



Semester:	I/II	Course Type:	IASC		
Course Title: Applied Chemistry for Advanced Mechanical Materials					
Course Code:	25CHI12/22D		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):					
These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching–Learning more effective					
a)Tutorial &remedial classes for needy students b)Conducting Makeup classes/Bridge courses for needy students c)Demonstration of concepts either by building models or by industry visit d)Experiments in laboratories shall be executed in blended mode(conventional or non-Conventional methods) e)Use of ICT–Online videos, online courses f)Use of online platforms for assignments/Notes/Quizzes(Ex. Google classroom)					
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, stress corrosion Real-world case studies that highlight the application of waste management in industry	
<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: Fluid Technology and Smart Sensors</b>	<b>8 Hours</b>
<b>Lubricants:</b> Introduction, classification, Mechanism of lubricating oil and greases,ideal properties and applications. Lubricant testing; experimental determination of viscosity. <b>Industrial Coolants:</b> Introduction, types-water and oil-based coolants, properties and industrial applications. <b>Industrial effluents:</b> Introduction, determination of COD and numerical problems. <b>Sensors:</b> Sensors: types and its applications in modern world. Sensor for the measurement of Dissolved Oxygen (DO). 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, 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) Engineering Chemistry by Jain & Jain: Chapter 6,8: Section: 6.1–6.8 and 3.5–3.8  
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)**

Water treatment , industrial water standards (WHO, BIS, EPA), Display Sensors. Real-world case studies that highlight Fluid Technology. Sewage water treatment, Reverse osmosis

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

**Module-5 : Materials for Engineering Applications**

**8 Hours**

**Engineering Polymers:** Introduction, molecular weight of polymers - numerical problems, synthesis, properties and engineering applications of chloro polyvinyl chloride (CPVC), and polymethyl methacrylate (PMMA), structure and property relationship of polymers. Glass transition temperature (T<sub>g</sub>), factor affecting T<sub>g</sub> and its significance.

**Polymer Composites:** Introduction, fiber-reinforced polymers (FRPs); Kevlar – Synthesis, properties and industrial applications. Carbon-fiber - Preparation from Polyacrylonitrile (PAN), properties and industrial applications.

**Nanomaterials:** Introduction, synthesis of TiO<sub>2</sub> nanoparticles by sol-gel method for catalytic converter applications, size-dependent properties of nanomaterial-surface area, catalytical, electrical and thermal conductivity. Graphene - Synthesis by chemical vapor deposition method, properties and engineering applications, role of carbon nanotubes (CNTs) in energy devices.

**Textbook: Chapter: Sections**

1)Engineering Chemistry by P.C. Jain & Monika J: Chapter 5: Section 5.2.1,5.2.2,5.2.3,5.2.4,5.3.1,5.3.2,5.3.3,5.3.4,5.3.5  
2)Textbook of Polymer Science – Fred W. Billmeyer Jr., 3rd Ed., Wiley: Chapter 2,7: Section: 2.1,7.1 and 3.5–3.8

**Pre-requisites (Self Learning)**

Types of polymers, Electrochemical cells, Nernst equation, 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.



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	1st 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	Takatoshi Tsujimura	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