K. S. INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU, Approved by AICTE

Department of Chemistry

FIRST/SECOND SEMESTER SYLLABUS

Name of the Course: **Applied Chemistry for ME stream** (Applied Chemistry for Advanced Metal Protection and Sustainable Energy Systems)		Semester	I/II
Course Code	**25BCHME 102/202**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- Develop understanding of corrosion science by linking with engineering branches.
- Apply chemistry knowledge to solve engineering-related chemical problems efficiently.
- Develop analytical skills; understand phase diagrams industrial and societal importance.
- Provide solid nanotechnology foundation to address and solve societal problems.

Teaching-Learning Process Pedagogy

These are sample Strategies; teachers can use to accelerate the attainment of the various course outcomes.

- 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
- Laboratory experiments using blended conventional and non-conventional methods.
- Use of ICT – Online videos, online courses
- Use of online platforms for assignments / Notes / Quizzes (Ex. Google classroom)

Module-1: **Corrosion Science and Coating Technologies**

Corrosion: Introduction, electrochemical theory of corrosion, factors affecting corrosion (Nature of the metal, Surface area, Cathode/Anode Area Ratio, Temperature), types of corrosion-differential metal and differential aeration corrosion, corrosion control-metal coating; galvanization, surface conversion coating; anodization and cathodic protection; sacrificial anode method.

Coating Technologies: Introduction, technological importance, electroplating - electroplating of chromium; hard and decorative, electro-less plating - electroless plating of Nickel, electroless plating of copper, difference between electroplating and electro less plating. **(8 hours)**

Text-1: Ch-3- pp 47-57**, Text-2:** Ch- 2, pp 62-73.

Module-2: Sustainable Green Fuels
Fuels: Introduction, calorific value, determination of calorific value using bomb calorimeter, numerical problems on GCV and NCV. Knocking in internal combustion engines - knocking mechanism and working principle of anti-knocking agents, and importance of octane and cetane rating of fuel. **Green Fuels**: Introduction, power alcohol – properties, applications and its limitations, biodiesel-synthesis by trans-esterification method, advantages and its applications. Production of green hydrogen by photo catalytic water splitting and its advantages, hydrogen storage – introduction, advantages and limitations of metal hydride and ammonia as chemical hydrogen carriers. **(8 hours)** **Text-3:** Ch-5, pp 109-129**, Text-2:** Ch-3, pp 89-90
Module-3: Materials for Energy Systems
Nanomaterials: Introduction, synthesis of TiO_2 nanoparticles by sol-gel method for catalytic converter applications, size-dependent properties of nanomaterial-surface area, catalytical, electrical and thermal conductivity. Graphene - Synthesis by chemical vapor deposition method, properties and engineering applications, role of carbon nanotubes (CNTs) in energy devices. **Energy Systems:** Batteries - Introduction, classification of batteries, characteristics-capacity, power density, cell balancing and cycle life, construction, working and applications of Li-ion battery, iron-based (iron-air or iron-flow) battery for EV applications. Fuel cells - Introduction, construction and working of solid oxide fuel (SOFCs) for auxiliary power units (APUs) applications, difference between fuel cell and battery, photovoltaic cells (PV cells) - construction, working, advantages and limitations. **(8 Hours)** **Text-2:** Ch- 5, pp 191-202**, Text-2:** Ch- 3, pp 104-110**, Text.5:** Ch-6, pp 149-161.
Module-4: Materials for Engineering Applications
Engineering Polymers: Introduction, molecular weight of polymers - numerical problems, synthesis, properties and engineering applications of polyvinyl chloride (PVC), and polymethyl methacrylate (PMMA), structure and property relationship of polymers. Glass transition temperature (Tg), factor affecting Tg and its significance. **Polymer Composites:** Introduction, fiber-reinforced polymers (FRPs); Kevlar – Synthesis, properties and industrial applications. Carbon-fiber - Preparation from Polyacrylonitrile (PAN), properties and industrial applications. **3D Printing materials:** Introduction, synthesis, properties and applications of polylactic acid (PLA) resin. **(8 Hours)** **Text-4:** Ch-4, pp 95-110, **Text-5:** Ch-7, pp 162-191.
Module-5: Fluid Technology and Smart Sensors
Lubricants: Introduction, classification, ideal properties and applications. Lubricant testing;

experimental determination of viscosity.

Industrial Coolants: Introduction, types-water and oil-based coolants, properties and industrial applications.

Industrial effluents: Introduction, determination of COD and numerical problems.

Sensors: Introduction, potentiometric sensor - principle and its application in the estimation of iron in steel industry effluent, conductometric sensor - principle and its application in the estimation of acids in electrochemical bath effluent. Mechanical sensor - Piezoelectric Sensor and its application in ground water monitoring, pH sensor - principle and its application in the estimation of pKa of acid electrolyte.

(8 Hours)

Text-2: Ch-5, pp 161-167**, Text-5:** Ch-8, pp 260-262.

List of Laboratory experiments (2 hours/week per batch/ batch strength 20) 10 lab sessions + 1 repetition class + 1 Lab Assessment.

Practical Module

1. Estimation of total hardness of water by EDTA method
2. Determination of chemical oxygen demand (COD) of industrial wastewater
3. Estimation of iron in steel industry effluent by diphenyl amine indicator method
4. Determination of alkalinity of water using standard NaOH solution
5. Estimation of acid mixture in electrochemical bath effluent using conductometric sensor (Conductometry)
6. Estimation of iron in rust sample by Potentiometric sensor (Potentiometry)
7. Determination of pKa of acid electrolyte using pH sensor (Glass electrode)
8. Estimation of copper present in e-waste by optical sensor (Colorimetry)
9. Determination of viscosity coefficient of lubricant using Ostwald's viscometer
10. Determination of acid value of biofuel
11. Green synthesis of copper nanoparticles for conductive inks
12. Synthesis of polylactic acid (PLA)

Course Outcome:

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

CO1: Apply the knowledge of control of corrosion and coating techniques

CO2: Apply basic knowledge of green fuel synthesis and commercial applications.

CO3: Apply the basic concepts of nano materials and its applications in various fields

CO4: Apply basic knowledge of concept of Engineering materials and its industrial applications.

CO5: Apply the knowledge of fluid technology and smart sensors in various applications.

Assessment Details (both CIE and SEE)

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

CIE for the theory component of the IC:

- There are 25 marks for the CIE for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 35-40% of the coverage of the syllabus, second test will be administered after 65-70%, and the third test will be administered after 90-100% of the coverage of the syllabus. The average of the three tests shall be scaled down to 15 marks.
- Two assignments (average is scaled down to 10 marks)/mini project/Quiz/Seminar are conducted for 10 marks.
- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 30 marks**, i.e., **12 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 20 marks**, i.e., **08 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE for the Lab component of the IC*:*

Every experiment in the laboratory will be evaluated for **15** marks for conducting the experiment and of the laboratory record. Another **10** marks shall be for the test conducted at the end of the semester.

Semester End Examination (SEE):

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 50 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

Suggested Learning Resources

Books

- **Text 1:** VTU Engineering chemistry, V.R. Kulkarni, K. Ramakrishna Reddy, New Age International publishers, First Edition, 2016.
- **Text 2:** Engineering Chemistry Dr.C.Muthukumar, Dr.Manjunatha D.H, Dr.Gurushantha K, Himalaya publishing House, Second Revision Edition,2018.
- **Text 3:** Engineering Chemistry Dr.R.V Gadag,Dr.A.Nityananda Shetty,MEDTECH A division of scientific International, First Edition,2019
- **Text 4:** Applied Chemistry, Padmavathy N,Dr.Hemakumar K.H.Dr.Preeta S ,sunstar publications, First Edition,2024.
- **Text 5:** Chemistry for Engineering students Dr.B.S.Jaiprakash, Prof. R Venugopal, Dr.Shivakumaraiah, Dr.Pushpa Iyengar, Subhas stores, 2014.

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-
- https://www.youtube.com/watch?v=X9GHBdyYcyo
- https://www.youtube.com/watch?v=1xWBPZnEJk8
- https://www.youtube.com/watch?v=wRAo-M8xBHM
- https://www.vlab.co.in/broad-area-chemical-sciences

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar
- Activity based learning
- Virtual Labs