



|| Jai Sri Gurudev ||  
Sri Adichunchanagiri Shikshana Trust (R)  
**SJB Institute of Technology**

BGS Health and Education City, Dr. Vishnuvardhana Road, Kengeri, Bengaluru-560060

Approved by AICTE, New Delhi.

Autonomous Institute affiliated to Visvesvaraya Technological University, Belagavi

Accredited by NAAC with 'A+' grade, Certified by ISO 9001 - 2015

Recognized by UGC, New Delhi with 2(f) & 12 (B)



Semester:	I/II	Course Type:	IASC		
Course Title: Applied Chemistry for Smart Materials					
Course Code:	25CHI12/22A		Credits:		4
Teaching Hours/Week (L:T:P:S)			3:0:2:1	Total Hours:	40+ Lab slots
CIE Marks:	50	SEE Marks:	50	Total Marks:	100
SEE Type:	Theory			Exam Hours:	3
I. Course Objectives					
<ul style="list-style-type: none"><li>To enable students to acquire knowledge on principles of chemistry for engineering applications.</li><li>To develop an intuitive understanding of chemistry by emphasizing the related branches of engineering.</li><li>To provide students with a solid foundation in analytical reasoning required to solve societal problems.</li></ul>					
II. Teaching-Learning Process (General Instructions)					
<p>These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching–Learning more effective</p> <p>a)Tutorial &amp;remedial classes for needy students</p> <p>b)Conducting Makeup classes/Bridge courses for needy students</p> <p>c)Demonstration of concepts either by building models or by industry visit</p> <p>d)Experiments in laboratories shall be executed in blended mode(conventional or non-Conventional methods)</p> <p>e)Use of ICT–Online videos, online courses</p> <p>Use of online platforms for assignments/Notes/Quizzes(Ex. Google classroom)</p>					
III. COURSE CONTENT					
III(a). THEORY PART					
Module-1: Sustainable Chemistry for Energy Devices					8 Hours
<b>Electrode System:</b> Introduction: Ion selective electrode – definition, construction, working and applications of glass electrode. Concentration cell – Definition, construction and numerical problems.					
<b>Next-Generation Energy Systems</b> - Introduction, battery characteristics(Voltage, Cycle life, Power density and shelf life) , Classification of batteries. Construction, working and applications of Li-ion battery and flow battery (Vanadium redox flow battery) for EV application. Construction and working of solar photovoltaic cell, advantages, and disadvantages. Ultra-small asymmetric super capacitor: Introduction, advantages and its applications in IoT/wearable devices.					
<b>Energy Sources:</b> Introduction, definitions of CV, LCV, and HCV. Determination of calorific value of solid/liquid fuel using bomb calorimeter, numerical problems. Octane and cetane number- Definition and its importance in rating of fuel.					

<b>Textbook:Chapter:sections</b> <b>1)Engineering Chemistry by R V Gadag: Chapter 6:Section:6.3,6.4,6.5,6.6,6.7</b> <b>2) Engineering Chemistry by Jain &amp; Jain Chapter 2 Section 3,4,5,6</b>	
<b>Pre-requisites (Self Learning)</b> Types of electrode, Na-ion battery, power alcohol, unleaded petrol, Real-world case studies that highlight the application of next-generation energy systems	
<b>RBT Levels: L1,L2,L3</b>	
<b>Module-2: Corrosion science and E-waste Management</b>	<b>8 Hours</b>
<b>Corrosion:</b> Introduction,Electrochemical corrosion of steel in concrete, Types of corrosion - Differential metal and differential aeration (pitting and water line). Corrosion Penetration Rate (CPR), numerical problems on CPR. <b>Corrosion Control:</b> Anodizing – Anodizing of aluminium, Cathodic protection - Sacrificial anode , Metal coatings – Galvanization. Introduction, technological importance, electroplating - electroplating of chromium; hard and decorative, electroless plating - electroless plating of Nickel, difference between electroplating and electroless plating. <b>E-Waste:</b> Introduction, sources of e-waste, effects of e-waste on environment and human health, Artificial intelligence in e-waste management and its applications, extraction of gold from e-waste by bioleaching method, direct recycling method of lithium-ion batteries. <b>Textbook:Chapter:sections-</b> <b>1)Engineering Chemistry by R V Gadag:Chapter 1,2,3,4:Section 1.5,2.3,3.11,3.12,4.6</b> <b>2)E-Waste Management Challenges and Opportunities in India by VarshaBhagat-Ganguly: Chapter 1,4,6: Section 1.1,4.1,6.1</b>	
<b>Pre-requisites (Self Learning)</b> Galvanic series, types of electrode. Real-world applications: Pipelines, marine structures, buildings, vehicles, Reference electrode-Calomel electrode	
<b>RBT Levels: L1,L2,L3</b>	
<b>Module-3: Green Materials</b>	<b>8 Hours</b>
<b>Green Principles:</b> Discussion on 12 principles of green chemistry, numerical problems on atom economy. Properties and applications of green solvents for server heat management, Synthesis of typical organic compounds by green route; Adipic acid –green synthesis from glucose. Advantages of green approach over conventional method. <b>Green fuel:</b> Hydrogen-production -electrolysis of water (Alkaline water electrolysis), photocatalytic water splitting and its advantages. Biodiesel- Preparation and Advantages. Construction, working principle, applications and limitations of solid-oxide fuel cell (SOFCs) <b>Biomaterials:</b> Definition and classification of biodegradable polymers. Polylactic acid-synthesis and its application. synthesis and properties of Alginate Hydrogel for Brain-Computer Interfaces (BCIs) applications. <b>Textbook: Chapter: sections</b> <b>1)An Introductory Text on Green Chemistry by Indu Tucker Sidhwani: Chapter 1,2,4,6:Section 1.1,2.1-2.13,4.5.2-4.5.3,6.2,6.3</b> <b>2) Handbook of Biodegradable Polymers by Lendlein &amp; Sisson: Chapter:1,7 Section 1.1,7.1</b>	
<b>Pre-requisites (Self Learning)</b> Sustainability, Eco Design , Smart Cities, Eco communication. Real-world case studies that highlight the application of green materials in industry and research.	
<b>RBT Levels: L1,L2,L3</b>	
<b>Module-4:Chemical Sensors and Advanced polymers</b>	<b>8 Hours</b>
<b>Advanced Polymer:</b> Introduction, molecular weight of polymers - number and weight average molecular weight of polymers, numerical problems, structure-property relationship of polymers, synthesis and properties of nylon-12 advantages in 3D printing applications, synthesis and properties of Polycarbonates and PMMA for device applications. <b>Conducting polymers-</b> Introduction, synthesis of polyacetylene, conduction mechanism and its engineering applications. <b>Sensors in Analytical Techniques:</b> Sensors: types and its applications in modern world. Electrochemical gas sensors for the detection of NO <sub>x</sub> & SO <sub>x</sub> in air sample. Principle and instrumentation of Colorimetric sensors; its application in the estimation of copper in PCB, principle and instrumentation of Potentiometric sensors; principle and instrumentation of its application in the estimation of iron in steel, Principle and	

instrumentation of Conductometric sensors; its application in the estimation of acid mixture.

**Textbook:Chapter:sections: 1)Engineering Chemistry by R V Gadag: Chapter 8: Section: 8.1,8.2,8.4, Chapter 10:10.1, 10.3,10.5, 10.6**

**2)Textbook of Polymer Science by Fred W. Billmeyer: Chapter 1,8: Section1.1,8.1**

**3)Engineering Chemistry,Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher, Bengaluru, ISBN 978-93-85155-70-3, 2022**

**Pre-requisites (Self Learning)**

Types of polymers, Display Sensors. Real-world case studies that highlight application of advanced polymers in modern technology.

**RBT Levels: L1,L2,L3**

**Module-5: Functional Materials for Memory and Display Systems**

**8 Hours**

**Memory Devices:** Introduction, organic semiconductors; types of organic semiconductors used in memory devices, construction, working and advantages of pentacene semiconductor chip.

**Display Systems:** Introduction, construction, working principle and applications of Quantum Dot Sensitized Solar Cells (QDSSCs) and Quantum Light Emitting Diodes QLEDs.

Liquid crystals (LC's) - Introduction, classification, properties and application in Liquid Crystal Displays (LCD's).

**Quantum Dot-** Definition, size dependent properties-quantum confinement effect, surface-to-volume ratio & band gap, synthesis of TiO<sub>2</sub>-RAM nanomaterial by sol-gel method, green synthesis of ZnO nanoparticles for magnetic Radio Frequency Identification (RFID) & Internet of Nano Things (IONT) system applications

**Textbook: Chapter: Sections-OLED Display Fundamentals and Applications by Takatoshi Tsujimura: Chapter 2,3: Section: 2.1,3.1/Engineering analysis of smart material systems: Chapter 1: Section 1.1-1.8**

**Engineering Chemistry by Dr. Mahesh B and Dr. Roopashree B, Sunstar: Chapter 4: Section 4.9,4.12, Chapter 5: Section 5.2**

**Pre-requisites (Self Learning)**

Photoluminescence and electroluminescence , ,graphene, fullerenes. Real-world case studies that highlight application of smart materials in technology.

**RBT Levels: L1,L2,L3**

**III(b). PRACTICAL PART**

**Sl.  
No.**

**Experiments / Programs / Problems**

1

Estimation of acid mixture using Conductometric sensors.

2

Estimation of iron in rust sample using Potentiometric sensors.

3

Determination of pK<sub>a</sub> of vinegar using pH sensor (Glass electrode).

4

Estimation of Copper present in electroplating effluent by optical sensor (colorimetry).

5

Determination of Viscosity coefficient of lubricant (Ostwald's viscometer).

6

Estimation of total hardness of water by EDTA method.

7

Estimation of percentage of CaO in cement by EDTA method.

8

Estimation of iron in TMT bar by diphenyl amine/external indicator method.

9

Determination of Chemical Oxygen Demand (COD) of industrial waste water sample.

10

Estimation of Alkalinity (OH<sup>-</sup>,CO<sub>3</sub><sup>2-</sup>,&HCO<sub>3</sub><sup>-</sup>) of water using standard HCl solution.

11

Data analysis of pK<sub>a</sub> of a weak acid and its interpretation using origin software(Demonstration experiment).

12

Chemical structure drawing using software: Chem Draw/ Chem Sketch(Demonstration experiment).

**Instructions for conduction of practical part:****Instructions for conduction of practical part: Instructions for conduction of practical part:**

- Strict discipline should be maintained inside the laboratory.
- Lab batches will be allotted at the beginning of the semester.
- Student should enter into the lab by wearing Apron and having the Lab Manual along with a calculator and observation notebook.
- The student should conduct one experiments in the specified time of 2hrs duration in regular lab sessions
- All entries of the observation should be done by using black pen only. Avoid writing by pencil and overwriting
- **The short procedure for the experiment must be prepared for writing in data sheet by the student before coming to the laboratory** All calculations pertaining to the experiments should be completed in the laboratory. The results must be got corrected by the batch teacher only Then entry should be made in the record and also enter the marks in index book before leaving the laboratory.
- Please remember that practical records are evaluated during regular class hours. Therefore it is imperative that each student takes care to see that experiments are well conducted and recorded.

**IV. COURSE OUTCOMES**

<b>CO1</b>	Use the concepts of electrode systems, energy sources, corrosion mechanisms, and e-waste management to solve real world problems.
<b>CO2</b>	Apply the principles of green chemistry and green materials to design sustainable solutions for energy and environmental applications.
<b>CO3</b>	Analyze the structure–property relationships of advanced polymers and utilize the knowledge of chemistry to investigate chemical species in environmental and engineering applications.
<b>CO4</b>	Evaluate and apply functional smart materials for memory and display systems in emerging technologies.

**V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)**

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	1				1	2					1				
CO2	3	1				1	2					1				
CO3	3	1		1		1	2					1				
CO4	3	1				1	1					1				

**VI. Assessment Details (CIE & SEE)****General Rules:**Refer Annexure section 2**Continuous Internal Evaluation (CIE):**Refer Annexure section 2**Semester End Examination (SEE):**Refer Annexure section 2**VII. Learning Resources****VII(a): Textbooks:**

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Green Chemistry: Theory and Practice	Paul T. Anastas, John Charles Warner	01-Jan-2000	Oxford University Press
2	Green Chemistry: Environmentally Benign Reactions	V.K. Ahluwalia	02-Jul-2021	Springer Nature
3	Nanotechnology A Chemical Approach to Nanomaterials	G.A. Ozin& A.C. Arsenault	2005	RSC Publishing

4	Linden's Handbook of Batteries	Kirby W.Beard	Fifth Edition, 2019.	McGraw Hill,
5	Corrosion Engineering	M.G.Fontana, N.D.Greene	3 <sup>rd</sup> Edition, 1996	McGrawHill Publications, NewYork
6	Wiley Engineering Chemistry	Wiley	2 <sup>nd</sup> Edition-2013	Wiley India Pvt.Ltd. NewDelhi
7	Engineering Chemistry	P. C. Jain & Monica Jain	17 <sup>th</sup> Edition-2015	Dhanpat Rai Publishing Company, New Delhi
8	Handbook of Biodegradable Polymers	Lendlein & Sisson	1 <sup>st</sup> Edition- 2011	Wiley-VCH

#### **VII(b): Reference Books:**

1	Engineering Chemistry	O.G.Palanna	Fourth Reprint 2017	Tata McGraw Hill Education Pvt. Ltd. New Delhi
2	Engineering Chemistry	Shubha Ramesh et.al.	1st Edition, 2011	Wiley India
3	Fundamentals of Analytical chemistry	Douglas A. Skoog et.al.	Eighth edition-2004	Thomson Asia pte Ltd
4	OLED Display Fundamentals and Applications	TakatoshiTsuji-mura	2012	Wiley–Blackwell
5	Super capacitors: Materials, Systems, and Applications	Max Lu, Francois Beguin, Elzbieta Frackowiak	1st edition, 2013	Wiley-VCH
6	Textbook of Polymer Science	Fred W. Billmeyer	3rd Edition (May 1984)	John Wiley & Sons, Ltd (Wiley)

#### **VII(c): 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=PLyhmwFtznRhuz8L1bb3X9IbHrDMjHWWH>  
<https://www.youtube.com/watch?v=j5Hml6KN4TI>  
<https://www.youtube.com/watch?v=X9GHBdyYcyo>  
<https://www.youtube.com/watch?v=1xWBPZnEJk8>

#### **VIII: Activity Based Learning / Practical Based Learning/Experiential learning:**

Seminar, Assignments, Quiz, Industry visit, self-study activities, case studies group discussions, etc