22UCH111C/211C	CHEMISTRY FOR COMPUTER SCIENCE (CS) STREAM	Credits: 04
L:T:P : **3:0:1**		**CIE Marks:**50
Total Hours/week: 05 Hrs		**SEE Marks:**50

UNIT - I	**10 Hrs**

Energy Systems

Electrode System: Introduction, types of electrodes. Reference electrode; Introduction, calomel electrode – construction, working and applications of calomel electrode. Ion selective electrodes; Introduction, construction, working and applications of glass electrode. Determination of pH using glass electrode. Concentration cell; Definition, construction and working. Numerical problems.

Battery Systems: Introduction to batteries, construction, working and applications of Lithium ion and Sodium ion batteries.

Green Fuels: Introduction, construction and working of solar photovoltaic cell, advantages, and disadvantages. Quantum Dot Sensitized Solar Cells (QDSSC's); Principle, Properties and Applications. Generation of energy (green hydrogen) by electrolysis of water and its advantages.

Self Study: Characteristics of batteries & Introduction to Fuel cell, MeOH – O2 fuel cell, Applications.

UNIT – II	**10 Hrs**

Corrosion Science and Polymers

Corrosion: Introduction, electrochemical theory of corrosion, types of electro-chemical corrosion; differential metal corrosion and differential aeration corrosion (Waterline and Pitting). Factors affecting rate of corrosion. Penetration Rate (CPR); Introduction and numerical problems.

Corrosion control: Introduction, Metal coating; Galvanization, surface conversion coating; Anodization and cathodic protection; Sacrificial anodic method.

Polymers: Introduction, Monomer, polymer, polymerization, degree of polymerization. Glass transition temperature (Tg), factors affecting Tg. Molecular weight - Number average and Weight average molecular weight and numerical problems. Conducting polymers; Synthesis and conducting mechanism of polyacetyline (n & p type) and commercial applications. Preparation, properties and commercial applications of Silicon rubber.

Self Study: Stress corrosion and Biodegradable polymers.

UNIT - III	10 Hrs

Nano materials and display systems

Nanomaterials: Introduction, size dependent properties of nanomaterials (Surface area, Catalytic, Conducting), preparation of nanomaterials by sol-gel and co-precipitation method with example.

Liquid crystals (LC's); Introduction, classification, positional and orientational order, director, requirement of a substance to exhibit liquid crystal state. Chemical constitution and liquid crystalline behavior, molecular ordering in liquid crystal phase, liquid crystal behavior in homologous series; PAA and MBBA homologous series, electro-optic effect in liquid crystals, construction of liquid crystal display and applications of Liquid Crystal in Displays.

Light Emitting Diode (LED): Introduction, working principle of LED. Application of LED.

Organic Light Emitting Diode (OLED): Introduction, Anatomy of OLED, Types of OLED. Comparison between LED and OLED. Advantages and Disadvantages of OLED, Applications of OLED. Quantum Light Emitting Diodes (QLED's); Properties and applications.

Self Study: Light emitting electrochemical cells.

UNIT - IV	10 Hrs

Analytical Techniques & E-Waste Management

Analytical Techniques: Sensors, Introduction, basic principle of sensor, Types of sensors; Conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Potentiometric sensors; Introduction, principle, working and application in the estimation of iron. Colorimetric sensors; Introduction, principle, working and application in the estimation of copper. Conductometric sensors; Introduction, principle, working and application in the estimation of weak acid.

E-Waste: Introduction, sources of e-waste, Composition, Characteristics, and Need of e- waste management. Toxic materials used in manufacturing electronic and electrical products, health hazards due to exposure to e-waste. Recycling and Recovery; Different approaches of recycling (separation, thermal treatments, hydrometallurgical extraction, pyrometallurgical methods, direct recycling). Extraction of gold from E-waste. Role of stake holders in environmental management of e-waste (producers, consumers, recyclers, and statutory bodies).

Self Study: Impact of heavy metals on environment & human health and control measures.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K_2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)

1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)

1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
3. Determination of CaO in cement solution
4. Determination of manganese dioxide in pyrolusite ore

Reference books:

1. Wiley (2013), Engineering Chemistry (2nd edition), Wiley India Pvt. Ltd. New Delhi.
2. Satyaprakash & Manisha Agrawal (2012), Engineering Chemistry (1st edition), Khanna Book Publishing, Delhi.
3. Shashi Chawla (2003), A Text Book of Engineering Chemistry (3rd edition), Dhantpat Rai & Co. Pvt., Pub. Delhi.
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16. Expanding the Vision of Sensor Materials. National Research Council 1995, Washington, DC: The National Academies Press. doi: 10.17226/4782

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18. Dr. Sudha Rani (1998), Laboratory Manual on Engineering Chemistry (1st edition), DhanapathRai Publishing Co. Ltd.

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- http://libgen.rs/
- https://nptel.ac.in/downloads/122101001/
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1bb3X- 9IbHrDMjHWWh

Course Outcomes:

CO1: Analyse the properties of raw materials in desigining energy systems for industrial and social applications.

CO2: Assess properties of metallic and polymer materials for variety of engineering applications.

CO3: Choose appropriate materials for desing of display systems.

CO4: Identify and determine composition of various materials using sensors and develop e-waste management for electrical and electronic products.

Course Outcomes	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1	1				1					

22UCH112C/212C	CHEMISTRY FOR MECHANICAL ENGINEERING (ME) STREAM	Credits: 04
L:T:P : **3:0:1**		CIE Marks:50
Total Hours/week: 05 Hrs		SEE Marks:50

UNIT - I	**10 Hrs**

Analytical Techniques & Energy Sources

Analytical techniques: Introduction, principle, instrumentation of potentiometric sensors; its application in the estimation of iron, Optical sensors (colorimetry); its application in the estimation of the copper, pH-sensor (Glass electrode); its application in the determination of pH of beverages.

Fuels: Introduction, classification and characteristics of a good fuel, calorific value, Gross calorific value (GCV) and Net calorific value (NCV), determination of calorific value using bomb calorimeter, numerical problems on GCV and NCV.

Green fuels: Introduction, synthesis and applications of Bio gas, Bio ethanol and biodiesel.

High energy fuels: Production of hydrogen by electrolysis of water and its advantages and limitations.

Self Study: Types of electrodes - Reference electrode, Calomel electrode; Construction, working and applications.

UNIT – II	**10 Hrs**

Corrosion Science and Metal Finishing

Corrosion: Introduction, electrochemical theory of corrosion, types of electrochemical corrosion - differential metal, differential aeration (waterline and pitting), stress corrosion (caustic embrittlement). Factors affecting rate of corrosion. Corrosion testing by weight loss method. Corrosion penetration rate (CPR)-numerical problems.

Corrosion control: Introduction, Metal coating; Galvanization, surface conversion coating; Anodization and cathodic protection; Sacrificial anodic method.

Metal finishing: Introduction, technological importances. Electroplating: Process, Factors affecting quality of electrodeposit. Determination of throwing power by Haring-Blum cell. Numerical problems on throwing Power. Electroplating of chromium (hard and decorative). Electroless plating: Introduction, Comparision between electroplating and electroless plating, electroless plating of nickel.

Self Study: Use of corrosion inhibitors to control corrosion. Factors governing electroplating – Polarization, Decomposition potential and Over voltage.

UNIT - III	10 Hrs

Macromolecules for Engineering Applications

Polymers: Introduction, Monomer, polymer, polymerization degree of polymerization, Glass transition temperature- factors affecting Tg. Molecular weight; number average and weight average, numerical problems. Synthesis, properties and industrial applications of Acrylo-Butadiene Styrene (ABS) plastics and silicon rubber.

Fibers: Introduction, synthesis, properties and industrial applications of Kevlar and Polyester.

Plastics: Introduction, synthesis, properties and industrial applications of poly methyl methacrylate (PMMA) and Polyurethene (PU).

Composites: Introduction, properties and industrial applications of carbon-based reinforced composites (grapheme/carbon nano-tubes as fillers) and metal matrix polymer composites.

Lubricants: Introduction, classification, properties and applications of lubricants.

Self Study: Biodegradable polymer: Introduction, synthesis, properties and applications of polylactic acid(PLA) and poly caprolactum (PCL).

UNIT - IV	10 Hrs

Phase Rule and Materials for Engineering Applications

Phase rule: Introduction, Definition of terms: phase, components, degree of freedom, phase rule equation. Phase diagram: Two component lead-silver system.

Alloys: Introduction, classification, composition, properties and applications of Stainless Steel, Solders, Brass and Alnico.

Ceramics: Introduction, classification based on chemical composition, properties and applications of perovskites ($CaTiO_3$).

Nanomaterials: Introduction, size-dependent properties of nanomaterial (surface area, catalytical and thermal), synthesis of nanoparticles by sol-gel and co-precipitation method. Synthesis, Properties and engineering applications of carbon nanotubes and graphene.

Self Study: Phase diagram of one component system; Water system and classification of nano particles.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K_2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)
1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)
1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
3. Determination of CaO in cement solution
4. Determination of manganese dioxide in pyrolusite ore

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- http://libgen.rs/
- https://nptel.ac.in/downloads/122101001/
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1b b3X- 9IbHrDMjHWWh

Course Outcomes:

CO1: Identify suitable sensor for the estimation of elements and fuel for future generation.

CO2: Assess and describe the forms, mechanisms, control of corrosion and surface
modifications.

CO3: Choose appropriate smart materials for design of display systems.

CO4: Identify and determine composition of various materials using sensors and synthesis of
polymers for specific engineering applications

Course Outcomes	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1					1					1

22UCH110C/210C	CHEMISTRY FOR CIVIL SCIENCES (CVS) STREAM	Credits:04
L:T:P : **3:0:1**		**CIE Marks:**50
Total Hours/week: 05 Hrs		**SEE Marks:**50

UNIT - I	10 Hrs

Chemistry of Water and Environment

Water technology: Introduction, water quality parameters, hardness of water, determination of total hardness by EDTA method, numerical problems. Determination of chlorides; Mohr's method. Softening of water by ion exchange method, desalination of water by electrodialysis, Reverse and Forward osmosis: Introduction, Process and applications.

Water pollution: Sources, water quality assessment, effect of oxygen demanding waste water, Sewage treatment; Primary, secondary and tertiary treatment. Determination of Biological Oxygen Demand (BOD), Chemical oxygen demand (COD) and Numerical problems.

Self Study: Determination of DO in water samples by Winkler's method. Impact of heavy metals on human health.

UNIT – II	10 Hrs

Analytical Techniques and Corrosion Science

Analytical Techniques: Sensors, Introduction, basic principle of sensor, Types of sensors; Conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Potentiometric sensors; Introduction, principle, working and application in the estimation of iron. Colorimetric sensors; Introduction, principle, working and application in the estimation of copper. Conductometric sensors; Introduction, principle, working and application in the estimation of weak acid. pH-sensors and its application in the determination of soil sample.

Corrosion: Introduction, electrochemical theory of corrosion, types of electrochemical corrosion; differential metal corrosion, differential aeration corrosion (waterline and pitting), stress corrosion (caustic embrittlement). Factors affecting rate of corrosion. Corrosion testing by weight loss method. Corrosion penetration rate (CPR)-numerical problems.

Corrosion control: Introduction, Metal coating; galvanization, Surface conversion coating; anodization and cathodic protection; sacrificial anodic method.

Self Study: Use of Corrosion inhibitors to control corrosion. Corrosion control by organic coatings.

UNIT - III	10 Hrs

Structural Materials

Metals and Alloys: Introduction, Properties and application of Iron and its alloys, Aluminium and its alloys.

Cement: Introduction, composition, properties, classification, manufacturing process of cement, process of setting and hardening of cement, additives for cement and testing of cement.

Refractories: Introduction, classification based on chemical composition, properties and application of refractory materials.

Glass: Introduction, Composition, Types, Preparation of Soda-lime glass, properties and applications of glass.

Nano materials: Introduction, size dependent properties of nanomaterial (surface area and catalytic), Synthesis of nanomaterial by sol-gel method and co-precipitation method. Synthesis, properties and engineering applications of carbon nanotubes and graphene. Nanomaterials for water treatment, Introduction and example.

Self Study: Chemistry of reinforced concrete from various sources of water (seawater, groundwater, treated water).

UNIT - IV	10 Hrs

Polymers and Composites

Polymer: Introduction, monomer, polymer, polymerization, degree of polymerization. Molecular weight of polymers, Weight average and number average molecular weight of polymer. Numerical problems. Synthesis, properties and engineering applications of Acrylo Butadiene Styrene (ABS) plastics and Silicon rubber.

Fibers: Introduction, Synthesis, properties & applications of Rayon & Nylon fibers.

Polymer composites: Introduction, properties and applications of fiber reinforced polymers composites (FRPC).

Geo polymer concrete: Introduction, synthesis, constituents, properties & applications.

Adhesives: Introduction, properties and applications of epoxy resin

Biodegradable polymers: Introduction, Synthesis, properties and applications of polylactic acid (PLA) and poly hydroxy butyrate (PHB).

Self Study: Introduction, structural properties and applications of cellulose and lignin.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments
1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K_2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)
1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)
1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
3. Determination of CaO in cement solution
4. Determination of manganese dioxide in pyrolusite ore

Reference books:
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- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1b b3X- 9IbHrDMjHWWh

Course Outcomes:
CO1: Able to evaluate quality of water and its treatment methods for domestic and industrial

applications..
CO2: Identify and evaluate composition of materials and mechanism involved in corrosion with controlling measures.
CO3: Outline the application of structural materials for engineering application.
CO4: Outline the various polymers and their properties with application in various engineering field.

Course Outcomes	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1					1					1

22UCH109C/209C	CHEMISTRY FOR ELECTRICAL SCIENCES (ES) STREAM	Credits : 04
L:T:P : **3:0:1**		CIE Marks:50
Total Hours/week: 05 Hrs		SEE Marks:50

UNIT - I	10 Hrs

Energy Systems

Electrode System: Introduction, types of electrodes. Reference electrode; Introduction, calomel electrode – construction, working and applications of calomel electrode. Ion selective electrode; definition, construction, working and applications of glass electrode. Determination of pH using glass electrode. Concentration cell; Definition, construction and working. Numerical problems.

Batteries: Introduction, Components and classification of batteries. Construction, working and applications of modern batteries; Na-ion battery, solid state battery (Li-polymer battery) and flow battery (Vanadium redox flow battery).

Fuel Cells: Introduction, construction, working and applications of methanol–oxygen and polymer electrolyte membrane (PEM) fuel cell.

Solar Cell: Introduction, Semiconductors as solar cell materials. Arrangement of atoms in space, arrangement of electrons in atoms. Formation of bonds. Charge carriers and their motion in semiconductors. Construction and working of Solar Photo voltaic cell, advantages and disadvantages.

Self study: Characteristics of batteries. A note on Quantum dot sensitized solar cells (QDSSC) and applications.

UNIT – II	10 Hrs

Corrosion Science and E-waste management

Corrosion: Introduction, electrochemical theory of corrosion, types of corrosion-differential metal corrosion and differential aeration corrosion (Water line and pitting). Factors affecting rate of corrosion. Corrosion Penetration Rate (CPR); Introduction and numerical problems.

Corrosion control: Introduction, Metal coating; galvanization, Surface conversion coating; anodization and cathodic protection; sacrificial anodic method.

Electroless Plating: Introduction, Electroless plating of copper in the manufacture of double-sided printed circuit board (PCB).

E-waste Management: Introduction, sources, types, effects of e-waste on environment and human health, methods of disposal, advantages of recycling.

Extraction of copper and gold from e-waste.

Self study: Recycling of printed circuit board (PCB) and battery components. Electroplating of Copper**.**

UNIT - III	10 Hrs

Nano materials and display systems

Nanomaterials: Introduction, size dependent properties of nanomaterials (Surface area, Catalytic, Conducting), preparation of nanomaterials by sol-gel and co-precipitation method with example.

Display Systems

Liquid crystals (LC's); Introduction, classification, positional and orientational order, director, requirement of a substance to exhibit liquid crystal state. Chemical constitution and liquid crystalline behavior, molecular ordering in liquid crystal phase, liquid crystal behavior in homologous series; PAA and MBBA homologous series, electro-optic effect in liquid crystals, construction of liquid crystal display and applications of Liquid Crystal in Displays (LCD's).

Light Emitting Diode (LED): Introduction, working principle of LED. Application of LED.

Organic Light Emitting Diode (OLED): Introduction, Anatomy of OLED, Types of OLED. Comparison between LED and OLED. Advantages and Disadvantages of OLED, Applications of OLED. Quantum Light Emitting Diodes (QLED's); Properties and applications.

Self Study: Light emitting electrochemical cells.

UNIT - IV	10 Hrs

Analytical technique and Polymers

Analytical Techniques: Sensors, Introduction, basic principle of sensor, Types of sensors; Conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Potentiometric sensors; Introduction, principle, working and application in the estimation of iron. Colorimetric sensors; Introduction, principle, working and application in the estimation of copper. Conductometric sensors; Introduction, principle, working and application in the estimation of weak acid.

Polymers: Introduction, Monomer, polymer, polymerization, degree of polymerization. Glass transition temperature, factors affecting glass transition temperature, Molecular weight; Number average and Weight average molecular weight. Numerical problems. Conducting polymers; synthesis and conducting mechanism of polyacetylene (n & p type). Preparation, properties and commercial applications of silicon rubber.

Self Study: Methods of polymerization. Polymer composites.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K_2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)

1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)

1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
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12. Fontana.M.G., Greene.N.D. (1996), Corrosion Engineering (3rd edition), McGraw Hill Publications, New York.

13. Kirby W. Beard (2019), Linden's Handbook of Batteries (5th edition), McGraw Hill.

14. Takatoshi Tsujimura (2012), OLED Display Fundamentals and Applications (2nd edition), Wiley–Blackwell.

15. Dr. Panda H. (2017), "Handbook on Electroplating with Manufacture of Electrochemicals" (1st edition), Asia Pacific BusinessPress Inc.

16. Expanding the Vision of Sensor Materials. National Research Council 1995, Washington, DC: The National Academies Press. doi: 10.17226/4782.

17. Laboratory Manual, Department of Chemistry, BEC Bagalkot.

18. Dr. Sudha Rani (1998), Laboratory Manual on Engineering Chemistry (1st edition), DhanapathRai Publishing Co. Ltd.

Web links and Video Lectures (e-Resources):

- http://libgen.rs/
- https://nptel.ac.in/downloads/122101001/
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/

- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1b b3X- 9IbHrDMjHWWh
- https://www.youtube.com/watch?v=j5Hml6KN4TI

Course Outcomes:

CO1: Analyse the properties of raw materials in designing energy system for industrial and social application.

CO2: Assess and evaluate the forms, mechanism, control of corrosion and develop e-waste management of electrical and electronic products.

CO3: Choose appropriate small material for design of display system.

CO4: Identify and determine composition of various material using sensors and synthesis of polymers for specific purpose.

Course Outcomes	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1					1					1