Mechanical Engineering and Allied branches
(Chemistry group)

Course Title:	Applied Chemistry for Mechanical Engineering stream		
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)[1]	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40 hours Theory + 10 to12 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 (not regular T/R)
- Conducting Makeup classes / Bridge courses for needy students
- Demonstration of concepts either by building models or by industry visit
- Experiments in laboratories shall be executed in blended mode (conventional or non–conventional methods)
- Use of ICT – Online videos, online courses
- Use of online platforms for assignments / Notes / Quizzes (Ex. Google classroom)

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

Fuels: Introduction, calorific value, determination of calorific value using bomb calorimeter, numerical problems on GCV and NCV.

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 Li-ion, Na-ion,Li-MnO_2 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)

Corrosion: Introduction, electrochemical theory of corrosion, types of corrosion-differential metal and differential aeration stress corrosion. Factors affecting corrosion (EMF, Temperature, pH, relative area of anode and cathode and polarization).

Corrosion control: Corrosion control – Metal coating-anodic coating- galvanization, Inorganic coating-anodization and Cathodic protection-sacrificial anode and impressed current method. Corrosion testing by weight loss method.

Metal finishing: Introduction, technological importance. Electroplating: Definition,

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

Electroplating of chromium. Electroless plating: Definition,electroless plating of nickel.
Self-learning: Electroless plating of copper in the manufacture of PCB.

Module-3: Macromolecules for Engineering Applications (8 hr)

Polymers: Introduction, types of polymerization (Addition and Condensation).Free radical mechanism of addition polymerization by ethylene. 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.

Polymer composites: Introduction, properties and applications of fiber reinforced polymers composites (FRPC).

Self-learning: Biodegradable polymer: Introduction, synthesis, properties and applications of polylactic acid (PLA), introduction, classification, properties and application of lubricants.

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, Conductometric Sensors; Coductometric Titration of strong acid versus strong base, 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.

Module-5: 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 and numerical problems. Determination of total hardness by EDTA method. Softening of water by Lime-Soda Process, determination ofCOD, numerical problems.

Purification of water: Reverse osmosis and chlorination methods.

Nanotechnology: Introduction,properties and engg.applications of carbon nanotubes, graphene.

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

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

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 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 14th /15th 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- 2nd 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. Grour Krishana, Vikas Publishing
7. A Text book of Engineering Chemistry, SS Dara & Dr. SS Umare, S Chand & Company Ltd., 12th

Edition, 2011.
8. A Text Book of Engineering Chemistry, R.V. Gadag and Nityananda Shetty, I. K. International Publishing house. 2nd Edition, 2016.
9. Text Book of Polymer Science, F.W. Billmeyer, John Wiley & Sons, 4th 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, 3rd 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. Sathiyanarayanan, Nirali Prakashan, 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, 2015-16th Edition.
23. Nanostructured materials and nanotechnology, Hari Singh, Nalwa, academic press, 1st Edition, 2002.
24. Nanotechnology Principles and Practices, Sulabha K Kulkarni, Capital Publishing Company, 3rd Edition 2014
25. Principles of nanotechnology, Phanikumar, Scitech publications, 2nd Edition, 2010.
26. Chemistry for Engineering Students, B. S. Jai Prakash, R. Venugopal, Sivakumaraiah & Pushpa Iyengar., Subash Publications, 5th 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											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1				1					
CO2	3	1	1				1					
CO3	3	1	1				1					
CO4	3	1	1				1					
CO5	3	1	1				1					