

<b>Course Title</b>	<b>CHEMISTRY FOR CIVIL ENGINEERING STREAM</b>		
<b>Course Code</b>	22CHEC22	<b>(L-T-P)C</b>	(3-1-2)4
<b>SEE duration</b>	3 hour	<b>Hours / Week</b>	06
<b>CIE (Theory) marks</b>	30	<b>CIE(Practicals)/Activity marks</b>	20
<b>SEE marks</b>	50	<b>Total contact hours</b>	70

**Course Objective:** The objective of this course is to build a strong foundation and basic skills in Engineering Chemistry for technological competence in industries.

**Course Outcomes:**

After the completion of the course, students shall be able to:-

Sl. No.	Course outcomes	Mapping to POs
1.	Describe the terms and chemical process involved in the scientific and engineering application.	PO1, PO2
2.	Illustrate the construction and working of the engineering process using basic concepts of chemistry.	PO1, PO2
3.	Outline the preparation, properties & applications associated with chemical substances in multidisciplinary fields.	PO1, PO2
4.	Apply the various principles and analytical techniques to solve the problems and quantitative analysis of materials in engineering applications.	PO1, PO2 & P10

**Course Contents:**

<b>MODULE –1</b>	<b>10 Hrs.</b>
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**Water and its Treatment**

Introduction, sources of water, impurities in water, standards of water for industrial supply. Hardness of water, types of hardness determination of total hardness by EDTA method.

**Boiler feed water and boiler problems,** Boiler scales and sludge's- meaning, formation, disadvantages and prevention, priming and foaming.

**External treatment of boiler feed water-** Hot Lime -Soda process and Ion exchange method.

**Internal treatment of water-** phosphate conditioning & calgon treatment.

**Desalination-** Meaning, purification of water by reverse osmosis.

**Potable water-** Meaning, Standards of potable water, treatment of water for town supply. BOD and COD- definition, experimental determination of COD of the industrial waste water sample.

<b>MODULE –2</b>	<b>10 Hrs.</b>
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**Chemical Energy Sources and Engineering Materials**

**Fuels-** Definition with examples. Characteristics of an ideal fuel. Calorific value- definition, types - Gross and Net calorific values, units in S.I system. Experimental determination of calorific value of a solid fuel using Bomb Calorimeter. Numerical problems on GCV and NCV.

**Chemical processing of Petroleum:** Cracking- Definition. Types of cracking- thermal and catalytic cracking. Fluidized catalytic cracking. Reforming of petrol with reactions (Isomerisation, cyclisation, aromatisation and dehydrogenation). Octane number & Cetane number. Knocking in IC engine.

**Prevention of knocking** - Anti knocking agents (TEL & MTBE).

**Green fuels: Power alcohol-** introduction, advantages and disadvantages. **Biodiesel-** introduction, synthesis, advantages, and disadvantages.

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

MODULE –3	10 Hrs.
<p><b>Electrochemistry and Battery Technology</b></p> <p>Introduction, electrochemical cells – Definition, Types of electrochemical cells, Construction, working &amp; representation of galvanic cell. Modern sign conventions, single electrode potential, standard electrode potential. E.M.F of a cell, standard E.M.F of a cell, derivation of Nernst's equation.</p> <p><b>Concentration cell-</b> Definition with example, derivation of emf of concentration cells.</p> <p><b>Electrodes -</b> Types of electrodes-Metal-metal ion electrode, Metal- metal salt ion electrode, gas-electrode and ion selective electrode.</p> <p><b>Secondary reference electrodes</b> – Calomel electrode-construction, working and applications.</p> <p><b>Ion selective electrode-</b> construction and working of glass electrode. Determination of pH of a solution using glass electrode. Numerical problems on E, E<sup>0</sup>, E<sub>cell</sub>, E<sup>0</sup><sub>cell</sub> and concentration cells. Potentiometric estimation of FAS using K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solution.</p> <p><b>Battery technology</b></p> <p><b>Batteries-</b> Definition, classification of batteries- primary &amp; secondary batteries.</p> <p><b>Secondary batteries</b> - construction, working and industrial applications of Lead- acid battery and Nickel-metal hydride battery.</p> <p><b>Modern battery-</b> construction, working and industrial applications of Li-ion batteries.</p> <p><b>Fuel Cells-</b> Introduction, definition, construction, working and industrial applications of H<sub>2</sub>-O<sub>2</sub> fuel cell &amp; Methanol-O<sub>2</sub> fuel cell.</p>	
MODULE – 4	10 hrs.
<p><b>Macromolecules for Engineering Applications</b></p> <p><b>Introduction</b>, definition with examples. <b>Glass transition temperature (T<sub>g</sub>)</b> - definition, factors affecting T<sub>g</sub> and significances of T<sub>g</sub>.</p> <p><b>Plastics</b> – Compounding of resins in to plastics. Synthesis, properties and Industrial applications of PMMA and Polyurethane.</p> <p><b>Polymer composites-</b> introduction, <b>fibers-</b> meaning, synthesis, properties and industrial applications of Kevlar and Polyester.</p> <p><b>Adhesives</b> –Meaning, preparation, properties and applications of Epoxy resins &amp; Phenol-formaldehyde resins.</p> <p><b>Bio-degradable polymers-</b> Introduction, types of bio-degradable polymers, preparation, properties and applications of polylactic acid (PLA).</p> <p><b>Corrosion chemistry</b></p> <p>Introduction, electrochemical theory of corrosion, types-differential metal, differential aeration (water line and pitting), factors affecting the nature of corrosion.</p> <p><b>Corrosion control-</b>galvanization, anodization and sacrificial anode method.</p>	

### List of experiments/Activities

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

- A1. Synthesis of polymer
- A2. Synthesis of iron oxide nanoparticles
- A3: Chemical Structure drawing using software: ChemDraw or ACD/ChemSketch
- A4. Determination of chloride content in the given water sample by Argentometric method

#### **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  $p^{K_a}$  of vinegar using  $p^H$  sensor
- 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
- 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: Evaluation of acid content in beverages by using  $p^H$  sensors and simulation
- D2. Estimation of copper in e-waste.
- D3. Volumetric estimation of gypsum in Portland cement
- D4. Searching suitable PDB file and target for molecular docking

#### **TEXT BOOKS**

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- 5. Instrumental Methods of Analysis, Dr. K. R. Mahadik and Dr. L. Sathiyarayanan.
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- 7. Vogels text book of quantitative inorganic analysis, revised by J. Bassett, R.C. Denny, G.H. Jeffery, 4th Ed.

<b>Course Title</b>	<b>CHEMISTRY FOR COMPUTER SCIENCE AND ENGINEERING STREAM</b>		
<b>Course Code</b>	22CHES12	<b>(L-T-P)C</b>	(3-1-2)4
<b>SEE duration</b>	3 hour	<b>Hours / Week</b>	06
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1.	Describe the terms and chemical process involved in the scientific and engineering application.	PO1, PO2
2.	Illustrate the construction and working of the engineering process using basic concepts of chemistry.	PO1, PO2
3.	Outline the preparation, properties & applications associated with chemical substances in multidisciplinary fields.	PO1, PO2
4.	Apply the various principles and analytical techniques to solve the problems and quantitative analysis of materials in engineering applications.	PO1, PO2 & PO10

**Course Contents:**

<b>MODULE –1</b>	<b>10 Hrs.</b>
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**Macromolecules for Engineering Applications**

**Introduction**, definition with examples. **Glass transition temperature (T<sub>g</sub>)** - definition, factors affecting T<sub>g</sub> and significances of T<sub>g</sub>.

**Plastics** – Compounding of resins into plastics. Synthesis, properties and industrial applications of PMMA, Polyurethane & PTFE.

**Polymer composites** - introduction. **Fibers**- meaning, synthesis, properties and industrial applications of Kevlar and Polyester.

**Adhesives** –Meaning, preparation, properties and applications of Epoxy resins & Phenol-formaldehyde resins.

**Bio-degradable polymers**- Introduction, types of bio-degradable polymers, preparation, properties and applications of polylactic acid (PLA).

**Elastomers**- Definition, types-natural and synthetic rubber. Preparation of natural rubber from latex, deficiencies of natural rubber, vulcanization of natural rubber.

**Synthetic rubbers**- Preparation, properties and industrial applications of SBR rubber, Thiokol, and Silicon rubber.

<b>MODULE –2</b>	<b>10 Hrs.</b>
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**Electrochemistry and Sensors**

**Electrochemistry**

Introduction, electrochemical cells – Definition, Types of electrochemical cells, Construction, working & representation of galvanic cell. Modern sign conventions, single electrode potential, standard electrode potential. E.M.F of a cell, standard E.M.F of a cell, derivation of Nernst's equation.

**Concentration cell**- Definition with example, derivation of emf of concentration cells.

**Electrodes** -Types of electrodes-Metal-metal ion electrode, Metal - metal salt ion electrode, gas electrode and ion selective electrode.

**Secondary reference electrodes** – Calomel electrode- construction, working and applications.

**Ion selective electrode**- construction and working of the glass electrode. Determination of  $p^H$  of a solution using glass electrode. Numerical problems on  $E$ ,  $E^0$ ,  $E_{cell}$ ,  $E^0_{cell}$  and concentration cells. Potentiometric estimation of FAS using  $K_2Cr_2O_7$  solution.

**Sensors:** Introduction, working principle and applications of electrochemical sensors - Potentiometric sensors, Amperometric sensors, and Conductometric sensors. Optical sensors.

### MODULE –3

10 Hrs.

#### Energy, Storage and Conversion

**Batteries**- Definition, difference between battery and cell. Classification of batteries- primary & secondary batteries. Battery characteristics.

**Secondary batteries** - construction, working and industrial applications of Lead- acid battery and Nickel-metal hydride battery.

**Modern batteries:** Construction, working and industrial applications of Li-ion battery.

**Fuel Cells**- Introduction, definition, construction, working and industrial applications of  $H_2$ - $O_2$  fuel cell & methanol-oxygen fuel cell. Differences between battery and fuel cell.

**Green fuels: Power alcohol**-introduction, advantages and disadvantages.

**Biodiesel**- Introduction, synthesis, advantages, and disadvantages.

**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.

### MODULE – 4

10 hrs.

#### Surface Finishing (PCB preparation)

Introduction, technological importance of metal finishing. factors affecting the nature of electro deposit - metal ion concentration, current density, complexing agents, organic additives,  $p^H$ , temperature & throwing power.

**Electroplating** – Definition, electroplating process. Methods of cleaning the metal surfaces to be coated. Electroplating of Copper by cyanide bath method and electroplating of gold.

**Electroless plating** - Definition, distinction between electroplating and electroless plating, advantages of electroless plating. Electroless plating of Nickel and electroless plating of Copper in the manufacture of double-sided PCB.

#### Corrosion chemistry

Introduction, electrochemical theory of corrosion, types-differential metal, differential aeration (water line and pitting), factors affecting the nature of corrosion.

**Corrosion control**-galvanization, anodization and sacrificial anode method.

### List of experiments/Activities

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

- A1. Synthesis of polymer
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- A3: Chemical Structure drawing using software: ChemDraw or ACD/ChemSketch
- A4. Determination of chloride content in the given water sample by Argentometric method

#### **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  $p^H$  sensor
- 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
- 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
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#### **D – Open Ended Experiments (any two):**

- D1: Evaluation of acid content in beverages by using pH sensors and simulation
- D2. Estimation of copper in e-waste.
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<b>Course Title</b>	<b>CHEMISTRY FOR ELECTRICAL AND ELECTRONICS ENGINEERING STREAM</b>		
<b>Course Code</b>	22CHEE22	<b>(L-T-P)C</b>	(3-1-2)4
<b>SEE duration</b>	3 hour	<b>Hours / Week</b>	06
<b>CIE (Theory) marks</b>	30	<b>CIE (Practicals)/Activity marks</b>	20
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3.	Outline the preparation, properties & applications associated with chemical substances in multidisciplinary fields.	PO1, PO2
4.	Apply the various principles and analytical techniques to solve the problems and quantitative analysis of materials in engineering applications.	PO1, PO2 & PO10

**Course Contents:**

**MODULE –1**

**10 Hrs.**

**Electrochemistry and Analytical Techniques**

**Electrochemistry-** Introduction, electrochemical cells – Definition, Types of electrochemical cells, Construction, working & representation of galvanic cell. Modern sign conventions, single electrode potential, standard electrode potential. E.M.F of a cell, standard E.M.F of a cell, derivation of Nernst's equation.

**Concentration cell-** Definition with example, derivation of emf of concentration cells.

**Electrodes -** Types of electrodes-Metal-metal ion electrode, Metal-metal salt ion electrode, gas-electrode and ion selective electrode.

**Secondary reference electrode –** Calomel electrode - construction, working and applications.

**Ion selective electrode-** construction and working of the glass electrode. Determination of  $p^H$  of a solution using glass electrode. Numerical problems on  $E$ ,  $E^0$ ,  $E_{cell}$ ,  $E^0_{cell}$  and concentration cells.

**Analytical techniques:** Introduction, principle and instrumentation: Colorimetric sensors – estimation of copper, Potentiometric sensors – estimation of iron and Conductometric sensors – estimation of weak acid.

**MODULE –2**

**10 Hrs.**

**Energy, Storage and Conversion**

**Batteries-** Definition, difference between battery and cell. Classification of batteries – primary & secondary batteries. Battery characteristics.

**Secondary batteries -** construction, working and industrial applications of Lead- acid battery and Nickel-metal hydride battery.

**Modern batteries:** Construction, working and industrial applications of Li-ion battery.  
**Fuel Cells-** Introduction, definition, construction, working and industrial applications of H<sub>2</sub>-O<sub>2</sub> fuel cell & methanol-oxygen fuel cell. Differences between battery and fuel cells.  
**Green fuels: Power alcohol-**Introduction, advantages and disadvantages. **Biodiesel-** Introduction, synthesis, advantages, and disadvantages.  
**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.

**MODULE –3**

**10 Hrs.**

**Macromolecules for Engineering Applications**

**Introduction**, definition with examples. **Glass transition temperature (T<sub>g</sub>)** - definition, factors affecting T<sub>g</sub> and significances of T<sub>g</sub>.

**Plastics** – Compounding of resins into plastics. Synthesis, properties and industrial applications of PMMA, Polyurethane & PTFE.

**Polymer composites-** introduction, **Fibers-** meaning, synthesis, properties and industrial applications of Kevlar and Polyester.

**Adhesives** –Meaning, Preparation, properties and applications of Epoxy resins & Phenol-formaldehyde resins.

**Bio-degradable polymers-** Introduction, types of bio-degradable polymers, preparation, properties and applications of polylactic acid (PLA).

**Elastomers-** Definition, types-natural and synthetic rubber. Preparation of natural rubber from latex, deficiencies of natural rubber, vulcanization of natural rubber.

**Synthetic rubbers-** Preparation, properties and industrial applications of SBR rubber, Thiokol, and Silicon rubber.

**MODULE – 4**

**10 hrs.**

**Surface Finishing**

Introduction, technological importance of metal finishing. factors affecting the nature of electro deposit - metal ion concentration, current density, complexing agents, organic additives, p<sup>H</sup>, temperature & throwing power.

**Electroplating** – Definition, electroplating process. Methods of cleaning the metal surfaces to be coated. Electroplating of Copper by cyanide bath method and electroplating of Gold.

**Electroless plating** - Definition, distinction between electroplating and electroless plating. Advantages of electroless plating. Electroless plating of Nickel.

**Corrosion chemistry**

Introduction, electrochemical theory of corrosion, types-differential metal, differential aeration (water line and pitting), factors affecting the nature of corrosion.

**Corrosion control-**galvanization, anodization and sacrificial anode method.

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- 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
- C2. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)
- C3. Estimation of iron in TMT bar by diphenyl amine/external indicator method
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**D – Open Ended Experiments (any two):**

- D1: Evaluation of acid content in beverages by using p<sup>H</sup> sensors and simulation
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**Course Contents:**

<b>MODULE –1</b>	<b>10 Hrs.</b>
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**Chemical Energy Sources and Engineering materials**

**Fuels-** Definition with examples. Characteristics of an ideal fuel. Calorific value- definition, types - Gross and Net calorific values, units in S.I system. Experimental determination of calorific value of a solid fuel using Bomb Calorimeter. Numerical problems on GCV and NCV.

**Chemical processing of Petroleum:** Cracking- Definition. Types of cracking- thermal and catalytic cracking. Fluidized catalytic cracking. Reforming of petrol with reactions (Isomerisation, cyclisation, aromatisation and dehydrogenation). Octane number & Cetane number. Knocking in IC engine.

**Prevention of knocking** - anti knocking agents (TEL & MTBE).

**Green fuels:** Power alcohol- introduction, advantages and disadvantages. **Biodiesel-** introduction, synthesis, advantages and disadvantages.

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

<b>MODULE –2</b>	<b>10 Hrs.</b>
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**Water and its Treatment**

Introduction, sources of water, impurities in water, standards of water for industrial supply. Hardness of water, types of hardness determination of total hardness by EDTA method.

**Boiler feed water and boiler problems,** Boiler scales and sludges- meaning, formation, disadvantages and prevention, priming and foaming.

**External treatment of boiler feed water-** Hot Lime -Soda process and Ion exchange method.

**Internal treatment of water-** phosphate conditioning & Calgon treatment.

**Desalination-** Meaning, purification of water by reverse osmosis.

**Potable water-** Meaning, Standards of potable water, treatment of water for town supply.

**BOD and COD-** definition, experimental determination of COD of the industrial waste water sample.

MODULE –3	10 Hrs.
<p><b>Electrochemistry and Battery Technology</b>            Introduction, electrochemical cells – Definition, Types of electrochemical cells, Construction, working &amp; representation of galvanic cell. Modern sign conventions, single electrode potential, standard electrode potential. E.M.F of a cell, standard E.M.F of a cell, derivation of Nernst equation.  <b>Concentration cell-</b> Definition with example, derivation of emf of concentration cells.  <b>Electrodes -</b> Types of electrodes-Metal-metal ion electrode, Metal- metal salt ion electrode, gas-electrode and ion selective electrode.  <b>Secondary reference electrodes</b> – calomel electrode-construction, working and applications.  <b>Ion-selective electrode-</b> construction and working of glass electrode. Determination of pH of a solution using glass electrode. Numerical problems on E, E<sup>0</sup>, E<sub>cell</sub>, E<sup>0</sup><sub>cell</sub> and concentration cells.            Potentiometric estimation of FAS using K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solution.  <b>Battery technology</b>  <b>Batteries-</b> Definition, Classification of batteries- primary &amp; secondary batteries.  <b>Secondary batteries -</b> construction, working and industrial applications of Lead- acid battery and Nickel -metal hydride battery.  <b>Modern battery-</b> construction, working and industrial applications of Li-ion batteries.  <b>Fuel Cells-</b> Introduction, definition, construction, working and industrial applications of H<sub>2</sub>-O<sub>2</sub> fuel cell &amp; Methanol-O<sub>2</sub> fuel cell.</p>	
MODULE –4	10 Hrs
<p><b>Macromolecules for Engineering applications</b>  <b>Introduction,</b> definition with examples. <b>Glass transition temperature (T<sub>g</sub>)</b> - definition, factors affecting T<sub>g</sub> and significances of T<sub>g</sub>.  <b>Plastics</b> – Compounding of resins in to plastics.            Synthesis, properties and Industrial applications of PMMA and Polyurethane.  <b>Polymer composites-</b> introduction, <b>fibers-</b> meaning, synthesis, properties and industrial applications of Kevlar and polyester.  <b>Adhesives</b> –Meaning, Preparation, properties and applications of Epoxy resins &amp; Phenol-formaldehyde resins.  <b>Bio-degradable polymers-</b> Introduction, types of bio-degradable polymers, preparation, properties and applications of polylactic acid (PLA).</p> <p><b>Corrosion chemistry</b>            Introduction, electrochemical theory of corrosion, types-differential metal, differential aeration(water line and pitting), factors affecting the nature of corrosion.  <b>Corrosion control-</b>galvanization, anodization and sacrificial anode method.</p>	
<p><b><u>List of experiments/Activities</u></b></p>	
<p><b>A – Demonstration (any two) offline/virtual:</b>            A1. Synthesis of polymer            A2. Synthesis of iron oxide nanoparticles            A3: Chemical Structure drawing using software: ChemDraw or ACD/ChemSketch            A4. Determination of chloride content in the given water sample by Argentometric method</p> <p><b>B – Exercise (compulsorily any 4 to be conducted):</b>            B1. Conductometric estimation of acid mixture            B2. Potentiometric estimation of FAS using K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>            B3. Determination of pKa of vinegar using pH sensor            B4. Determination of rate of corrosion of mild steel by weight loss method            B5. Estimation of total hardness of water by EDTA method</p>	

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

- C1. Estimation of Copper present in electroplating effluent by optical sensor
- 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: Evaluation of acid content in beverages by using pH sensors and simulation
- D2. Estimation of copper in e-waste.
- D3. Volumetric estimation of gypsum in Portland cement
- D4. Searching suitable PDB file and target for molecular docking

**TEXT BOOKS**

- 1. Engineering Chemistry by M.M. Uppal, Khanna Publishers.
- 2. A text Book of Engineering Chemistry- by P C Jain and Monica Jain, Dhanapatrai Publications, New Delhi.(2015 edition)
- 3. A Text Book of Engineering Chemistry, R.V. Gadag and Nitthyananda Shetty, I.K. International Publishing house. 2nd Edition, 2016.
- 4. Chemistry for Engineering Students, B. S. Jai Prakash, R. Venugopal, Sivakumaraiah & Pushpa Iyengar., Subash Publications, Bangalore.5th Edition,2014.

**REFERENCE BOOKS**

- 1. Principles of Physical Chemistry B.R.Puri, L.R.Sharma & M.S.Pathania, S.Nagin Chand &Co., (2008 edition).
- 2. Industrial Chemistry by B.K.Sharma, GOEL Publishing House (2014 edition).
- 3. Industrial Electrochemistry, Second Edition by Derek Pletcher & Frank C. Walsh publisher: Chapman & Hall, USA (1993 edition)X
- 4. Corrosion Engineering, M.G. Fontana, N.D. Greene, McGraw Hill Publications, New York, 3rd Edition, 1996.
- 5. Instrumental Methods of Analysis, Dr. K. R. Mahadik and Dr. L. Sathiyarayanan.
- 6. Text Book of Polymer Science, F.W. Billmeyer, John Wiley & Sons, 4th Edition, 1999.
- 7. Vogels text book of quantitative inorganic analysis, revised by J. Bassett, R.C. Denny, G.H. Jeffery, 4th Ed.