potential for Excellence – CPE (Phase - II) by UGC

Accredited at the G-AAA Highest Grade ‘A-1’ Level by KCG, Govt. of Gujarat

UGC-DDU KAUSHAL Kendra

GPCB-Government of Gujarat approved Environmental Audit Centre

**SYLLABUS
(In light of UGC’s LOCF and NEP-2020)**

of

B. Sc. CHEMISTRY

(w.e.f. June 2021)

Discipline Specific Core For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester - V		
Course Code	Course Title	Course Credit and Hours
21UCHCC501	Core 10: Spectral and Separation Techniques	4 Credits - 4 hrs/wk

Course Description:

Foundation of molecular spectroscopy and thorough compliance of students with molecular symmetry and chromatography as an analytical tool for separation, isolation, identification and understanding molecular structure of organic/natural compound from multi-component mixtures. The course also gives a theoretical as well as a practical introduction to principles and techniques of chromatography: adsorption and partition chromatography (normal and reversed-phase systems), thin layer chromatography (TLC), column liquid chromatography including HPLC, gas chromatography, ion exchange and size exclusion chromatography. The course aims to address SDG-9: Industry, Innovation & Infrastructure.

Course Purpose:

- To give the foundation of molecular spectroscopy and Ultraviolet spectroscopy.
- To understand multi-perspective structure through molecular symmetry.
- To understand concept, types, instrumentation and applications of various planner, ion exchange and column chromatography techniques.
- The course provides hands-on training on TLC and Column chromatography.
- To provide the conceptual as well working knowledge of sophisticated instruments like HPLC and GC.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K6)
CO ₁	Understand the principle, fundamental theory of molecular spectroscopy and Ultraviolet spectroscopy.	K1, K3
CO ₂	Understand and identify structural symmetry of various molecules.	K1, K3
CO ₃	Calculate R _f values, Apply theoretical knowledge to design and develop suitable operating conditions for separation and identification of organic/natural compounds from multi-	K4

	component mixtures.	
CO ₄	Understand the principle, fundamental theory and instrumentation of column chromatographic techniques & ion exchange chromatographic techniques.	K2, K3
CO ₅	Understand and differentiate the importance and perfection of HPLC and GC techniques and various applications of separation techniques to medicinal and pharmaceutical field.	K4

Course Content	Hours
Unit-1: Introduction to Molecular Spectroscopy and UV-Visible Spectroscopy	14 hrs
<p>Introduction to Molecular Spectroscopy : General principles, Introduction to Molecular spectra, Electromagnetic radiations, Interaction of electromagnetic radiation and molecule, Lambert Beer's Law, Origin of spectra, Classification of Spectra, Rotational and vibrational transition selection rules.</p> <p>UV-Visible Spectroscopy: Introduction, Theory of ultra violet spectra, Instrumentation, Types of transition in organic molecules and order of energy; Explanation of auxochrome & chromophore, Different shifts observed, Effect of solvent, Franck-Condon principles, Application of UV spectra, Calculation of λ-max (1) Dienes and conjugated dienes (2) enones and dienones, i.e., unsaturated carbonyl compounds, (3) aromatic carbonyl system.</p>	
Unit-2: Molecular Symmetry	11hrs
Introduction, Symmetry elements and symmetry operation with illustration, Definition of Properties of group, subgroup and classes, Products of symmetry operations, Symmetry Point group: C ₁ , C _s , C _i , C _n , C _{nv} , C _{nh} , D _n , D _{nh} , D _{nd} , C _{∞v} , D _{∞h} , T _d , O _h , I _h , Multiplication Table for C _{2v} , C _{3v} , C _{2h} point groups.	
Unit-3: Introduction of Chromatography and Planner Chromatography	13hrs
<p>Chromatography: Introduction and Classification or types of chromatography, Different terminology related to chromatography.</p> <p>Paper chromatography: Principle of paper chromatography, Properties of paper, Experimental methods like: Ascending containing one dimensional and two dimensional method; Descending method; circular method, Role of Spray reagent e.g. Ninhydrine and applications of paper chromatography.</p> <p>Thin Layer Chromatography (TLC): Introduction, Principle, Method of preparation & development of chromatographic plate, Visualization methods, Applications of TLC.</p>	
Unit-4: Column Chromatography and Ion-Exchange chromatography	10 hrs

<p>Column Chromatography: Principle, Adsorbent selection, Solvent selection, Experimental techniques, Visualization methods, and applications of column chromatography.</p> <p>Ion-Exchange chromatography: Introduction, Principle & Theory, Type of Ion Exchange Chromatography & resins, Properties of ion exchange resins, Applications of ion exchange chromatography.</p>	
Unit-5: Gas chromatography and Liquid chromatography	12 hrs
<p>Gas chromatography: Introduction & principle, Types of Gas Chromatography: GLC and GSC, Component of GC Instrument, selection and characteristic of carrier gas, Effect of temperature & pressure of gas and applications.</p> <p>HPLC: Principle, Working theory, Component of HPLC Instrument - Flow diagram and Applications.</p>	

Text book:

1. Sharma, Y. R. (2013). *Elementary organic spectroscopy*. New Delhi: S. Chand Publishing (ISBN: 9788121928847).
2. Gurdeep, R., Chatwal, S., & Anand, K. (2016, 7th edition). *Instrumental methods of chemical analysis*. Himalaya publishing house (ISBN: 978-9350512067).

Reference Books:

1. Dewan, S. K. (2019, 1st edition). *Organic spectroscopy*. (ISBN: 9788123919065)
2. Braithwaite, A., & Smith, J. F. (2012, 5th edition). *Chromatographic methods*. Springer Science & Business Media (ISBN: 978-0751401585).
3. Dr. A. V. Kasture, Dr. S. G. Wadodkar, Dr. K. R. Mahadik, Dr. H. N. More (2008, 7th edition) *Pharmaceutical Analysis Vol.- II*. Nirali Prakashan. (ISBN: 978-8185790084).
4. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug (2013, 7th edition) *Analytical chemistry*. John Wiley & sons, Inc. (ISBN: 978-0-470-88757-8).
5. B. K. Sharma (2014) *Instrumental method of chemical analysis*. Meerut: Krishna Prakashan Media (P) Ltd. (ISBN: 978-8182836730).

Suggested reading / E-resources

- Part A (Journal of Chromatography Library). Philadelphia: Elsevier Publishing Company. (ISBN: 0444511075).
- Journal of Planar chromatography (JPC)

Suggested MOOCs:

1. <http://www.nptel.ac.in/courses/104103069/#>
2. <http://ocw.mit.edu/courses/chemistry>

Methods of assessing the Course Outcomes

1. Continuous Internal Assessment (CIA)
2. Semester End Evaluation (SEE)

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st 2 nd units	1 ^{1/2} hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 70)	
B	Assignment			10	20
C	Class activity			10	
Grand Total					40
	Assignment	<ul style="list-style-type: none">• Abstract and executive summary• Case study writing• Concept mapping• Student generated handbook• Essay writing etc.			
	Class activity	<ul style="list-style-type: none">• Presentation (PPT, Poster, Chart)• Seminar• Quiz• Model Making• Think Pair Share• Free writing• Class test• Debate/ Group Discussion• Open Book Test• Class test			

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Core For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester - V		
Course Code	Course Title	Course Credit and Hours
21UCHCC502	Core 11: Synthetic molecules	4 Credits - 4 hrs/wk

Course Description: This course provides knowledge of classification and synthetic methods of known dyes and focuses on types of disease, classification and synthetic methods of known drugs, such as antibiotics, analgesic & anti-inflammatory and antipyretic drugs. A short introduction to the biological and pharmacological properties of the drugs will also be included, moreover to replicate some of the most intriguing molecules of living nature in the laboratory and apply their developed synthetic strategies and technologies to construct variations of them. The course aims to address SDG-9: Industry, Innovation and Infrastructure

Course Purpose:

- To make the students well aware with the types, synthesis and application of dyes, explosives, perfumes, and sweetening agents
- To familiarize the basic nomenclature of drug, classification and important terms.
- To familiarize students with the mode of action of drugs.
- To know the uses and the side effects of certain drugs for various diseases.
- To study the synthesis of different drug intermediates and drugs.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K6)
CO ₁	Classification, synthesis and application of dyes.	K2, K3
CO ₂	Understand the different explosives, perfumes, and sweetening agents with their synthesis and application.	K3
CO ₃	Well acquainted with the synthesis of some important class of drugs.	K4
CO ₄	Employ the core subject knowledge of antibiotic, antiviral, antimalarial drugs.	K2, K3
CO ₅	To understand various industrially important reactions and rearrangements with mechanism and application.	K3, K4

Course Content	Hours
Unit:1 Dyes and dyeing	12 hrs

Introduction and classification of natural and synthetic dyes. Synthesis and uses of following dyes: Alizarin, Indigo, Malachite green, Congo red, Methyl orange, Crystal violet, Diamond black –F, Methylene blue, Aniline yellow, Butter yellow.	
Unit-II: Explosives, perfumes and sweetening agents	10 hrs
Explosives: Introduction, Synthesis and uses: RDX, PETN, TNT, HMX, Tetryl. Perfumes: Introduction, Synthesis and uses: Musk Xylene, Musk Ketone, Musk Ambrette, Muscone, Heliotropin. Sweetening agents: Introduction, Synthesis and uses: Saccharin, p-anisyl urea, Dulcin, Aspartame, Neotame.	
Unit-III: Synthetic drugs: Anaesthetics & Analgesics and Antipyretics, Anti-inflammatory	14 hrs
Introduction and classification of drugs, use, dose, dosage form, structure activity relationship and synthesis of: Local and General Anesthetics: Benzocaine, Lignocaine, Ketamine, Helothane. Antipyretic - Analgesics: Paracetamol, Phenyl butazone. Anti-inflammatory: Ibuprofen, Aceclofenac.	
Unit-IV: Drugs action on common Disease	12 hrs
Introduction, use, structure activity relationship and synthesis of: Anti-malarial: Chloroquine, Pyrimethamine. Antibiotics: Penicillin-V, Amoxicillin. Antiviral Drugs: Acyclovir, Amantadine.	
Unit- V: Reaction, Rearrangement and Reagent	12 hrs
Reactions: Principle, mechanism, and applications of: Baeyer-Villiger oxidation, Wittig reaction, Appel reaction, Michael addition, Suzuki coupling. Rearrangement: Principle, mechanism and applications of: Beckmann, Benzil-Benzilic acid, Pinacol-Pinacolone rearrangement. Reagents: Preparation, properties, and applications of: LiAlH_4 , NaNH_2 , N-bromosuccinamide (NBS), NaBH_4 .	

Text book:

1. Gurdeep, R., Chatwal, S., & Anand, K. (2016, 7th edition). *Instrumental methods of chemical analysis*. Himalaya publishing house (ISBN: 978-9350512067).
2. Sharma, B. K. (2014) *Industrial chemistry*, Goel publishing house, (ISBN; 9788187224006).
3. Bansal, Raj K. (2009, 5th edition) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8).

Reference Books:

1. Douglas S. Johnson, Jie Jack Li (2007, 1st edition) *The Art of Drug Synthesis*. John Wiley & Sons, Inc., Hoboken, New Jersey (ISBN 978-0-471-75215-8).
2. R. S. Vardanyan and V. J. Hruby (2006) *Synthesis of Essential Drugs*. Elsevier Science (ISBN: 978-0-444-52166-8).
3. Ashutosh Kar (2018, 7th edition) *Medicinal Chemistry*. New Age International (P) Ltd. (ISBN: 978-9386649720).

- M. E. Wolff (2010, 7th Edition,) Burgers Medicinal and Drug Discovery. John Wiley. (ISBN: 978-0-470-27815-4).
- Ahluwalia, V. K. (2011, 5th edition) Organic Reaction Mechanism. New Delhi: Narosa (ISBN: 978-81-8487-115-9).

Suggested reading / E-resources

- <https://www.ipc.gov.in/e-resources.html>
- <https://ub-bw.libguides.com/c.php?g=1181298&p=9156756>

Suggested MOOCs:

- <http://www.nptel.ac.in/courses/104103069/#>
- <http://ocw.mit.edu/courses/chemistry>

Methods of assessing the Course Outcomes

- Continuous Internal Assessment (CIA)
- Semester End Evaluation (SEE)

Components of CIA: 50 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st 2 nd units	1 ^{1/2} hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 70)	
B	Assignment			10	30
C	Class activity			20	
Grand Total					50
Assignment		<ul style="list-style-type: none"> Abstract and executive summary Case study writing Concept mapping Student generated handbook Essay writing etc. 			
Class activity		<ul style="list-style-type: none"> Presentation (PPT, Poster, Chart) Seminar Quiz Model Making Think Pair Share Free writing Class test Debate/ Group Discussion Open Book Test Class test 			

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Core		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester - V		
Course Code	Course Title	Course Credit and Hours
21UCHCC503	Core 12: (Self-Study) Industrial Formulations	4 Credits – 1hr/wk

Course Description:

This course provides knowledge about formulations of chemicals. It is based on manufacturing of materials which are useful for our daily life. This course explains different kind of processes with raw materials. It also covers the chemical and physical properties of different industrial formulations materials. It also entails the types of soap, detergents, paints, primers, ceramics, refractories, cement and glass and its applications. This course provides basic understanding, method for preparation of materials and its role. This course aims to address SDG No-4 & 8: Quality education & Industrial application

Course Purpose:

This course aims to provide knowledge of how to prepare different industrial formulations which are directly or indirectly helpful in our daily life. Students can comprehend knowledge about how to make soap and detergent and different types of it. To enable students to identify various paints, primers, refractories, ceramics, glass, cements and also can be able to understand its applications.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level(K ₁ to K ₆)
CO ₁	Understand and apply the concepts of soaps and detergents.	K ₂ , K ₃
CO ₂	Interpret chemistry of binders to develop green coatings and its manufacturing.	K ₃
CO ₃	Define and Compare applications, manufacturing and properties of refractories and ceramics.	K ₁ , K ₂
CO ₄	Identify and recognize various types of cement and its properties.	K ₂ , K ₃
CO ₅	Understand the types, manufacturing, properties and raw materials of glass.	K ₂

Course Content	Hours
Unit-I : Soap and Detergents	12hrs
Introduction to soap, Raw materials for manufacturing of soap, Methods for manufacturing of soap: (a) Batch process, (b) Continuous process, Types of soap: toilet soap, transparent soap, shaving soap, neem soap, Liquid soap, Recovery of glycerin from spent lye. Introduction to detergents, Principal group of synthetic detergents, Bio degradability of surfactants, Classification of surface active agents, Anionic detergents, Manufacturing of anionic detergents: (a) Oxo process(b) Alfol process (c) Welsh process, Cationic detergents, Manufacturing of non-ionic detergents, Manufacturing by batch process, Amphoteric detergents, Manufacturing of shampoo.	
Unit-II: Paints and Primers	12hrs
Introduction, Classification of paints, Constituents of paints, Manufacture of paints, requirements for a good paint, Paints failure, Emulsion paints, constituents of emulsion paints	
Unit- III: Ceramics and Refractories	12hrs
Introduction to ceramics, Raw materials, Classification based on reduction in porosity, Manufacturing of ceramics, Body preparation using clay slip, Introduction to refractories, Classification of refractories, Properties of refractories, Manufacturing of refractories, Fire clay bricks manufacturing, properties and uses.	
Unit- IV: Cement	12hrs
Introduction, Types of cement, Raw material for manufacturing, Cement rock beneficiation, Manufacturing processes (a) Dry process (b) Wet process, Setting of cement: (a) Hydrolysis (b) Hydration, Properties of cement, Testing of cement, Indian Standard Institute (ISI) specification of cement, Uses of cement.	
Unit- V: Glass	12hrs
Introduction, Physical and chemical properties of glass, Raw materials for manufacture, Chemical reactions involved, Method of manufacturing: Formation of batch material, melting, shaping, annealing, finishing.	

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Videos

Text books :

1. Sharma, B. K. (2021) *Industrial chemistry-I*, Krishna publication, (ISBN; 9388140435).
2. Sharma, B. K. (2021) *Industrial chemistry-II*, Krishna publication, (ISBN; 9389594138).

Reference books :

1. Flick, E. W. (2013, 1st edition). *Advanced cleaning product formulations* (Vol. 2). Elsevier.(ISBN: 9780815516064)
2. Hannan, H. J. (2007). *Technician's Formulation Handbook for Industrial and Household Cleaning Products*. Lulu. com.(ISBN: 978-0615156019).
3. Flick, E. W. (2014,1st edition). *Cosmetic and toiletry formulations* (Vol. 3). Elsevier (ISBN: 9780815516712).

Suggested reading/ E-resources:

1. <https://www.extension.harvard.edu/academics/courses/chemistry>
2. <https://libguides.reading.ac.uk/chemistry/e-resources>
3. <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5>
4. <http://library.iiti.ac.in/>

Suggested MOOCs:Not applicable

Methods of Assessment & Tools:

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st 2 units	1 ^{1/2} hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 60)	
B	Assignment			05	10
C	Class activity			05	
Grand Total					40
Assignment		<ul style="list-style-type: none"> • Abstract and executive summary • Case study writing • Concept mapping • Student generated handbook • Essay writing etc. 			
Class activity		<ul style="list-style-type: none"> • Presentation (PPT, Poster, Chart) • Seminar • Quiz • Model Making • Think Pair Share • Free writing • Class test • Debate/ Group Discussion • Open Book Test 			

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Course- Core Elective 2		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester –VI		
Course Code	Course Title	Course Credit and Hours
21UCHCL501	Core Elective 2: Unit Operations & Processes	4Credits –4hrs/wk

Course Description:

This course provides an introductory knowledge of chemical process & operation and an overview of important chemical reaction and their application in chemical industry. It also explains the theoretical principles and important applications of classical chemicals operation such as filtration, centrifuge and drying which helps in manufacturing of various organic and inorganic chemicals. The course shall bring out concepts forming the basis of the chemical process and to give a solid background for innovative process development. It shall discuss the actual industrial processes that present opportunities and challenges for chemical industries for the development of chemical process. This course also reinforces the basic understanding of oxidation, sulphonation, reduction alkylation and Esterification.

Course Purpose:

The aim of this course is to deepen the student's knowledge of the unit operations with a focus on distillation, filtration, centrifuge and drying. This course is sketched in such a way that students will be able to understand the rudimentary scientific skill to study process technologies of various organic processes like sulphonation and hydrogenation. To make the student understand the properties of hydrogenation catalyst and mechanism of catalytic reactions for the design of processes involving catalytic reaction. To understand basic concepts of oxidation/alkylation and its application to chemical process

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level(K ₁ to K ₆)
CO ₁	Remember basic of equipment design and important parameters of equipment design for Filtration and Centrifuge.	K1
CO ₂	Get adequate knowledge about the drying, mass transfer, distillation and extraction process.	K2
CO ₃	Apply basic knowledge and predict the reaction mechanism of sulphonation and hydrogenation.	K3

CO ₄	Correlate and Compare various methods for oxidation and hydrolysis for different substrates.	K2,K3
CO ₅	Understand manufacturing of various organic molecules by alkylation and Esterification.	K2,K3

Course Content	Hours
Unit-I : Filtration and Centrifuge	13 hrs
<p>Filtration: Introduction, Filter media and Filter aids, Classification, Construction, working, merits and demerits of following Equipment: Bed Filter/Sand filter, Sparkler filter, Rotary drum filter, Nutch filter, Nutrex Filter, Bag filter, Plate and frame filter, Leaf filter.</p> <p>Centrifuge: Introduction, Types of centrifuges, Tubular bowl, Disc bowl.</p>	
Unit-II: Drying	12 hrs
Introduction, Drying curve, Factors affecting rate of drying, Classification of dryers, Construction, working, merits and demerits of following Equipment: Tray dryer, Rotary dryer, Flash dryer, Drum dryer, Spray dryer.	
Unit- III: Sulphonation& Hydrogenation	11hrs
<p>Sulphonation: Introduction, Sulfonating agents, Chemical factors and Physical factors, Outline of mechanism of Sulphonation process, Sulphonation process of: Benzene, Naphthalene, Dodecyl benzene</p> <p>Hydrogenation: Introduction, Various methods of reduction, Chemical factors and Physical factors, Outline of chemical kinetic mechanism and thermodynamics, Various hydrogenating catalyst: Hydrogenation process of vegetable oil and Synthesis process of methanol</p>	
Unit- IV: Oxidation & Hydrolysis	12 hrs
<p>Oxidation: Introduction, Types of oxidation reaction, Various oxidizing agents, Chemical factors and Physical factors, Manufacturing process, properties and uses of: Acetic acid, Acetaldehyde, Benzoic acid, Phthalicanhydride, Maleic anhydride.</p> <p>Hydrolysis: Introduction, Hydrolyzing agents, Chemical factors and Physical factors. Outline of chemical kinetic and mechanism, Hydrolysis of starch.</p>	
Unit- V: Alkylation & Esterification	12 hrs
<p>Alkylation: Introduction, Types of alkylation reaction, Types of alkylating agents, Chemical factors and Physical factors, Manufacturing process, properties and uses of: Alkyl aryl detergents, Ethyl benzene, Dimethyl aniline, Phenyl ethyl alcohol.</p> <p>Esterification: Introduction, Types of Esterification reaction, Types of Esterification agents, Chemical factors and Physical factors, Manufacturing process, properties and uses of: Cellulose acetate, Vinyl acetate, Ethyl acetate.</p>	

Pedagogic Tools:

- Chalk and Talk
- PPT and Videos.
- Assignment
- Group discussion

Text Books:

1. K. A. Gavhane, (2016, 1st edition), *Unit Operations-I*, Nirali Publications, (ISBN: 978-81-96396-11-4).
2. Bansal, R. K. (2005). *A textbook of fluid mechanics*. Firewall Media (ISBN: 9788131802946)
3. Narayanan C.M. and Bhattacharya B.C. (2016,1st edition), “*Unit Operations and Unit Processes: Including Computer Programs*”, Volume 2, CBS: (ISBN: 9788123914879)
4. Groggins P. H. (2007, 14th edition), *Unit Processes in Organic Synthesis*, Tata Mcgraw-Hill (ISBN: 978-0074621431)

Reference Books:

1. Sukhatme, S. P. (2005). *A textbook on heat transfer*, Universities Press (IN) Pvt. Ltd. (ISBN: 81-7371-544-0).
2. Mohanty A. K., (2006), *Fluid Mechanics*, Prentice Hall of India Pvt. Ltd., (ISBN: 81-203-0894-8).
3. Warren McCabe, Julian Smith, Peter Harriott, (2017, 7th edition), *Unit Operations of Chemical Engineering*, McGraw Hill Education (ISBN: 978-8184959635).
4. Austin G. T., (1984, 5th edition), *Shreve’s Chemical Process Industries*, McGraw-Hill (ISBN: 978-0070661677)

Suggested reading / E-resources:

- <https://archive.nptel.ac.in/courses/103/103/103103155/>
- <https://www.slideshare.net/JohnKrijgsman1/chemical-processes-70167195>
- https://en.wikipedia.org/wiki/Unit_operation
- <https://www.youtube.com/watch?v=ajRUejrx6z0>

Suggested MOOCs:

1. <https://swayam.gov.in/>
2. <https://nptel.ac.in/>

Methods of assessing the course outcomes

Components of CIE: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st 2 units	1 ^{1/2} hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 60)	
B	Assignment			10	20
C	Class activity			10	
Grand Total					40
Assignment		<ul style="list-style-type: none">• Abstract and executive summary• Case study writing• Concept mapping• Student generated handbook• Essay writing etc.			
Class activity		<ul style="list-style-type: none">• Presentation (PPT, Poster, Chart)• Seminar• Quiz• Model Making• Think Pair Share• Free writing• Class test• Debate/ Group Discussion• Open Book Test• Class test			

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Course-Elective		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester –VI		
Course Code	Course Title	Course Credit and Hours
21UCHCL502	Core Elective 2: Surface Coating Techniques	4Credits –4hrs/wk

Course Description:

The course provides basic information about theory and application of surface chemistry. Techniques of Surface Preparation for different substrates. The course introduces highlights on different paint application techniques and its efficiency. The course introduces various classifications of coatings, mechanisms of film formation in surface coatings. The course emphasizes on principles of inorganic surface coating - Non-electric coatings, role of additive like Brightener, Solvent and Emulsifiers technology in electroplating techniques.

Course Purpose:

The aim of this course is to give an overview of various cleaning processes for surface chemistry. This course is designed in such a way that students will be able to formulate various electrolytes and to determine the quality of electrolyte. To make the student familiar with the different types of organic surface coating and inorganic surface coating. Discuss Formulation; Application; Properties of various additives like Solvent, Brightener and Emulsifiers.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level(K ₁ to K ₆)
CO ₁	Decide the surface preparation methods suitable for different substrate materials.	K1
CO ₂	Summarize the basic concept of electroplating & interpret testing & evaluation. Explain importance of electroplating & its applications.	K2
CO ₃	Student should be able to discover formulations of Electrolyte based on different processes.	K3
CO ₄	Student should be able to understand the fundamental principles of Paint and Coating Formulation via classification and film formation mechanisms.	K2,K3
CO ₅	Basic understanding of designing Solvent, Brightener and	K2,K3

	Emulsifiers for formulation of various electrolytes	
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Course Content	Hours
Unit-I : Fundamentals of Surface Coating	12 hrs
Introduction, Classification of surface coatings (inorganic & organic), Preliminary treatment of surfaces: Ultrasonic cleaning, Barrel cleaning, Hand cleaning or scouring, Alkaline cleaning, Electrolytic cleaning, Solvent cleaner, Emulsifiable solvent cleaner, Diemulsifiable solvent cleaner. Current Efficiency, Rate of Deposition, Throwing Power, Average Coating Thickness, Solution, Electrolytes & Electrolysis, Current, Resistance, EMF.	
Unit-II: Inorganic Surface Coating	10hrs
Basic process of electroplating, Theory and application of following electroplating techniques: Silver plating, Copper plating, Nickel plating, Chromium plating, Gold plating, Cadmium plating, Zinc plating.	
Unit- III:Electroplating	14hrs
Brass plating: Solution maintenance and plating process, Barrel brass plating, Brass plating for rubber adhesion, Passivation process for Zinc and Cadmium: Chromate Passivation solution, Heavy bronze Passivation. Tin and tin alloy plating: Tin plating solution, Alkaline tin plating process, Acid tin plating process. Lead and indium plating: Lead fluoroborate plating solution, Acid indium plating solution. Plating of platinum group metal.	
Unit- IV: Organic Surface Coating:	11 hrs
Theory and application of following electroplating techniques: Electrophoretic coating, Plating of plastic, Phosphating Process, Hot dipping, Metal spraying, Cementation, Metal cladding, Anodizing, Vitreous coating, Surface conversions, Oil paint, Water paint (emulsion paint), Varnishes.	
Unit- V: Process Control	13 hrs
Analysis of following plating solution: Cadmium plating solution, Chromium plating solution, Copper plating solution, Gold plating solution, Nickel plating solution, Silver plating solution, Physical test on solution: Density, pH, Surface tension, Hull cell, Testing of electrodeposits: Thickness test, Accelerated and outdoor corrosion test, Porosity tests, Testing of surface crack patterns, Ductility and stress determinations, Adhesion testing.	

Pedagogic Tools:

- Chalk and Talk
- PPT and Videos.
- Assignment
- Group discussion

Text Books:

1. Swaraj Paul, (1997, 2st edition), Surface Coatings: Science and Technology, (ISBN:978-0-471-95818-5).
2. Arthur A. Tracton (2007, 1st edition), Coatings Materials and Surface Coatings, (ISBN: 9781420044041).
3. BG Mellor (2006, 1st edition), Surface Coatings for Protection against Wear, (ISBN: 9781855737679).
4. A. D. Wilson (2011, 1st edition), Surface Coatings 1&2, Springer; (ISBN: 9789401071017).

Reference Books:

1. A. Tracton (2006, 1st edition), Coatings materials and surface coatings - Arthur (Editor), CRC Press, Tailor & Fransis Group (ISBN:9780429144790).
2. R. Gopalan, D. Venkappayya, S. Nagarajan. (2018, 4th edition), Engineering chemistry, Vikas; (ISBN:9670527113056).
3. M. K. Fulekar. (2013, 1st edition), Industrial hygiene and chemical safety, I K International Publishing House Pvt. Ltd; (ISBN: 978-8188237920).
4. Tromans B (2000, 23rd edition), The Canning Handbook Surface Finishing Technology, CBS HB; (ISBN: 978-8123907086).
5. Durney L.J.(2000, 4th edition), Grahams Electroplating Engineering Handbook, CBS Publishers and Distirbutors; (ISBN: 978-8123913650).

Suggested reading / E-resources:

1. <https://www.scaael.com/moodle/>
2. <http://www.destip.org/course.asp>
3. <https://freevideolectures.com/course/3485/technology-of-surface-coating>
4. <http://www.digmat.in/nptel/courses/video/112105053/L05.html>

Suggested MOOCs:

1. <https://swayam.gov.in/>
2. <https://nptel.ac.in/>

Methods of assessing the course outcomes

Components of CIE: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st &2 nd units	1 ^{1/2} hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 60)	

B	Assignment			10	20
C	Class activity			10	
Grand Total					40
Assignment		<ul style="list-style-type: none"> • Abstract and executive summary • Case study writing • Concept mapping • Student generated handbook • Essay writing etc... 			
Class activity		<ul style="list-style-type: none"> • Presentation (PPT, Poster, Chart) • Seminar • Quiz • Model Making • Think Pair Share • Free writing • Class test • Debate/ Group Discussion • Open Book Test • Class test 			

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Core For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester - V		
Course Code	Course Title	Course Credit and Hours
21UCHCC505	Core Practical 5: Combined Practical	4 Credits - 9 hrs/wk

Course Description:

This course contains important aspects of experimental quantitative analysis of Inorganic compounds. This practical course is designed to understand the study of the physical and chemical properties of chemical compounds, and with application of the same for separation. The course also contains the organic synthetic aspect, analytical aspect, purification and separation by chromatography, qualitative separation which are industrially important. The course aims to address SDG No-4 & 9: Quality Education & Industry, Innovation, and Infrastructure.

Course Purpose:

- The main aim and objective of qualitative analysis is the detection or identification of individual elements or ions present in given compounds.
- Students will learn how to get pure substances through different separation techniques, which are necessary for domestic, and industrial purposes as well as in research work.
- The synthesis of extremely pure organic compounds is important for economic and industrial growth.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K6)
CO ₁	Identification of unknown inorganic salt mixture of 6 radicals, to record observation and to prepare laboratory reports according to disciplinary standards.	K2, K3
CO ₂	Understanding the principle of capillary and partition action with solubility difference and identify the metals, organic molecules from mixtures and decide the reaction progress.	K2
CO ₃	Students able to decide and design the precursor for the produced synthetic molecule as well the route with confirmation of the synthesized molecule.	K2, K3

CO ₄	To estimate the molecule available in the market and check purity.	K2, K3
CO ₅	Synthesis and understand the important dyes molecule and their result on the sample.	K2, K4

Course Content	Hours
Inorganic Qualitative Analysis: (12-15)	
To analyze the given inorganic mixture containing six radicals [Minimum 15 inorganic mixtures should be analyzed] (Na ⁺ , K ⁺ , NH ₄ ⁺ , Cu ⁺² , Ca ⁺² , Mn ⁺² , Zn ⁺² , Mg ⁺² , Ba ⁺² , Sr ⁺² , Ni ⁺² , Pb ⁺² , Al ⁺³ , Fe ⁺² , Co ⁺² , Cl ⁻ , Br ⁻ , I ⁻ , NO ₂ ⁻ , NO ₃ ⁻ , CO ₃ ⁻² , SO ₄ ⁻² , SO ₃ ⁻² , S ⁻² , PO ₄ ⁻³)	
Chromatography: (12-15)	
<ol style="list-style-type: none"> To determine R_f value of individual and mixture of different amino acid by ascending paper chromatography. (4) To determine R_f value of individual and mixture of different amino acid by circular paper chromatography. (4) To determine R_f value of individual and mixture of different metal ions by ascending paper chromatography. (2) To determine R_f value of individual and mixture of different metal ions by circular paper chromatography. (2) Demonstration of preparation of TLC plate. (1) To separate mixture of organic compounds by thin layer chromatography. (1) Demonstration of Column Preparation. (1) 	
Synthesis of Drugs Molecule: (06-08)	
<ol style="list-style-type: none"> Aspirin (Acetylation of salicylic acid) Paracetamole from 4-aminophenol Pyrazole from EAA and Phenyl hydrazine PABA from p-nitrobenzoic acid Methyl salicylate Lidocaine Benzocaine Acetophenone phenyl hydrazone 	
Pharmaceutical Drug Estimation: (04-06)	
<ol style="list-style-type: none"> To determine % of Vitamin – C (Ascorbic acid) in the given tablet. Determination of %W/W of lactic acid and lactide together. Estimation of Isoniazide in the given sample. To determine the Aspirin content in the given sample. To estimate the Cephalaxin content in the given sample. To perform the assay of ZnO in the given unknown sample 	
Synthesis of Dyes: (12-15)	
<ol style="list-style-type: none"> Nitrosodimethyl Aniline Butter yellow Fast Green O dye.(Dinitroresorcinol) Fast Red A Methyl orange dye Methyl Red 	

7. Mordant Yellow dye 8. Naphthol blue black dye 9. Benzoparpurine 10. Orange I 11. Orange II 12. Yellow 4-G 13. Dyeing of cotton with direct dye Congo Red 14. Dyeing of cotton with acid dye Fast Red A 15. Dyeing of cotton with Crystal Violet	
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Pedagogic Tools:

- Chalk and Talk

Laboratory Manual/ Book:

1. Brian S. Furniss (1989, 5th edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Nad A.K.; Mahapatra B.; Ghoshal A. (2004, 2nd edition) *An Advanced Course in Practical Chemistry*; New Central Book agency (ISBN: 81-7381-302-7).

Reference Books:

1. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989, 5th edition) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
2. Svehla, G. (1979, 5th edition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).
3. Hassner, A. (2012, 3rd edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
4. Braithwaite, A., & Smith, J. F. (2012, 5th edition). *Chromatographic methods*. Springer Science & Business Media (ISBN: 978-0751401585).
5. Smith R.M. (2004) *Separation Techniques in Analytical Chemistry*; Wiley-Blackwell (ISBN: 978-0471493884)

Suggested reading / E-resources:

1. <https://www.sciencedirect.com/book/9780125033541/chemistry-inorganic-qualitative-analysis-in-the-laboratory>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8676269/>
3. <https://bitesizebio.com/29947/basics-column-chromatography/>

Suggested MOOCs:

1. https://swayam.gov.in/nc_details/NPTEL
2. <https://lab-training.com/courses/paper-chromatography/>
3. <https://archive.nptel.ac.in/courses/116/104/116104046/#>

Methods of assessing the Course Outcomes

1. Continuous Internal Assessment(CIA)
2. Semester End Evaluation (SEE)

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test	After Completion of 50% to 60 % of Experiment	6 hours	60	30
B	Observation book & Record			10	10
Grand Total					40

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Course- Core Elective		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester –VI		
Course Code	Course Title	Course Credit and Hours
21UCHCL503	Core Elective Practical 2: Unit Operations & Processes	1 Credits – 3hrs/wk

Course Description:

This course contains important aspects of laboratory operations as well as organic process in chemistry through experiments. These courses provide hands-on experience needed to perform experiments and determinations with the precision required in a broad range of industries. It layout of chemical processes such as oxidation, diazotization, nitration and sulfonation of various organic compounds. The course illustrates study of crystallization of various inorganic compounds. The course covers various distillation techniques along with preparation & standardization of analytical solutions. The course aims to address SDG No-4 & 9: Quality education & Industry, innovation and Infrastructure.

Course Purpose:

The Prevalent target of the practical course is that the students will get familiar with experimental procedures in a chemical laboratory. This course is fabricate in such a way that students will be capable to carry out various types of organic and inorganic synthesis. With help of this practical course student will learn many experimental techniques and they will be capable to distinguish the experiments, by which student can effectuate experiment precisely and write accurate results. Students will be proficient and analyze various distillation techniques for liquid organic compounds. This course is obligatory to furnish the practical skill and laboratory techniques to students in the field of chemistry.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K ₁ to K ₆)
CO ₁	Synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.	K ₂
CO ₂	Interpret experimental results, perform calculations of results and draw reasonable, accurate conclusions.	K ₂
CO ₃	Built ability for planning and preparing various crystals by organic	K ₁

	reagents and solutions.	
CO ₄	Correlate various distillation methods for separation of organic mixture.	K4
CO ₅	Understand, planning and performing experiments for preparation of organic molecule.	K2, K3

Course Content	Hours
Analytical chemistry (12 – 15 experiment)	45 hrs
<p>Unit Operations</p> <ul style="list-style-type: none"> • To determine practical yield for crystallization of Benzoic acid (By Cooling) • To determine practical yield for crystallization of Copper Sulphate (By evaporation) • To determine practical yield for crystallization of mixture of compounds (Benzoic acid + Copper Sulphate) • To determine practical yield for crystallization of Benzoic acid with seeding and none seeding. • Introduction and Demonstration of Pilot plant. • To calculate the average particle size and reduction ratio of: <ul style="list-style-type: none"> ➤ Jaw crusher ➤ Roll crusher ➤ Ball mill • To separate the given mixture of liquid (Polar & Non-polar solvent) by distillation. <p>Unit Processes:</p> <ul style="list-style-type: none"> • Preparation of Fumaric acid from Maleic acid. • Preparation of Benzil from Benzoin. • Preparation of Sulfanilic acid from Aniline • Preparation of p-nitro aniline from p-nitro acetanilide • Preparation of O-chlorobenzoic acid from anthranilic acid. • Preparation of α – nitronaphthalene from naphthalene • To prepare 1-methoxynaphthalene form naphthalen-1-ol. • Preparation of following salt form their oxide <ul style="list-style-type: none"> ➤ Copper sulphate/chloride ➤ Nickel sulphate/chloride 	

Pedagogic Tools:

- Not applicable

Text Books:

1. J. M. Smith (2019, 8thedition) Introduction to Chemical Engineering Thermodynamics, McGraw-Hill; Eighth edition; (ISBN: 978-9353168490).
2. Warren McCabe (2017, 7thedition) Unit Operations of Chemical Engineering, McGraw Hill Education; (ISBN: 978-8184959635).
3. Hassner, A. (2012, 3rdedition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
4. Jerry R. Mohrig (2010, 3rdedition) *Techniques in Organic chemistry*. London: W. H. Freeman &Company (ISBN: 1-4292-1956-4).

Reference Books:

1. Robert Treybal (2017, 3rd edition) Mass Transfer Operations, McGraw Hill Education; (ISBN: 978-1259029158).
2. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989, 5th edition) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
3. Svehla, G. (1979, 5thedition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).
4. Octave Levenspiel(2006, 3rd edition) Chemical Reaction Engineering; Wiley; (ISBN: 978-8126510009).

Suggested reading / E-resources:

1. <https://www.youtube.com/watch?v=9M0HqQEFL6k>
2. <https://www.slideshare.net/JohnKrijgsman1/chemical-processes-70167195>
3. https://en.wikipedia.org/wiki/Unit_operation
4. <https://www.youtube.com/watch?v=ajRUejrx6z0>

Suggested MOOCs:

1. <https://swayam.gov.in/>
2. <https://nptel.ac.in/>

Methods of assessing the course outcomes

Components of CIE: 40 marks

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test	50% to 60 % of Experiment	3hrs	30	30
2.	Observation book & Record	-	-	10	10
Total					40

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Course-Elective		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester –VI		
Course Code	Course Title	Course Credit and Hours
21UCHCL504	Core Elective Practical 2: Surface Coating Techniques	1 Credits – 3hrs/wk

Course Description:

This course of Surface Coating Techniques practical aims to provide hands-on training for electroplating of various metal objects with desired finish and thickness of coating. It also offers an opportunity to determine quality of electroplating bath, through methods employed in industries. The course contributes to understand basic information about application of surface chemistry, Interfacial tension, wetting & emulsification. The course introduces to the study of important characteristics of surface coating, rheological properties, optical properties, adhesion and mechanical properties, corrosion, chemical resisting properties, film thickness, liquid paint, surface coating defects and durability of coatings.

Course Purpose:

The Prevalent target of the practical course is that the students will get understanding of Principles of coating deposition and surface modification methods - Fundamental coating properties and their relationship - Introduction to corrosion and wear protection, and various functionalities obtainable by coatings and surface treatments. With the help of this course students will be capable to carry out specialty coatings & interpret testing & evaluation. - explain importance of specialty coatings & its applications. Student will determine quality of electroplating bath by various chemical and physical analysis. The course emphasizes on principles of paint formulation, theory of pigment wetting and dispersion technology.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level(K ₁ to K ₆)
CO ₁	Arrangement, Set-up instrumental and deterring place of each individual component, sample object and other electrodes for electroplating.	K ₁ , K ₂
CO ₂	Explicate experimental results, accomplish calculations on these results and draw reasonable, accurate conclusions.	K ₂
CO ₃	Follow guided procedures for coating surface of a metal object with	K ₁ , K ₂

	another metal by electroplating.	
CO ₄	Analyze amount of available metal in plating bath by various chemical analysis methods.	K2, K3
CO ₅	Determine quality of coating medium/bath by evaluating physicochemical parameters.	K4

Course Content	Hours
Analytical chemistry (12 – 15 experiment)	45hrs
<ul style="list-style-type: none"> • To electroplate silver on given object • To determine the amount of silver in silver plating bath by volumetric titration. • To determine the amount of silver metal as silver sulphide by gravimetric method. • To electroplate of nickel on object. • To determine the amount of nickel in bath. • To determine the amount of Ni as Nickel dimethyl glyoxime (Ni(C₄H₇O₂)₂) gravimetrically from the acidic solution of NiSO₄.7H₂O • To electroplate copper on given object • To determine the amount of copper sulphate in copper plating bath. • To determine the amount of copper in copper plating bath by gravimetric analysis. • To electroplate chrome on given object. • To determine the amount of chrome in chrome plating bath. • To electroplate copper on given plastic object. • To electroplate nickel on given plastic object. • To electroplate chrome on given plastic object. • To determine the density and refractive index of lacquer coating bath. 	

Pedagogic Tools:

- Not applicable

Text Books:

1. Satas, D., Tracton, A. A., & Rafanelli, A. J. (2002, 2nd edition). *Coatings technology handbook*. CRC Press (ISBN: 0824704398).
2. Freitag, W., & Stoye, D. (Eds.). (2008, 2nd edition). *Paints, coatings and solvents*. John Wiley & Sons (ISBN: 978-3527288632).

Reference Books:

1. Michel Cartier (2003, 1st edition) *Handbook of Surface Treatment and Coatings*. John Wiley (ISBN: 9781860583759).
2. Friedrich-Wilhelm Bach, Kai Moehwald, Andreas Laarmann, Thomas Wenz (2006, 1st edition) *Modern Surface Technology*, Wiley-VCH Verlag GmbH (ISBN: 9783527311111).

9783527315321).

3. Mahendra K. Sharma (2013, 3rdedition) Surface Phenomena and Additives in Water-Based Coatings and Printing Technology, Springer (ISBN: 978-1489923639).
4. Anthony E. Hughes (2016, 2ndedition) Active Protective Coatings: New-Generation Coatings for Metals. Springer (ISBN: 978-9401775380).
5. David M. Howell (2000, 1stedition) The Technology, Formulation and Application of Powder Coatings: Powder Coatings – The Technology, Formulation & Application of Powder Coatings. Wiley–Blackwell (ISBN: 978-0471978992).

Suggested reading / E-resources:

1. <http://www.digimat.in/nptel/courses/video/112105053/L05.html>
2. <https://en.wikipedia.org/wiki/Electroforming>
3. <https://en.wikipedia.org/wiki/Electroplating>
4. <https://www.youtube.com/watch?v=tyKtUoQo9VM>

Suggested MOOCs:

1. <https://swayam.gov.in/>
2. <https://nptel.ac.in/>

Methods of assessing the course outcomes

Components of CIE: 40 marks

Sr. No	CIA Component	Content	Duration	Marks	Total Marks
1	Test	50% to 60 % of Experiment	3hrs	30	30
2.	Observation book & Record	-	-	10	10
Total					40

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Discipline Specific Core For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Chemistry	Offered to: B.Sc. Chemistry	
Semester - V		
Course Code	Course Title	Course Credit and Hours
	Core Enrichment Course/Component 4: Minor Project/Dissertation / Review Article / Instrumental Training/Industrial visit	2 Credits – 3 hrs/wk

Course Description:

The aim of the Project/Internship/Skill Training is to enable students to develop deeper knowledge, understanding, capability and attitudes in the context of the programme. The course aims to address SDG-9: Industry, Innovation & Infrastructure.

Course Purpose:

- To develop research/practical skills commensurate with the accomplishment of a degree.
- To develop laboratory protocol/ training reports.
- To address issues of practical's, design methodology ethics and theoretical arguments and apply this to practical's.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K6)
CO ₁	Identify skills and capabilities that intersect effectively with the needs of industry.	K2
CO ₂	Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach.	K3
CO ₃	Students will be able to practice acquired knowledge within the chosen area of technology for project development.	K2, K3
CO ₄	Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.	K3

CO ₅	Present the finding of their project in a written report.	K4
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Minor Project:

- The candidates will be given the option of selecting a research problem in a preferred area that falls within the disciplines of courses undertaken.
- Candidates have to present their outcomes in the Pre-presentation (Internal committee) before final Project Report & oral presentation.
- At the end of the semester the candidates are required to present their project outcomes in the form of a Project Report & oral presentation.
- The evaluation (Presentation & Viva) of the Project work (Dissertation) will be carried out at the end of Sem-VI.

Dissertation:

- The candidates will be given the option of selecting a research problem in a preferred area that falls within the disciplines of courses undertaken.
- Candidates have to present their outcomes in the Pre presentation (Internal committee) before final Dissertation Report & oral presentation.
- At the end of the Semester-VI the candidates are required to present their findings in the form of a Dissertation Report & oral presentation & Viva.

Review Article

- The purpose of a review paper is to succinctly review recent progress in a particular topic.
- Overall, the paper summarizes the current state of knowledge of the topic.
- It creates an understanding of the topic for the reader by discussing the findings presented in recent research papers.

Instrumental Training

- Instrumental learning is a type of learning in which behaviours are strengthened or weakened by their consequences.
- It refers to non-reflexive behaviors that are instrumental in producing changes to the environment

Industrial visit

- Interpersonal skills enhancement: Industrial visit help students to enhance their interpersonal, communication skills, and teamwork abilities.
- Work experience offered by an Institution/industries for a limited period of time.
- The evaluation of Industrial visit by oral Presentation & Viva will be carried out at the end of Sem-VI.

Note: Evaluated at the End of SEM-VI