

## Civil Engineering and Allied branches (Chemistry group)

<b>Course Title:</b>	<b>Applied Chemistry for Civil Engineering stream</b>		
<b>Course Code:</b>	<b>22CHEC12/22</b>	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S) <sup>1</sup>	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40 hours Theory + 10 to 12 Lab slots	Credits	04
<b>Course objectives</b> <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>			
<b>Teaching-Learning Process</b> These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching–Learning more effective <ul style="list-style-type: none"> <li>• Tutorial &amp; remedial classes for needy students (not regular T/R)</li> <li>• Conducting Makeup classes / Bridge courses for needy students</li> <li>• Demonstration of concepts either by building models or by industry visit</li> <li>• Experiments in laboratories shall be executed in blended mode (conventional or non-conventional methods)</li> <li>• Use of ICT – Online videos, online courses</li> <li>• Use of online platforms for assignments / Notes / Quizzes (Ex. Google classroom)</li> </ul>			
<b>Module-1: Structural Materials (8 hr)</b>			
<b>Metals and Alloys:</b> Introduction, Properties and application of Iron and its alloys, Aluminium and its alloys. <b>Cement:</b> Introduction, composition, properties, classification, manufacturing process of cement, process of setting and hardening of cement, additives for cement and testing of cement. <b>Refractories:</b> Introduction, classification based on chemical composition, properties and application of refractory materials. <b>Glass:</b> Introduction, Composition, Types, Preparation of Soda-lime glass, properties and applications of glass. <b>Self-learning:</b> Chemistry of reinforced concrete from various sources of water (seawater, groundwater, treated water).			
<b>Module-2: Energy Conversion and Storage, Corrosion (8 hr)</b>			
<b>Energy conversion:</b> Introduction, construction, working, and applications of Na-ion cell, methanol-oxygen fuel cell. <b>Storage devices:</b> Introduction, construction and working of Li-ion battery.			

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

**Corrosion:** Introduction, mechanism of electrochemical theory of corrosion by taking iron as an example, types of corrosion-differential metal and differential aeration. Corrosion control: Metal coating-anodic coating- galvanization, Inorganic coating-anodization and Cathodic protection-sacrificial anode and impressed current method. Factors affecting corrosion – Temperature, EMF, pH, relative anode and cathode area, polarization.

**Self-learning:** Corrosion inhibitors.

### **Module-3: Water Technology and Nanotechnology (8 hr)**

**Water technology:** Introduction, sources and nature of impurities of water, hardness of water, types of hardness, determination of temporary, permanent and total hardness, numerical problems, determination of total hardness by EDTA method. Softening of water by Lime-Soda Process, determination of COD, numerical problems.

**Purification of water:** Reverse osmosis and chlorination methods.

**Nanotechnology:** Introduction, properties and engineering application of carbon nanotubes, graphene.

**Self-learning:** Introduction, classification, properties and application of silicon carbide.

### **Module-4: Polymer and Composites (8 hr)**

**Polymers:** Introduction, types of polymerization, free radical mechanism of addition polymerization, techniques of addition polymerization, molecular weight; number average and weight average, numerical problems. Synthesis, properties and industrial applications of polyvinylchloride (PVC) and polystyrene.

**Conducting polymers** – synthesis and conducting mechanism of Polyacetylene

**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.

**Adhesives:** Introduction, synthesis, properties and application of epoxy resin.

**Polymer Composite:** Introduction, properties and applications of fibre reinforced polymer composites.

**Self-learning: Biopolymer:** Introduction, structural properties, and applications of cellulose and lignin, synthesis of polylactic acid and their application.

### **Module-5: 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 (colorimetry); 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.

## **PRACTICAL MODULE**

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

- A1. Synthesis of polyurethane
- A2. Quantitative estimation of Aluminium by precipitation method
- A3. Synthesis of iron oxide nanoparticles
- 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 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. Gravimetric estimation of gypsum in Portland cement  
 D2. Electroplating of desired metal on substrate  
 D3. Estimation of manganese dioxide in pyrolusite  
 D4. Analysis of cement for its components

**Course outcome (Course Skill Set)**

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

<b>C01.</b>	Identify the terms and processes involved in scientific and engineering applications
<b>C02.</b>	Explain the phenomena of chemistry to describe the methods of engineering processes
<b>C03.</b>	Solve for the problems in chemistry that are pertinent in engineering applications
<b>C04.</b>	Apply the basic concepts of chemistry to explain the chemical properties and processes
<b>C05.</b>	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<sup>th</sup>/15<sup>th</sup> 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 for IC**

Theory SEE will be conducted by University as per the scheduled time table, with common question papers for the course (duration 03 hours)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. 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.
3. The students have to answer 5 full questions, selecting one full question from each module.

**The theory portion of the Integrated Course shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).**

#### **Passing standard:**

- The minimum marks to be secured in CIE to appear for SEE shall be 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than 30 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.

### **Suggested Learning Resources:**

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

1. Wiley Engineering Chemistry, Wiley India Pvt. Ltd. New Delhi, 2013- 2<sup>nd</sup> Edition.
2. Engineering Chemistry, Satyaprakash & Manisha Agrawal, Khanna Book Publishing, Delhi
3. A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd.
4. Essentials of Physical Chemistry, Bahl & Tuli, S.Chand Publishing
5. Applied Chemistry, Sunita Rattan, Kataria 5. Engineering Chemistry, Baskar, Wiley
6. Engineering Chemistry – I, D. Grounkrishana, Vikas Publishing
7. A Text book of Engineering Chemistry, SS Dara & Dr. SS Umare, S Chand & Company Ltd., 12<sup>th</sup> Edition, 2011.
8. A Text Book of Engineering Chemistry, R.V. Gadag and Nityananda Shetty, I. K. International Publishing house. 2<sup>nd</sup> Edition, 2016.

9. Text Book of Polymer Science, F.W. Billmeyer, John Wiley & Sons, 4<sup>th</sup> Edition, 1999.
10. Nanotechnology A Chemical Approach to Nanomaterials, G.A. Ozin & A.C. Arsenault, RSC Publishing, 2005.
11. Corrosion Engineering, M. G. Fontana, N. D. Greene, McGraw Hill Publications, New York, 3<sup>rd</sup> Edition, 1996.
12. Linden's Handbook of Batteries, Kirby W. Beard, Fifth Edition, McGraw Hill, 2019.
13. OLED Display Fundamentals and Applications, Takatoshi Tsujimura, Wiley-Blackwell, 2012
14. Supercapacitors: Materials, Systems, and Applications, Max Lu, Francois Beguin, Elzbieta Frackowiak, Wiley-VCH; 1st edition, 2013.
15. "Handbook on Electroplating with Manufacture of Electrochemicals", ASIA PACIFIC BUSINESS PRESS Inc., 2017. Dr. H. Panda,
16. Expanding the Vision of Sensor Materials. National Research Council 1995, Washington, DC: The National Academies Press. doi: 10.17226/4782.
17. Engineering Chemistry, Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher, Bengaluru, ISBN 978-93-85155-70-3, 2022
18. High Performance Metallic Materials for Cost Sensitive Applications, F. H. Froes, et al. John Wiley & Sons, 2010
19. Instrumental Methods of Analysis, Dr. K. R. Mahadik and Dr. L. Sathiyarayanan, NiraliPrakashan, 2020
20. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch Seventh Edition, Cengage Learning, 2020
21. Polymer Science, V R Gowariker, N V Viswanathan, Jayadev, Sreedhar, Newage Int. Publishers, 4th Edition, 2021
22. Engineering Chemistry, P C Jain & Monica Jain, Dhanpat Rai Publication, 2015-16<sup>th</sup> Edition.
23. Nanostructured materials and nanotechnology, Hari Singh, Nalwa, academic press, 1<sup>st</sup> Edition, 2002.
24. Nanotechnology Principles and Practices, Sulabha K Kulkarni, Capital Publishing Company, 3<sup>rd</sup> Edition 2014
25. Principles of nanotechnology, Phanikumar, Scitech publications, 2<sup>nd</sup> Edition, 2010.
26. Chemistry for Engineering Students, B. S. Jai Prakash, R. Venugopal, Sivakumaraiah & Pushpa Iyengar., Subash Publications, 5<sup>th</sup> Edition, 2014
27. "Engineering Chemistry", O. G. Palanna, Tata McGraw Hill Education Pvt. Ltd. New Delhi, Fourth Reprint, 2015.
28. Chemistry of Engineering materials, Malini S, K S Anantha Raju, CBS publishers Pvt Ltd.,
29. Laboratory Manual Engg. Chemistry, Anupma Rajput, Dhanpat Rai & Co.

**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=PLyhmwFtznRhuz8L1bb3X-9IbHrDMjHWWH>
- <https://www.youtube.com/watch?v=j5Hml6KN4TI>
- <https://www.youtube.com/watch?v=X9GHBdyYcyo>
- <https://www.youtube.com/watch?v=1xWBPZnEjk8>
- <https://www.youtube.com/watch?v=wRAo-M8xBHM>

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- <https://www.vlab.co.in/broad-area-chemical-sciences>
- <https://demonstrations.wolfram.com/topics.php>
- <https://interestingengineering.com/science>

**COs and POs Mapping (Individual teacher has to fill up)**

PO												
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
C01	3	1	1				1					
C02	3	1	1				1					
C03	3	1	1				1					
C04	3	1	1				1					
C05	3	1	1				1					