Course Title:	**Chemistry for Mechanical Engineering stream**	Semester	I/II
Course Code:	**BCHEM102/202**	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
Total Hours of Pedagogy	40 hours Theory+10to12 Lab slots	Credits	04

Course Learning Objectives

CLO1. To enable students to acquire knowledge on principles of chemistry for engineering applications.

CLO2. To develop an intuitive understanding of chemistry by emphasizing the related branches of Engineering.

CLO3. To provide students with a solid foundation in analytical reasoning required to solve societal Problems.

Teaching-Learning Process

1. Tutorial & remedial classes for needy students(not regular T/R)
2. Conducting Make up classes/Bridge courses for needy students
3. Demonstration of concept either by building models or by industry visit
4. Experiments in laboratories shall be executed in blended mode(conventional or non–conventional methods)
5. Use of ICT–Online videos, online courses
6. Use of online platforms for assignments/Notes/Quizzes(Ex. Google classroom)

Module-1: Fuels (8hours)

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

Fuels: Introduction, Definition, Classification of Fuels, calorific value, Types of Calorific value, determination of calorific value using bomb calorimeter, numerical problems on GCV and NCV, Proximate Analysis and Ultimate Analysis. Cracking- Definition, Reforming-Definition, Process, Knocking and its mechanism, Cetane Number, Octane Number, Anti knocking agents-Leaded Petrol and Unleaded Petrol, Diesel Knocking, Construction and working of catalytic converter.
Green fuels: Introduction, Power alcohol, synthesis and applications of biodiesel.
High energy fuels: Production of hydrogen (water electrolysis), advantages of hydrogen as fuel.

Applications: Fuels - Automobiles, Green fuels - environmentally friendly energy, cost-effective and offer significant long-term economic benefits, Fuel cells-Aircrafts.
(RBTLevels:L1,L2andL3)

Module-2: Corrosion Science and Metal Finishing (8hours)

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

Corrosion: Introduction, electrochemical theory of corrosion, types of corrosion-differential metal, differential aeration (waterline and pitting), stress corrosion (caustic embrittlement).
Corrosion control: Metal coating-galvanization, surface conversion coating-anodization and cathodic protection-sacrificial anode method. Corrosion testing by weight loss method, Corrosion penetration rate (CPR)-numerical problems.
Metal finishing: Introduction, technological importance, electroplating of chromium (hard and decorative). Electroless plating: Introduction, electroless plating of nickel.

Applications: Understanding corrosion control methods and mitigate damage from corrosion
(RBTLevels:L1,L2andL3)

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

Self-study: Biodegradable polymer: Introduction, synthesis, properties and application of Poly Lactic acid (PLA).

Polymers: Introduction, methods of polymerization (Condensation and Free radical), molecular weight; number average and weight average, numerical problems. Synthesis, properties and industrial applications of polyvinylchloride (PVC) 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 to composites**,** properties and industrial applications of carbon –based reinforced composites (grapheme/carbon nano-tubes as fillers), Properties and industrial applications of metal matrix polymer composites.
Lubricants:Introduction, classification- Liquid, solid and synthetic lubricants, properties and applications of lubricants

Applications: Aerospace, Automotive and Biomedical
(RBTLevels:L1,L2andL3)

Module-4: Phase Rule, Energy devices and Analytical Techniques (8hours)

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

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

Energy devices: Introduction, construction, working, and applications of Photovoltaic cells, Li-ion battery

Fuel cells: Introduction, working with reactions and applications of Methanol-oxygen Fuel cell

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, Numerical on Beer-Lambert's law.

Applications: Fuel cells- Aircrafts, Analytical techniques – Identify the adulterants, soil tests, medical tests

(RBTLevels:L1,L2andL3)

Module-5: Materials for engineering applications (8hours)

Self-study: Abrasives: Introduction, Classification, Properties and Applications of silicon carbide (Carborundum)

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.

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

Applications: Aerospace (Heat shields, Turbine blades), Biomedical, Nanoscale additives in polymer composite materials (Baseball bats, tennis rackets, motorcycle helmets, automobile parts), and water treatment.

(RBTLevels:L1,L2andL3)

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(compulsorilyany 4 to be conducted):

C1.Estimationof Copper present in electroplating effluent by optical sensor(Colorimetry)

C2.Determinationof Viscosity coefficient of lubricant(Ostwald'sviscometer)

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(anytwo):

D1. Estimation of percentage of iron in steel

D2. Electroplating of desired metal on substrate

D3 . Synthesis of biodiesel

D4. Synthesis of Aluminium Oxide nanoparticle

Course outcome

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

1. Classify Engineering materials and apply its knowledge to select suitable materials for specific application.

2. Explain the phenomena of chemistry to describe the methods of engineering processes

3. Solve the problems in chemistry that are pertinent in engineering applications

4. Apply the basic concepts of chemistry to explain the chemical properties and processes

5.Analyze properties and multi processes associated with chemical substances in disciplinary situations

Course Assessmentand Evaluation Details (bothCIE andSEE)

Continuous Internal Evaluation: 50 marks		
Theory Assessment Tool	**Marks**	**Reduced marks**
IAT-1	25	15
IAT-2	25	
Assessment -1(activity based)	25	10
Assessment -2(activity based)	25	
Lab Assessment Tool	**Marks**	**Reduced marks**
Conducting Experiment and Laboratory Record(10 labs)	15(each lab)	15
Lab Test	10	10
Semester End Examination (SEE) : 50 marks		
SEE	**Marks**	**Reduced marks**
Course end examination (Answer any one question from each unit – Internal choice)	100	50

Activity Based Learning/ Practical Based learning

Suggested activities are:

1. Construction of Bomb calorimeter model and demonstration of calorific value determination.
2. Construction and working of Zn-Air Battery.
3. Determination of Molecular weight of the polymer by viscosity method
4. Manufacturing of epoxy based polymer composites using natural fiber
5. Synthesis of ZnO nano particles by precipitation method
6. Estimation of Total Dissolved Solids of water using Conductometric sensor.
7. Estimation of λmax and Molar absorption Coefficient (ε)
8. Identifying the possibilities of various types of alkalinities in a given water sample.
9. Electroless plating of Nickel on a substrate.
10. Boiler troubles: Causes and remedial actions

Suggested Learning Resources:

Text Books:

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, DhanpatRai & Co.(P)Ltd.

4.Engineering Chemistry, Baskar, Wiley

5.A Text Book of Engineering Chemistry, R.V.Gadag and Nityananda Shetty,I.K.International Publishing house. 2nd Edition, 2016. Instrumental Methods of Analysis, Dr. K .R. Mahadik and Dr. L. Sathiyanarayanan, Nirali Prakashan,2020

6.Engineering Chemistry, Edited by Dr. Mahesh B and Dr. Roopashree B, Sunstar Publisher, Bengaluru, ISBN97 8-93-85155-70-3, 2022

7.Chemistry for Engineering Students, B.S. JaiPrakash, R.Venugopal, Sivakumaraiah & Pushpa Iyengar., Subash Publications, 5th Edition, 2014

8."Engineering Chemistry",O.G.Palanna, Tata McGraw Hill Education Pvt. Ltd. NewDelhi, Fourth Reprint, 15.

Reference Books:

1.Principles of Instrumental Analysis, Douglas A. Skoog, F.James Holler, Stanley R. Crouch Seventh Edition, Cengage Learning, 2020

2.Polymer Science, VR Gowariker, NV Viswanathan, Jayadev, Sreedhar, NewageInt.Publishers,4th Edition, 2021

3. Engineering Chemistry, PC Jain & Monica Jain, Dhanpat Rai Publication, 2015-16th Edition.

4.Nano structured materials and nanotechnology, Hari Singh, Nalwa, academic press, 1stEdition,2002.

5. Nanotechnology Principles and Practices, Sulabha K Kulkarni, Capital Publishing Company, 3rd Edition 2014 25. Principles of nanotechnology, Phanikumar, Scitech publications,2nd Edition,2010.

6.Nanotechnology A Chemical Approach to Nanomaterials, G.A.Ozin & A.C.Arsenault, RSC Publishing, 2005 .

7.Corrosion Engineering, M.G.Fontana, N.D.Greene, McGrawHill Publications, NewYork,3rd Edition,1996. Corrosion Engineering, M.G. Fontana, N.D. Greene, McGraw Hill Publications, New York, 3rd Edition, 1996.

8. Linden's Handbook of Batteries, Kirby W. Beard, Fifth Edition, McGrawHill, 2019.

9.High Performance Metallic Materials for Cost Sensitive Applications, F.H. Froes, et al. JohnWiley & Sons, 2010

10.Instrumental Methods of Analysis, Dr. K. R. Mahadik and Dr. L. Sathiyanarayanan, Nirali Prakashan,2020

11. Chemistry of Engineering materials, MaliniS, KSAnanthaRaju, CBS publishers Pvt Ltd.,

12. Laboratory Manual Engg. Chemistry, Anupma Rajput, Dhanpat Rai & Co.

13. Engineering materials, MaliniS, KSAnanthaRaju, CBS publishers Pvt Ltd., Laboratory Manual Engg.Chemistry, Anupma Rajput, DhanpatRai& Co.

Weblinks 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

Cos and POs Mapping (CO-PO mapping are only Indicative)

COs and POs Mapping (CO – PO mappings are only Indicative)												
	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					

Level3- HighlyMapped, Level 2-ModeratelyMapped, Level1-LowMapped, Level0-NotMapped