K. S. INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU, Approved by AICTE

Department of Chemistry

FIRST / SECOND SEMESTER SYLLABUS – 2025 scheme

Name of the Course: Applied Chemistry for ECE stream (Applied Chemistry for Emerging Electronics and Futuristic Devices)		Semester	I / II
Course Code	**25BCHEC102/202**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy (Theory and Lab hours)	60	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- Enable students to learn energy conversion and storage applications.
- Provide foundation in nanotechnology, quantum dots for societal problem-solving.
- Understand polymer applications as plastics, develop environmentally friendly alternatives.
- Impart chemistry knowledge in electrochemistry, corrosion, and effective control.
- Develop intuitive understanding of corrosion science across engineering disciplines.

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 executed in blended conventional–nonconventional modes.
- Use of ICT – Online videos, online courses
- Use of online platforms for assignments / Notes / Quizzes (Ex. Google classroom)

Module-1: Materials for Energy Devices

Semiconductors: Introduction, n-type and p-type semiconductor materials, difference between organic and inorganic semiconductors, organic photovoltaics - Poly (3-hexylthiophene) (P3HT) as a donor and Phenyl-C61-butyric acid methyl ester (PCBM) as a acceptor, construction, working and applications.

Energy Storage Devices: Introduction, classification of batteries-primary, secondary and reserve battery, characteristics (capacity, power density, cell balancing & cycle life), construction and working of lithium-ion battery advantages in EV applications, construction and working of ultra-small asymmetric super capacitor and its applications in IoT/wearable devices. Fe based batteries: Fe air or Fe flow batteries.

Energy Conversion Devices: Introduction, construction, working principal, advantages and applications of photovoltaic cell of (PV cell), Introduction to MEMS-Based Energy Harvesters, working principle and applications. **(8 hours)**

Text 1: Ch-6, pp 148-161, Ch-2, pp 37-48, **Text 3:** Ch-1.3, pp 23-38.

Module-2: Nano and Quantum Dot Materials

Nanomaterials: Introduction, size dependent properties of nanomaterials -Surface area, Catalytic and electrical, synthesis of TiO_2 nanoparticles by sol-gel method for sensor applications.

Quantum Dot Materials: Introduction, types, optical and electronic properties of quantum dots (QDs).

Inorganic Quantum Dot Materials (IQDMs): Introduction, synthesis and properties of silicon based QDs by Sol-Gel method and CdSe Quantum Dots by hot injection method and applications in optoelectronic devices, Quantum Dot-based copper conductive ink by wet chemical reduction method, properties and applications.

Organic Quantum Dot Materials (OQDMs): Introduction, synthesis and properties of chitosan-carbon quantum dots hydrogel applications in next-generation flexible and wearable electronics, synthesis and properties of Graphene Quantum Dots using citric acid method its applications in emerging electronics.

(8 hours)

Text 1: Ch-9, pp 251- 276.

Module-3: Functional Polymers and Hybrid Composites in Flexible Electronics

Stretchable and Wearable Microelectronics: Introduction, basic principle and working of Lithography for micro-patterned copper deposition, synthesis, properties and applications of PDMS (Polydimethylsiloxane) in e-skin (electronic skin) applications.

Polymers: Introduction, Synthesis, conduction mechanism polyaniline and electronic devices applications, Number average molecular weight and weight average and numerical. Synthesis, structure–property relationship (Solubility, Glass Transition Temperature (T_g), thermal Stability, Tensile Strength) of Polydimethylsiloxane (PDMS) in RFID (Radio Frequency Identification) applications, and Polyvinylidene Fluoride (PVDF) applications in E-nose devices.

Polymer Composites: Introduction, synthesis and properties of epoxy resin- Fe_3O_4 composite for sensors applications, synthesis of Kevlar Fiber Reinforced Polymer (KFRP)-properties and smart electronic devices applications. **(8 hours)**

Text 1: Ch-7, pp161- 210.

Module-4: Electrode System and Electrochemical Sensors

Electrode System: Introduction, types of electrodes, Nernst equation (Preview), reference electrode, construction, working and applications of calomel electrode, Ion selective electrode- definition, construction, working of glass electrode, determination of pH using glass electrode, construction and working of concentration cell and numericals.

Sensing Methods: Introduction, principle and instrumentation of colorimetric sensors; its application in the estimation of copper in PCBs, principle and instrumentation of potentiometric sensors; applications in the estimation of iron in steel, conductometric sensors; its application in the estimation of acid mixture in sample. **(8 hours)**

Text 1: Ch-1, pp 1-36, **Text 2:** Ch-9, pp 190-213.

Module-5: Corrosion Science and E-waste Management

Corrosion Chemistry: Introduction, electrochemical theory of corrosion, types of corrosion differential metal corrosion in electronic circuits and differential aeration corrosion, corrosion control-galvanization and anodization, cathodic protection and impressed current method, Factors affecting the rate of corrosion (Nature of the metal, Surface area, Cathode/Anode Area Ratio, Temperature).

Metal Finishing: Introduction, difference between electroplating & electroless plating, electroplating of chromium for hard and decorative coatings, electroless plating of copper on PCBs.

E-waste: Introduction, need of e-waste management, sources & effects of e-waste on environment and human health, extraction of gold from e-waste from bioleaching method. **(8 hours)**

Text 1: Ch-3, pp 63-86, Ch-3, pp- 91-113, **Text 4:** Ch-2, pp 23–59.

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 effluent sample.
3. Estimation of iron in TMT bar by diphenyl amine indicator method.
4. Determination of alkalinity of given boiler water sample.
5. Green precipitation synthesis of copper nanoparticles for conductive ink applications.
6. Estimation of acid mixture by conductometric sensor (Conductometry)
7. Estimation of iron in rust sample by Potentiometric sensor (Potentiometry)
8. Determination of pKa of vinegar using pH sensor (Glass electrode)
9. Estimation of copper present in e-waste by optical sensor (Colorimetry).
10. Smartphone-Based colorimetric estimation of total phenolic content in coffee products.
11. Data analysis of pk_a of a week acid and its interpretation using origin software.
12. Chemical structure drawing using software: Chem Draw/ Chem Sketch.

Course Outcome

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

CO1: Apply knowledge of semiconductor properties, classification, and energy devices.

CO2: Apply knowledge of nanomaterials, quantum dots, synthesis, properties, and applications.

CO3: Apply the role of functional polymers and composites in flexible electronic applications.

CO4: Apply electrochemical concepts to sensors, corrosion control, and e-waste management.

CO5: Apply the knowledge of corrosion and its control, coating techniques & E-waste management.

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

1. **Text 1:** Chemistry for Engineering Students by Dr B S Jai Prakash, Prof R Venugopal, Dr Shivakumaraiah.
2. **Text 2:** A Textbook of Engineering Chemistry, R.V. Gadag and Nityananda Shetty, Medtech, 1st Edition, 2019.
3. **Text 3:** Engineering Chemistry: Dr.Muthukumar, Dr.Manjunatha D.H, Dr.Gurushantha K, Himalaya Publishing House, 2nd revised Edition ,2018.
4. **Text 4:** E-Waste Management: From Waste to Resource - R. K. Singh & R. K. Tiwari, Routledge, 1st Edition, 2012.

Reference books / Manuals:

1. Electrochemical Energy System: Dr. K. K. Rajeshwar (IIT Madras), Publisher: IIT Madras Open Courseware (Free PDF & videos), ISBN: N/A (Open Educational Resource).
2. Advances in corrosion science and technology, M.G. Fontana, R.W. Staettle, Springer publications, 2012, ISBN: 9781461590620.
3. Engineering Chemistry: Jain & Jain, Publisher: Dhanpat Rai Publishing Company, ISBN: 978-9353161181.
4. Smart materials, Harvey, James A. Handbook of materials selection, 2002, John Wiley & Sons Canada, Limited, ISBN: 9780471359241.
5. Energy storage and conversion devices; Supercapacitors, batteries and hydroelectric Cells Editor: Anurag Gaur, 2021, CRC Press, ISBN: 9781000470512.
6. Engineering Chemistry, Suba Ramesh, Vairam, Ananda Murthy, 2011, Wiley India, ISBN: 9788126519880.
7. Engineering chemistry, Shubha Ramesh et.al., Wiley India, 1st Edition, 2011, ISBN: 9788126519880.

Web links and Video Lectures (e-Resources):

1. https://youtu.be/HT21wrGl6oM
2. https://youtu.be/aG2F-fd2drM
3. https://youtu.be/ivWXuOd5SrI
4. https://www.youtube.com/watch?v=BGdCj3-PEoE
5. https://www.youtube.com/watch?v=xvtOPHsukzE
6. https://www.youtube.com/watch?v=VxMM4g2Sk8U
7. https://www.youtube.com/watch?v=0bjRNq1PKak
8. https://youtu.be/XIjDw5Sw9c4
9. https://youtu.be/lB2zbQvnwXw
10. https://youtu.be/FNohb7ZKxMI
11. https://www.youtube.com/watch?v=Y-nZbZzBOPg
12. https://en.wikipedia.org/wiki/Graphene_quantum_dot
13. https://youtu.be/NCOwWEMEQN8
14. https://youtu.be/u_2YRTmOTWQ
15. https://youtu.be/ygtbo5KDXeI
16. https://youtu.be/whyIdJab1kM
17. https://youtu.be/3TYH-8pPDV4
18. https://youtu.be/xS60SGWSw4s
19. https://youtu.be/zJTQLce-WC8
20. https://www.youtube.com/watch?v=dmZtRntO1QI
21. https://www.youtube.com/watch?v=Kbta_BXZ4Vs&t=73s

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
- Quizzes
- Assignments
- Seminar