

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU-572103

(Autonomous Institution affiliated to VTU, Belagavi)

Department: CHEMISTRY

II Semester B.E.

(For CS/IS/AIML/BT Branches)

Syllabus from the Academic year 2025-26 onwards

APPLIED CHEMISTRY FOR SMART SYSTEMS

(CSE Stream)

Contact Hours/ Week:	03+ 02	Credits:	04
Total Lecture Hours:	40+ 26	CIE Marks:	50
Course Code:	1BCHES	SEE Marks:	100

Course objectives:

This course will enable students to:

1.	Implement the knowledge of battery and fuel cell construction, operation and applications in the production of hydrogen as a clean energy fuel.
2.	Learn the art of sensor technology, mechanism of corrosion and its control.
3.	Master the knowledge of principles of green chemistry, biomaterials, e-waste and their applications, along with the role of chemistry in forensic science.
4.	Gain knowledge on quantum dots, polymers, photovoltaic cells and its applications in real time sensor technologies.
5.	To impart foundational knowledge on the structure, mechanistic perspectives of electronic memory and display systems.

UNIT I

SUSTAINABLE CHEMISTRY FOR ENERGY DEVICES

Advanced Battery Chemistry: Introduction, Electrochemical cell and classification. Nernst equation (overview), Concentration cell - Definition, construction & working and numerical problems on Nernst equation and concentration cell. Batteries: Basic concepts, classification of batteries (primary, secondary and reserve batteries).

Next - Generation Energy Systems: Introduction, construction and working of commercial batteries like Lithium - ion and Sodium - ion batteries.

Clean Energy Chemistry: Introduction, Fuel cell, difference between fuel cell and battery, construction and working of methanol - oxygen fuel cell and Solid-oxide Fuel Cell (SOFCs).

Clean Fuel: Hydrogen as a clean Fuel, hydrogen production by photocatalytic water splitting using TiO_2 and its advantages.

8 Hours

UNIT II
CHEMISTRY OF CHEMICAL SENSORS AND CORROSION TECHNOLOGY

Chemical Sensors: Colorimetry - Principle, instrumentation and application in the estimation of copper and numerical problems.

Biosensors: Principle and working mechanism for the detection of glucose in biofluids.

Electrochemical Sensors: Potentiometry - Principle, instrumentation and application in redox titration (FAS v/s $K_2Cr_2O_7$). **Conductometric Sensors** - Principle, instrumentation and application in titrations of strong acid against a strong base, and mixture of acids (strong acid + weak acid) against a strong base.

Corrosion: Metallic corrosion, electrochemical theory of corrosion, types of corrosion - differential metal and differential aeration corrosion (waterline and pitting corrosion). Corrosion penetration rate (CPR) - numerical problems. Corrosion control: Metal coatings - Galvanization, Inorganic coatings - Anodization of Alumina. Cathodic protection - Impressed voltage method and Sacrificial anode method.

8 Hours

UNIT III
GREEN MATERIALS AND E-WASTE MANAGEMENT

Green Chemistry: Introduction, principles of green chemistry, atom economy - definition and numerical problems. Green synthesis of nano ZnO for magnetic radio frequency identification (RFID) and internet of nanothings (IONT) applications.

Biomaterials: Introduction, synthesis, properties and applications of polylactic acid (PLA) and polyethylene glycol (PEG) for touch screen and brain computer interfaces.

Chemistry in forensic Science: Definition and its applications (relevant to computer science & engineering).

E-waste: Introduction, sources (E - waste items), toxic materials used in the manufacturing electronic and electrical products, problem of E - waste on environment and human health, solution for E - waste, methods of disposal, advantages of recycling. Extraction of gold from E - waste via hydrometallurgy.

8 Hours

UNIT IV
ADVANCED CHEMISTRY: QUANTUM MATERIALS AND POLYMERS

Quantum dots: Introduction, size dependent properties (Quantum confinement effect, Surface-to-volume ratio & Band gap). Solar Cells: Definition with principle, construction, working and applications of Quantum Dot Sensitized Solar Cells (QDSSC's).

Polymers: Definition, classification - based on occurrence, structure and effect of heat on

polymers (thermoplastic and thermosetting polymers). Number average and weight average molecular weight - Definition and numerical problems. Synthesis, properties and applications of PVC & PMMA for device applications.

Conducting polymers: Definition, mechanism of conduction in polyacetylene (oxidative doping). Synthesis and applications of Polyaniline.

8 Hours

**UNIT V
FUNCTIONAL MATERIALS IN MEMORY AND DISPLAY SYSTEMS**

Memory Devices: Introduction, basic structure (concept) of electronic memory devices, classification of electronic memory devices: based on principle of electronic material used (transistor type, capacitor type, resistor type, charge transfer complex type). Based on the type of material used (organic and inorganic memory devices).

Resistive Ram (ReRAM) materials: Introduction, synthesis of nano ZnO by combustion method and nano TiO₂ by hydrothermal method.

Display Systems: Introduction, Liquid crystals: Definition, types (Thermotropic & lyotropic liquid crystals). Properties of liquid crystals: Electric effect & Optic effect. Applications of liquid crystals in Liquid crystal display (LCD). Light emitting diode (LED): Definition, working principle. Types of LED: Organic light emitting diodes (OLED's), Quantum Light emitting diodes (QLED's) and Light emitting electrochemical cells (LEEC's).

8 Hours

TEXT BOOK

Sl. No.	Author/s	Title, Publisher, Edition, Year
1	Suba Ramesh and S. Vairam.	Engineering Chemistry - A text book of Chemistry for Engineers, Wiley India, 2020.

REFERENCE BOOKS

Sl. No.	Author/s	Title, Publisher, Edition, Year
1	Sankar P. Dey, Nayim Sepay	A Textbook of Green Chemistry, First Edition, Techno World Publisher, 2021.
2	S.K. Dhawan and Hema Bhandari	Corrosion Preventive Materials and Corrosion Testing, CRC Press, 2020, ISBN-13: 978-1351588430.
3	Kavita Shakya Chahal & Twinkle Solanki	Green Chemistry & E-Waste Management IGI Global (2022), ISBN-13: 978-1799898511.

4	Poushali Das, Sayan Ganguly	Quantum Dots and Polymer Nanocomposites: Synthesis, Chemistry and Applications: CRC Press, 2022.
5	Sabar D. Hutagalung	Materials science and technology, InTech Publishers, 2012.

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Explore the use of electrode materials for the construction of batteries and green chemistry for environmental sustainability.
CO2	Apply the knowledge of sensors in chemical analysis, also to apply the electrochemical theory of corrosion and its control.
CO3	Apply the concepts of green materials and its application in forensic science and E - Waste management.
CO4	Describe the concepts of quantum materials, polymers and applications in the development of solar and fuel cells.
CO5	Explain the importance of functional materials in the development of memory and display systems.

Course Articulation Matrix

		POs											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	
COs	CO1		√												
	CO2		√												
	CO3	√													
	CO4	√													
	CO5	√													

PRACTICAL MODULE

COURSE OBJECTIVES:

Course objectives: This course will enable students to:	
1.	The use of pH sensor for the determination of pK_a of given soft drinks.
2.	The construction and use of electrochemical cell as sensor for the determination of emf /concentration of redox species.
3.	The usage of optical sensor (colorimeter) for the estimation of metals in various matrices.
4.	The use of conductivity meter for the determination of conductance in electrolytic solutions.
5.	The application of volumetry in the analysis of water quality parameters.

A - INSTRUMENTAL METHODS OF ANALYSIS:

A1. Determination of pK_a of given sample of soft drink using pH sensor and its graphical interpretation using origin software.

A2. Estimation of iron present in stainless steel solution using electrochemical sensor and its graphical interpretation using origin software.

A3. Optical sensor for copper determination from E - waste sample (printed circuit board) And its graphical interpretation using origin software.

A4. Conductometric sensor for the estimation of HCl and its graphical interpretation using origin software.

B - VOLUMETRIC METHODS OF ANALYSIS:

B1. Determination of total hardness of water for drinking purpose.

B2: Determination of Chemical Oxygen Demand (COD) of the given industrial waste water sample.

B3. Determination of iron in the given TMT bars by external indicator method.

B4. Determination of alkalinity of given water sample.

C - DEMONSTRATION EXPERIMENTS: (ANY TWO)

C1. Synthesis of nano CuO by combustion method.

C2. Green synthesis of conductive inks for flexible electronic applications.

C3: Evaluation of acid content in beverages using pH sensors.

C4. Detection of sugar in a blood sample using Fehling's solution.

D - OPEN ENDED EXPERIMENTS (ANY TWO):**TEXT BOOK:**

Sl. No.	Author/s	Title, Publisher, Edition, Year
1.	Arthur I. Vogel	Quantitative Inorganic Analysis and Elementary Instrumental Analysis: ELBS, Longmann Group, 5 th Edition, 1989.

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Determine the electrode potential of newly constructed electrodes; calculate the voltage of galvanic cell and batteries and determination of pH of water and other liquid samples.
CO2	Estimate the amount of metal(s) in effluents by potentiometer.
CO3	Determine the metals/pollutants in water and alloys using colorimeter.
CO4	Measure the conductance of solutions/electrolytes which in turn can be used for the determination of its characteristics.
CO5	Use the knowledge of volumetric analysis for estimation of metals and water samples.

Mapping of Course Outcomes with Program outcomes

1. Ability to apply knowledge of science to engineering problems.
2. Ability to analyze problems using the principles of science.

Course Articulation Matrix

		POs											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	
COs	CO1		√												
	CO2		√												
	CO3		√												
	CO4		√												
	CO5		√												