Course Title:	**Chemistry for Civil Engineering Stream**		
Course Code:	**22CHEE12/22**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)**	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Credits	04

Course objectives

- 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.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

- Tutorial & remedial classes for needy students of small batches (not regular T/R)
- Demonstration of concepts either by building models or by industry visit
- Experiments in laboratories using non- conventional methods
- Use of ICT – Online videos, online courses
- Use of Google classroom for assignments/Notes
- Conducting Make up class / Bridge courses for needy students
- Publication of paper in conference or journal on Teaching & Learning Process

Module-1: Energy; Source, Conversion and storage (8 hr)

Fuels: Introduction, calorific value, determination calorific value using bomb calorimeter, numerical problems.

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

High energy fuels: Production (water electrolysis), advantages and storage of hydrogen.

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

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

Module-2: Corrosion science and engineering (8 hr)

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 of chromium (hard and decorative). Electroless plating: Introduction, electroless plating of nickel.

Self-learning: Factors affecting the rate of corrosion, Factors influencing the nature of quality electrodeposit (Current density, concentration of metal ion, pH, and temperature).

Module-3: Macromolecules for engineering applications (8 hr)

Polymers: Introduction, methods of polymerization, molecular weight, number average, weight average, numerical problems, synthesis, properties and industrial applications of Chlorinated polyvinylchloride (CPVC) and polystyrene.

Fibers: Introduction, synthesis, properties and industrial applications of Kevlar and Polyester.

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

Composites: Introduction, properties and industrial applications of carbon based reinforced materials and metal matrix polymer composites.

Lubricants: Introduction, classification, properties and application of lubricants.

Self-learning: Biodegradable polymer: Introduction, synthesis, properties and application of

* NOTE: Wherever the contact hours is not sufficient, tutorial hour can be converted to theory hours

poly lactic acid (PLA).

Module-4: Phase rule and Analytical techniques (8 hr)

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 (colorimetric); its application in the estimation of the copper, pH-sensor (Glass electrode); its application in the determination of pH of beverages.

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

Module-5: Materials for mechanical applications (8 hr)

Alloys: Introduction, classification, composition, properties and application 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, electrical, optical 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 application of silicon carbide (carborandum).

PRACTICAL MODULE

A – Demonstration (any two) offline/virtual:

A1. Synthesis of polymer

A2. Quantitative estimation of Aluminium by precipitation method

A3. Synthesis of iron oxide nanoparticles

A4. Estimation of total hardness of water by EDTA method

B – Exercise (compulsorily any 3 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

C – Structured Enquiry (compulsorily any 3 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 method

C4. Estimation of **Sodium present in soil/effluent sample** using flame photometer

D – Open Ended Experiments (any two):

D1. Gravimetric estimation of gypsum in Portland cement

D2. Electroplating of desired metal on substrate

D3. Determination of COD of an industrial effluent sample

D4. Analysis of cement for its components

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1	Identify the terms and processes involved in scientific and engineering applications
CO2	Explain the phenomena of chemistry to describe the methods of engineering processes
CO3	Solve for the problems in chemistry that are pertinent in engineering applications
CO4	Apply the basic concepts of chemistry to explain the chemical properties and processes
CO5	Analyze properties and processes associated with chemical substances in multidisciplinary situations

Semester End Examination(SEE):

SEE will have two component Theory Examination and Practical Examination

Theory Examination;

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**
- The question paper shall be set for 100 marks. The medium of the question paper shall be English). The duration of SEE is 03 hours.

The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks. The students have to answer 5 full questions, selecting one full question from each module. The student has to answer for 100 marks and **marks scored out of 100 shall be proportionally reduced to 30 marks**

- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

Practical Examination;

- SEE marks for the practical course is **100 Marks.**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and **scored marks shall be scaled down to 20 marks** (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 02 or 03 hours

Note:

1. Students have to appear in both theory and practical components of CIE and SEE and score a minimum of 40% of the maximum marks of CIE and a minimum of 35% of the maximum marks of SEE. An average of a minimum 40% of the maximum marks of course (100 marks) to pass the course.
2. Passing is CIE is compulsory to become eligible to appear for SEE
3. In SEE passing both theory and practical examinations is compulsory.
4. If a student fails in any one of the components (Theory/Practical) then he/she has to reappear in the next semester for both components (i.e theory and practical) and pass the both the components.

Course Title:	**Chemistry for EEE Stream**		
Course Code:	**22CHEE12/22**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)**	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Credits	04

Course objectives

- 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.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

- Tutorial & remedial classes for needy students of small batches (not regular T/R)
- Demonstration of concepts either by building models or by industry visit
- Experiments in laboratories using non- conventional methods
- Use of ICT – Online videos, online courses
- Use of Google classroom for assignments/Notes
- Conducting Make up class / Bridge courses for needy students
- Publication of paper in conference or journal on Teaching & Learning Process

MODULE 1: Chemistry of electronic materials (8hr)

Conductors and Insulators: Introduction, principle with examples, semiconductors- production of electronic grade silicon-Czochralski process (CZ) and float zone (FZ) methods.

Polymers: Introduction, Molecular weight - Number average, weight average and numerical problems, Conducting polymers – synthesis and conducting mechanism of polyacetylene. Preparation, properties and commercial applications of graphene oxide.

PCB: Electroless plating – Introduction, Principle of Electroless plating - copper in the manufacture of double-sided PCB.

Self-Study Components: Technological importance of metal finishing and distinction between electroplating and Electroless plating.

MODULE 2: Energy conversion and storage (8hr)

Batteries: Introduction, classification of batteries, components, construction, working and applications of modern batteries: Na-ion battery, solid state battery (Li-polymer battery) and flow battery (Vanadium redox flow battery).

Fuel cells: Introduction, construction, working and applications of methanol–oxygen and polymer electrolyte fuel cell.

Solar energy: Introduction, importance of solar PV cell, construction and working solar PV cell, advantages and disadvantages.

Self-Study Components: Electrodes for electrostatic double layer capacitors, pseudo capacitors, and hybrid capacitor.

MODULE 3: Corrosion science and e-waste management (8hr)

Corrosion chemistry: Introduction, electrochemical theory of corrosion, types-differential metal, differential aeration, corrosion control-galvanization, anodization and sacrificial anode method. Corrosion penetration rate (CPR) - introduction and numerical problem.

E-waste management: Introduction, sources, types of, effects of e-waste on environment and human health, methods of disposal, advantages of recycling, extraction of copper and gold from e-waste.

Self-Study Components: Recycling of PCB and battery components

* NOTE: Wherever the contact hours is not sufficient, tutorial hour can be converted to theory hours

MODULE 4: Nanomaterials and Display systems (8hr)

Nanomaterials: Introduction, size dependent properties of nanomaterials (Surface area, Catalytic, Conducting), preparation of nanomaterials by sol-gel and co-precipitation method with example. Introduction, properties and applications- nanofibers, nanophotonics, nanosensors,

Display systems: Liquid crystals - Introduction, classification, properties and application in Liquid Crystal Displays (LCD's). properties and application in Organic light emitting diodes (OLED's), Quantum Light emitting diodes (QLED's).

Perovskite materials- Introduction, properties and applications in optoelectronic devices

Self-Study Components: Properties and Electrochemical applications of carbon nanotubes and graphene.

MODULE 5: Sensors in Analytical techniques (8hr)

Electrode system: Introduction, types of electrodes, Ion selective electrode – definition, construction, working and applications of glass electrode. Determination of pH using glass electrode. Reference electrode: Introduction, calomel electrode – construction, working and applications of calomel electrode. Concentration cell – Definition, construction and Numerical problems.

Sensors: Introduction, working principle and applications of conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors

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

Self-Study Components: IR and UV- visible spectroscopy.

PRACTICAL MODULE

A – Demonstration (any two) offline/virtual:

A1. Synthesis of polymer.

A2. Quantitative estimation of aluminum by precipitation as basic sulphate.

A3. Synthesis of iron oxide nanoparticles by precipitation method.

A4. Electroplating of copper on metallic objects.

B – Exercise (compulsorily any 3 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

C – Structured Enquiry (compulsorily any 3 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 method

C4. Estimation of **Sodium present in soil/effluent sample** using flame photometer

D – Open Ended Experiments (any two):

D1. Estimation of metal in e-waste by optical sensors.

D2. Electroless plating of Nickle on Copper

D3. Determination of glucose by electrochemical sensors.

D4. Synthesis of polyaniline and its conductivity measurement

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1	Identify the terms and processes involved in scientific and engineering applications
CO2	Explain the phenomena of chemistry to describe the methods of engineering processes
CO3	Solve for the problems in chemistry that are pertinent in engineering applications
CO4	Apply the basic concepts of chemistry to explain the chemical properties and processes
CO5	Analyze properties and processes associated with chemical substances in multidisciplinary situations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation(CIE):

Two Unit Tests each of 20 Marks (duration 01 hour)

- First test after the completion of 30-40 % of the syllabus
- Second test after completion of 80-90% of the syllabus

One Improvement test before the closing of the academic term may be conducted if necessary. However best two tests out of three shall be taken into consideration.

Two assignments each of 10 Marks

The teacher has to plan the assignments and get them completed by the students well before the closing of the term so that marks entry in the examination portal shall be done in time. Formative (Successive) Assessments include Assignments/Quizzes/Seminars/ Course projects/Field surveys/ Case studies/ Hands-on practice (experiments)/Group Discussions/ others. . The Teachers shall choose the types of assignments depending on the requirement of the course and plan to attain the Cos and POs. (to have a less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course). CIE methods /test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

The sum of two tests, two assignments, will be out of 60 marks and will be scaled down to 30 marks

CIE for the practical component of the Integrated Course

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and **scaled down to 15 marks**.
- The laboratory test **(duration 02/03 hours)** at the end of the 14^{th} /15^{th} week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and **scaled down to 05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

Semester End Examination(SEE):

SEE will have two component Theory Examination and Practical Examination

Theory Examination;

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**
- The question paper shall be set for 100 marks. The medium of the question paper shall be English). The duration of SEE is 03 hours.

The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks. The students have to answer 5 full questions, selecting one full question from each module. The student has to answer for 100 marks and **marks scored out of 100 shall be proportionally reduced to 30 marks**

- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

Practical Examination;

- SEE marks for the practical course is **100 Marks.**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
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- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and **scored marks shall be scaled down to 20 marks** (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 02 or 03 hours

Note:

1. Students have to appear in both theory and practical components of CIE and SEE and score a minimum of 40% of the maximum marks of CIE and a minimum of 35% of the maximum marks of SEE. An average of a minimum 40% of the maximum marks of course (100 marks) to pass the course.
2. Passing is CIE is compulsory to become eligible to appear for SEE
3. In SEE passing both theory and practical examinations is compulsory.

If a student fails in any one of the components (Theory/Practical) then he/she has to reappear in the next semester for both components (i.e theory and practical) and pass the both the components.

Mechanical Engineering Stream (Chemistry group)

Course Title:	**Applied Chemistry for MES**		
Course Code:	**22CHEM12/22**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)**	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Credits	04

Course objectives

- 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.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

- Tutorial & remedial classes for needy students of small batches (not regular T/R)
- Demonstration of concepts either by building models or by industry visit
- Experiments in laboratories using non- conventional methods
- Use of ICT – Online videos, online courses
- Use of Google classroom for assignments/Notes
- Conducting Make up class / Bridge courses for needy students
- Publication of paper in conference or journal on Teaching & Learning Process

Module-1: Energy; Source, Conversion and storage (8 hr)

Fuels: Introduction, calorific value, determination calorific value using bomb calorimeter, numerical problems.

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

High energy fuels: Production (water electrolysis), advantages and storage of hydrogen.

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

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

Module-2: Corrosion science and engineering (8 hr)

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 of chromium (hard and decorative). Electroless plating: Introduction, electroless plating of nickel.

Self-learning: Factors affecting the rate of corrosion, Factors influencing the nature of quality electrodeposit (Current density, concentration of metal ion, pH, and temperature)**.**

Module-3: Macromolecules for engineering applications (8 hr)

Polymers: Introduction, methods of polymerization, molecular weight, number average, weight average, numerical problems, synthesis, properties and industrial applications of Chlorinated polyvinylchloride (CPVC) and polystyrene.

Fibers: Introduction, synthesis, properties and industrial applications of Kevlar and Polyester.

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

Composites: Introduction, properties and industrial applications of carbon based reinforced materials and metal matrix polymer composites.

Lubricants: Introduction, classification, properties and application of lubricants.

Self-learning: Biodegradable polymer: Introduction, synthesis, properties and application of

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poly lactic acid (PLA).

Module-4: Phase rule and Analytical techniques (8 hr)

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 (colorimetric); its application in the estimation of the copper, pH-sensor (Glass electrode); its application in the determination of pH of beverages.

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

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Alloys: Introduction, classification, composition, properties and application 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, electrical, optical 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 application of silicon carbide (carborandum).

PRACTICAL MODULE

A – Demonstration (any two) offline/virtual:

A1. Synthesis of polymer

A2. Preparation of urea formaldehyde resin

A3. Synthesis of iron oxide nanoparticles

A4. Determination of acid value of biofuel

B – Exercise (compulsorily any 3 to be conducted):

B1. Conductometric estimation of acid mixture

B2. Potentiometric estimation of FAS using $K_2Cr_2O_7$

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C3. Estimation of iron in TMT bar by diphenyl amine method

C4. Estimation of Sodium present in soil/effluent sample using flame photometry

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 graphene oxide nano particle

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1	Identify the terms and processes involved in scientific and engineering applications
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- The duration of SEE is 02 or 03 hours

Note:

1. Students have to appear in both theory and practical components of CIE and SEE and score a minimum of 40% of the maximum marks of CIE and a minimum of 35% of the maximum marks of SEE. And average of minimum 40% of out of 100 marks to pass the course.
2. Passing is CIE is compulsory to become eligible to appear for SEE
3. In SEE passing both theory and practical examinations is compulsory.
4. If a student fails in any one of the components (Theory/Practical) then he/she has to reappear in next semester for both the components i.e theory and practical and pass the both the components.

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)

1. Engineering Chemistry, Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher (2022) Bengaluru, ISBN 978-93-85155-70-3
2. High Performance Metallic Materials for Cost Sensitive Applications, F. H. Froes, et al. 2010
3. Instrumental Methods of Analysis, Dr. K. R. Mahadik and Dr. L. Sathiyanarayanan.
4. Polymer Science, V R Gowariker, 3rd Edition
5. Engineering Chemistry, P C Jain & Monica Jain, Dhanpat Rai Publication, 2015-16th Edition.
6. Nanostructured materials and nanotechnology, Hari Singh, Nalwa, academic press 2002- 1st Edition.
7. Wiley Engineering Chemistry, Wiley India Pvt. Ltd. New Delhi, 2013- 2nd Edition.
8. Polymer chemistry, by Anil Kumar P V
9. Nanotechnology Principles and Practices, Sulabha K Kulkarni, Capital Publishing Company, 2014-3rd Edition.
10. Principles of nanotechnology, Phanikumar, Scitech publications, 2010-2nd Edition.
11. A Text book of Engineering Chemistry, SS Dara & Dr. SS Umare, S Chand & Company Ltd., 12th Edition, 2011.
12. A Text Book of Engineering Chemistry, R.V. Gadag and Nitthyananda Shetty, I.K. International Publishing house. 2nd Edition, 2016.
13. Chemistry for Engineering Students, B. S. Jai Prakash, R. Venugopal, Sivakumaraiah & Pushpa Iyengar., Subash Publications, Bangalore.5th Edition, 2014
14. Text Book of Polymer Science, F.W. Billmeyer, John Wiley & Sons, 4th Edition, 1999.
15. Corrosion Engineering, M.G. Fontana, N.D. Greene, McGraw Hill Publications, New York, 3rd Edition, 1996.

Course Title:	**Chemistry for CSE**		
Course Code:	**22CHEE12/22**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)*	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Credits	04

Course objectives

- 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.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

- Tutorial & remedial classes for needy students of small batches (not regular T/R)
- Demonstration of concepts either by building models or by industry visit
- Experiments in laboratories using non- conventional methods
- Use of ICT – Online videos, online courses
- Use of Google classroom for assignments/Notes
- Conducting Make up class / Bridge courses for needy students
- Publication of paper in conference or journal on Teaching & Learning Process

MODULE 1: Sensors and energy Systems (8hr)

Sensors: Introduction, working principle and applications of conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Sensors for the measurement of DO. Electrochemical sensors for the pharmaceuticals, surfactants, hydrocarbons, electrochemical gas sensors for SOx, NOx, Disposable sensors in the detection of biomolecules and pesticides.

Energy Systems: Introduction to batteries, Construction, working and applications of Lithium ion and Sodium ion batteries. Quantum dots sensitized solar cells (QDSSC's)- Principle, Properties and Applications

Self -Learning Topics: Type of electrochemical sensors. Gas sensor- O_2 sensor, biosensor- Glucose sensors,

MODULE 2: Materials for memory and display systems (8hr)

Introduction, Basic concepts of electronic memory, History of organic/polymer electronic memory devices, Classification of electronic memory devices, types of organic memory devices (organic molecules, polymeric materials, organic-inorganic hybrid materials), organic superconducting materials.

Photoactive and electroactive materials, Nanomaterials, organic materials used in optoelectronic devices, Organic photovoltaics, alternative organic photovoltaic materials. Composition, Characteristics, working and applications of Liquid Crystal Displays (LCD's), Organic light emitting diodes (OLED's), Quantum Light emitting diodes (QLED's), Light emitting electrochemical cells.

Self -Learning Topics:

Properties and functions of Silicon (Si), Germanium (Ge), Copper (Cu), Aluminum (Al), and Brominated flame retardants in computers

MODULE 3: Corrosion and electrode system (8hr)

*** NOTE: Wherever the contact hours is not sufficient, tutorial hour can be converted to theory hours**

Corrosion chemistry: Introduction, electrochemical theory of corrosion, types-differential metal, differential aeration, corrosion control-galvanization, anodization and sacrificial anode method. Corrosion penetration rate (CPR) - introduction and numerical problem.

Electrode system: Introduction, types of electrodes, Ion selective electrode – definition, construction, working and applications of glass electrode. Determination of pH using glass electrode. Reference electrode: Introduction, calomel electrode – construction, working and applications of calomel electrode. Concentration cell – Definition, construction and Numerical problems.

Analytical techniques: Introduction, principle and instrumentation: Conductometry – estimation of weak acid. Potentiometry – estimation of iron.

Self-Study Components: IR and UV- visible spectroscopy.

MODULE 4: Polymers and Green fuels (8hr)

Polymers: Introduction, Molecular weight - Number average, weight average and numerical problems, Conducting polymers – synthesis and conducting mechanism of polyacetylene and commercial applications. Preparation, properties, and commercial applications of graphene oxide.

Green fuels: Introduction, construction and working of solar photovoltaic cell, advantages, and disadvantages. Generation of energy (green hydrogen) from water electrolysis, advantages, and storage of hydrogen.

Self -Learning Topics: *Regenerative fuel cells*

MODULE 5: E-Waste Management (8hr)

Introduction, sources of e-waste, Composition, Characteristics, and Need of e-waste management. E - waste. Toxic materials used in manufacturing electronic and electrical products, health hazards due to exposure to e-waste, recycling and recovery, different approaches of recycling (separation, Thermal treatments, hydrometallurgical extraction, pyrometallurgical methods, direct recycling). Extraction of gold from E-waste. Role of stake holders in environmental management of e-waste (producers, consumers, recyclers, and statutory bodies).

Self -Learning Topics: Impact of heavy metals on environment and human health.

PRACTICAL MODULE

A – Demonstration (any two) offline/virtual:

A1. Chemical Structure drawing using software: ChemDraw or ACD/ChemSketch

A2. Estimate the amount of copper in e-waste by optical sensors (colorimetry)

A3: Synthesis of Iron-oxide Nanoparticles

A4. Electrolysis of water

B – Exercise (compulsorily any 3 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

C – Structured Enquiry (compulsorily any 3 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 method

C4. Estimation of Sodium present in soil/effluent sample using flame photometer

D– Open Ended Experiments (any two):

D1: Evaluation of acid content in beverages by using pH sensors and simulation.

D2. Construction of photovoltaic cell.

D3. Design an experiment to Identify the presence of proteins in given sample.

D4. Searching suitable PDB file and target for molecular docking

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1	Identify the terms and processes involved in scientific and engineering applications
CO2	Explain the phenomena of chemistry to describe the methods of engineering processes
CO3	Solve for the problems in chemistry that are pertinent in engineering applications
CO4	Apply the basic concepts of chemistry to explain the chemical properties and processes
CO5	Analyze properties and processes associated with chemical substances in multidisciplinary situations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation(CIE):

Two Unit Tests each of 20 Marks (duration 01 hour)

- First test after the completion of 30-40 % of the syllabus
- Second test after completion of 80-90% of the syllabus

One Improvement test before the closing of the academic term may be conducted if necessary. However best two tests out of three shall be taken into consideration.

Two assignments each of 10 Marks

The teacher has to plan the assignments and get them completed by the students well before the closing of the term so that marks entry in the examination portal shall be done in time. Formative (Successive) Assessments include Assignments/Quizzes/Seminars/ Course projects/Field surveys/ Case studies/ Hands-on practice (experiments)/Group Discussions/ others. . The Teachers shall choose the types of assignments depending on the requirement of the course and plan to attain the Cos and POs. (to have a less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course). CIE methods /test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

The sum of two tests, two assignments, will be out of 60 marks and will be scaled down to 30 marks

CIE for the practical component of the Integrated Course

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and **scaled down to 15 marks**.
- The laboratory test **(duration 02/03 hours)** at the end of the 14^{th} /15^{th} week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and **scaled down to 05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

Semester End Examination(SEE):

SEE will have two component Theory Examination and Practical Examination

Theory Examination;

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**
- The question paper shall be set for 100 marks. The medium of the question paper shall be English). The duration of SEE is 03 hours.

The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks. The students have to answer 5 full questions, selecting one full question from each module. The student has to answer for 100 marks and **marks scored out of 100 shall be proportionally reduced to 30 marks**

- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

Practical Examination;

- SEE marks for the practical course is **100 Marks.**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and **scored marks shall be scaled down to 20 marks** (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 02 or 03 hours

Note:

1. Students have to appear in both theory and practical components of CIE and SEE and score a minimum of 40% of the maximum marks of CIE and a minimum of 35% of the maximum marks of SEE. An average of a minimum 40% of the maximum marks of course (100 marks) to pass the course.
2. Passing is CIE is compulsory to become eligible to appear for SEE
3. In SEE passing both theory and practical examinations is compulsory.

If a student fails in any one of the components (Theory/Practical) then he/she has to reappear in the next semester for both components (i.e theory and practical) and pass the both the components.

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)

1. Engineering Chemistry, Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher (2022) Bengaluru, ISBN 978-93-85155-70-3
2. High Performance Metallic Materials for Cost Sensitive Applications, F. H. Froes, et al. 2010
3. Instrumental Methods of Analysis, Dr. K. R. Mahadik and Dr. L. Sathiyanarayanan.
4. Polymer Science, V R Gowariker, 3rd Edition
5. Engineering Chemistry, P C Jain & Monica Jain, Dhanpat Rai Publication, 2015-16th Edition.