| 22CHEM22 | Chemistry for Mechanical stream | (2-2-2) 4 |
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**Contact Hours: 40 Theory + 12 Lab Sessions**

**Course Learning Objectives (CLOs):** This course focuses on the following learning perspectives:

- To enable students to acquire knowledge on principles of chemistry for engineering applications.
- To develop an intuitive understanding of chemistry by emphasizing the related branches of engineering.
- To provide students with a solid foundation in analytical reasoning required to solve societal problems.

**Course Outcomes (COs):**

| **Description of the Course Outcome:** At the end of the course the student will be able to: | | **Mapping to POs(1-12) / PSOs(13-16)** | | |
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| | | **Substantial Level (3)** | **Moderate Level (2)** | **Slight Level (1)** |
| **CO-1** | **Identify** the terms and processes involved in scientific and engineering applications. | 1 | - | 2,3,7 |
| **CO-2** | **Explain** the phenomena of chemistry to describe the methods of engineering processes. | 1 | - | 2,3,7 |
| **CO-3** | **Solve** for the problems in chemistry that are pertinent in engineering applications. | 1 | - | 2,3,7 |
| **CO-4** | **Apply** the basic concepts of chemistry to explain the chemical properties and processes. | 1 | - | 2,3,7 |
| **CO-5** | **Analyze** properties and processes associated with chemical substances in multidisciplinary situations. | 1 | - | 2,3,7 |

| **POs/PSOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
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| **Mapping Level** | 3.0 | 1.0 | 1.0 | - | - | - | 1.0 | - | - | - | - | - | - | - | - | - |

**Pre-requisites:** Basics of Electrochemistry.

**Contents:**

**Unit-I**

**Fuels:** Introduction, calorific value, determination of calorific value using bomb calorimeter, numerical problems on GCV and NCV. Knocking and its mechanism, anti-knocking agents, octane and cetane numbers.

**Green fuels:** Introduction, power alcohol, synthesis and applications of biodiesel.

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

**Energy devices:** Introduction, construction, working, and applications of Photovoltaic cells, Li-ion battery and methanol-oxygen fuel cell.

**Self-study:** Plastic recycling to fuels and its monomers or other useful products.

**8 Hrs**

## Unit-II

**Corrosion:** Introduction, electrochemical theory of corrosion, types of corrosion-differential metal, differential aeration (waterline and pitting), stress corrosion (caustic embrittlement).

**Corrosion control:** Metal coating-galvanization, surface conversion coating-anodization and cathodic protection-sacrificial anode method. Corrosion testing by weight loss method. Corrosion penetration rate (CPR)-numerical problems.

**Metal finishing:** Introduction, technological importance. Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electroless plating: Introduction, electroless plating of nickel.

**Self-learning:** Factors affecting the rate of corrosion, **f**actors influencing the nature and quality of electro-deposit (Current density, concentration of metal ion, pH and temperature)**.** **8 Hrs**

## Unit-III

**Polymers**: Introduction, methods of polymerization (Condensation and Freeradical), molecular weight; number average and weight average, numerical problems. Synthesis, properties and industrial applications of chlorinated polyvinylchloride (CPVC) and polystyrene.

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

**Composites & Fibers:** Introduction, properties and industrial applications of metal matrix polymer composites. Fibers: Introduction, synthesis, properties and industrial applications of Kevlar and Polyester.

**Biodegradable polymer:** Introduction, synthesis, properties and applications of polylactic acid (PLA).

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

**Self-learning:** carbon-based reinforced composites (graphene/carbon nano-tubes as fillers).

**8 Hrs**

## Unit-IV

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

**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); Construction, working and its application in the determination of pH of beverages.

**Self-learning:** Determination of viscosity of biofuel and its correlation with temperature. **8 Hrs**

## Unit-V

**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 ($CaTiO_3$).

**Nanochemistry:** Introduction, size-dependent properties of nanomaterial (surface area, catalytical and thermal), synthesis of nanoparticles by sol-gel, and co-precipitation method.

**Nanomaterials:** Introduction, properties and engineering applications of carbon nanotubes and graphene.

**Self-learning: Abrasives**: Introduction, classification, properties and applications of silicon carbide (carborundum).

**Self-study:** Types of electrochemical sensor, Gas sensor -O2 sensor, Biosensor – Glucose sensors. **8 Hrs**

## PRACTICAL MODULE

***A – Demonstration (any two) offline/virtual:***

A1. Synthesis of polyurethane

A2. Preparation of urea formaldehyde resin A3. Synthesis of iron oxide nanoparticles A4. Determination of acid value of biofuel

***B – Exercise (compulsorily any 4 to be conducted):***

B1. Conductometric estimation of acid mixture

B2. Potentiometric estimation of FAS using $K_2Cr_2O_7$

B3. Determination of pKa of vinegar using pH sensor (Glass electrode)

B4. Determination of rate of corrosion of mild steel by weight loss method.

B5. Estimation of total hardness of water by EDTA method

***C – Structured Enquiry (compulsorily any 4 to be conducted):***

C1. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry).

C2. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

C3. Estimation of iron in TMT bar by diphenyl amine/external indicator method C4. Estimation of Sodium present in soil/effluent sample using flame photometry

C5. Determination of Chemical Oxygen Demand (COD) of industrial waste water sample

***D – Open Ended Experiments (any two):***

D1. Estimation of percentage of iron in steel

D2. Electroplating of desired metal on substrate D3. Synthesis of biodiesel

D4. Synthesis of Aluminium Oxide nano particle

**Reference Books:**


1. A Text book of Engineering Chemistry, SS Dara & Dr. SS Umare, S Chand & Company Ltd., 12th Edition, 2011.
2. A Text Book of Engineering Chemistry, R.V. Gadag and Nityananda Shetty, I. K. International Publishing house. 2nd Edition, 2016.
3. Text Book of Polymer Science, F.W. Billmeyer, John Wiley & Sons, 4th Edition, 1999.
4. Nanotechnology A Chemical Approach to Nanomaterials, G.A. Ozin & A.C. Arsenault, RSC Publishing, 2005.
5. Corrosion Engineering, M. G. Fontana, N. D. Greene, McGraw Hill Publications, New York, 3rd Edition, 1996.
6. Linden's Handbook of Batteries, Kirby W. Beard, Fifth Edition, McGraw Hill, 2019.
7. OLED Display Fundamentals and Applications, Takatoshi Tsujimura, Wiley–Blackwell , 2012.
8. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch Seventh Edition, Cengage Learning, 2020.
9. Polymer Science, V R Gowariker, N V Viswanathan, Jayadev, Sreedhar, Newage Int. Publishers, 4th Edition, 2021.
10. Engineering Chemistry, P C Jain & Monica Jain, Dhanpat Rai Publication, 2015-16th Edition.
11. Chemistry for Engineering Students, B. S. Jai Prakash, R. Venugopal, Sivakumaraiah & Pushpa Iyengar., Subash Publications, 5th Edition, 2014
12. "Engineering Chemistry", O. G. Palanna, Tata McGraw Hill Education Pvt.

Ltd. New Delhi, Fourth Reprint, 2015.

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