DEPARTMENT OF CHEMISTRY

Lesson Plan

Year: **2024-2025**	Semester: **II**
Course Title: CHEMISTRY OF FUNCTIONAL MATERIALS	Course Code: **CM221IB**
Total Contact Hours: 45L + 30 P	CIE Marks: 100
Credits: L: T:P: 3:0:1	SEE Marks: 100
Academic Year: 2024-25	Duration of SEE: 3 h
Lesson Plan: **Dr. Swetha S M**	Date: 27.03.2025

Course Learning Objectives:
Graduates shall be able to:

1. Learn to apply the knowledge of behavior of materials that play a vital role in selection of materials and design of products in Engineering.
2. Describe the basic concepts of chemistry behind the development of futuristic functional and smart materials for various applications in Engineering and technology.
3. Explain the Chemistry and processes involved in development of alternate and sustainable energy materials.
4. Understand the importance of renewable resources and aim at solutions for sustenance of life.
5. Motivate to gain the knowledge of analytical techniques involved in the analysis of e-waste and other environmental parameters.

Course Outcomes: After completing the course, the students will be able to:-	
CO 1	Identify the materials, conventional & non-conventional energy systems for engineering applications.
CO 2	Investigate chemical properties of materials for various technological applications.
CO 3	Apply the knowledge of material property and energy to analyze environmental issues.
CO 4	Develop solutions in the areas of applied materials and energy systems for sustainable engineering application.

Week-Days	Unit Topics	Sub Topics	BTL	COs	Mode of teaching
1-1	Unit -1	Introduction to course (Chemistry of functional materials) along with lab	1,2	1,2	White board offline
1-2		Battery: Introduction, types, characteristics of a advanced battery	1,2	1,2	Offline/PPT/White Board
1-3		Components/materials, construction, working and applications of Lithium cobalt oxide battery along with advantages and limitations	2,3	2,3	PPT/white board with Real life example
1-4		Construction and working of Metal air batteries along with their advantages and limitations.	2,3	2,3	PPT/White Board
2-5		Super-capacitors: Introduction, types (EDLC,pseudocapacitors, hybrid capacitors), with examples.	1,2, 3	1,2	Offline/PPT/White Board, Flip class room
2-6		Construction and working mechanism of EDLC, pseudo capacitors, hybrid capacitors along with applications.	3,4	3,4	PPT/White Board/real life example
2-7		Energy conversion devices: Introduction, characteristics, materials, working and applications of H_2-O_2 fuel cells.	1,2, 3	1,2	PPT/White Board
2-8		Solar energy: Amorphous Silicon solar cells construction and working	1,2, 3	1,2	Offline/PPT along with real life example
3-9		Construction and working of Quantum dot sensitized solar cells.	3,4	3,4	PPT, white board, Real time examples. along using AI tool Quizalize (zzi.sh/dfe43260)
3-10		Materials used in solar energy conversion	4,5		Self-learning/online learning
3-11	Un it - 2	Introduction to nanomaterials -Classification	1,2	1,2	PPT, white board
3-12		Size dependent properties of nanomaterials- Surface area, optical and catalytic properties. Synthesis of nanomaterials- Combustion and numerical problems,	2,3	1,2	Offline (PPT, white board)
4-13		Sol-gel methods, Principles and reaction mechanisms	1,2	1,2	Offline (PPT, white board)

4-14		Carbon Nanomaterials- Properties, functionalization and application	3	2,3	Offline (PPT, white board)
4-15		Graphene: Introduction, structure, preparation by Hummer's method	3	2,3	Offline (PPT, whiteboard)
4-16		Graphene- functionalization and application	4	3	Offline (PPT, videos, white board)
5-17		Basis of thin film fabrication; CVD – preparation and mechanisms	1,2	1,2	Offline (PPT, white board)
5-18		PECVD and MOCVD – preparation and mechanisms; similarities and differences among the deposition methods; applications	4	3	Offline (PPT, white board) Think pair share – Flip classroom.
5-19	Unit – 3	Introduction to inorganic semiconductors, classification of semiconductors; extrinsic and intrinsic semiconductors, n- and p- type semiconductor	1,2	1,2	Offline (PPT, white board)
5-20		Electronic grade semiconductor production, Czochralski method, working, Float zone method disadvantages	1,2	1,2	Offline (PPT, white board)
6-21		GaAs, properties, drift velocity, optical property, semi-insulating property and its application	1,2	1,2	Offline (PPT, white board)
6-22		SiGe, thermoelectric property, band gap, synthesis band application of SiGe, InP, optoelectronic property, synthesis and application	3,4	3,4	Offline (PPT, white board, interactive session)
6-23		Synthesis, fabrication of thin film, thermal evaporation technique, spin coating and application of pentacene	3,4	3,4	Offline (PPT, white board)
6-24		Fullerene, synthesis of fullerene derivatives, and application. Conductuve polymers, properties of conductive polymers	1,2	1,2	Offline (PPT, white board)
7-25		Polyaniline, structure of PANI, synthesis of PANI, and application	2,3	2,3	Offline (PPT, whiteboard, group discussion)
7-26		Data storage material, principle, dielectric material and application	1,2	1,2	Offline (PPT, white board, flip classroom)
7-27	Unit- 4	Introduction to Chromic materials, Photochromic Materials mechanism, examples and applications	1,2	1,2	Offline (PPT, white board)

7-28		Thermochromic Materials, working mechanism, and applications	1,2	1,2	Offline (PPT, white board)
8-29		Electrochromic Materials, working mechanism, and applications	1,2	1,2	Offline (PPT, white board), online quiz (https://quizizz.com/join?gc=02666756) using ICT tools.
8-30		Electrostrictive, Magnetostrictive materials working mechanism, and applications.	3,4	3,4	Offline (PPT, whiteboard, interactive session)
8-31		RFID concept, types, working and applications.	3,4	3,4	Offline (PPT, white board)
8-32		MEMS and NEMS working mechanism, and applications	1,2	1,2	Offline (PPT, white board)
9-33		E-Nose and E-Skin, basics. Materials, working mechanism, and applications	2,3	2,3	Offline (PPT, whiteboard)
9-34		E-waste - Types, environmental risks. E-waste- recycle management and synopsis	1,2	1,2	Offline (PPT, white board, group discussion)
9-35	Unit-5	Introduction to sensor technology, types of sensors	1,2	1,2	Offline (PPT, white board)
9-36		Optoelectronic sensors- working principle, materials used, applications	1,2	1,2	Offline (PPT, white board)
9-37		piezoelectric sensor- working principle, materials used, plications	1,2	1,2	Offline (PPT, white board)
10-38		Electrochemical sensor- working principle, materials used, plications	3,4	3,4	Offline (PPT, white board, interactive session)
10-39		Gas sensors- working principle, materials used, plications	3,4	3,4	Offline (PPT, white board)
10-40		Colorimetry: Principle, instrumentation, working	1,2	1,2	Offline (PPT, white board)
10-41		Potentiometry: Principle, instrumentation, working	2,3	2,3	Offline (PPT, whiteboard)
11-42		Flame photometry: Principle, instrumentation, working	1,2	1,2	Offline (PPT, white board)
11-43		Conductometry: Principle, instrumentation, working	1,2	1,2	Offline (PPT, white board, group discussion)

Plan of distribution of units for CIE and SEE

Unit	Chapter	Teaching Hours	Quiz	No. of Questions in			No. of Questions in SEE
				CIE-1	CIE-2	CIE-3	
I	Energy storage and conversion devices	8	5	4		3	2
II	Nanomaterials and thin film fabrication techniques	9	5	2	4	-	2
III	Chemistry of electronic materials	9	8		3		2
IV	Advanced electronic materials and E –waste	9	7			2	2
V	Sensors and Instrumental methods of analysis	8	5			2	2

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	-	-	-	-	-	-	-	-
CO2	3	3	2	1	-	-	-	-	-	-	1
CO3	3	3	2	2	2	-	-	-	-	2	1
CO4	3	2	-	-	2	-	-	-	-	2	1

	Reference Books
1	Chemistry in microelectronics, Yannick Le Tiec, 2013, Wiley Publications, ISBN: 9781848214361.
2	Electronics properties of materials, Rolf E, Hummel, 2012, Springer Publications New York, 4th Edition, ISBN 9781441981639.
3	Smart nanomaterials for sensor application, Li S, Ge Y, Li H, 2012, Bentham Science Publishers, ISBN: 9781608055425.
4	Energy storage and conversion materials, Skinner S, 2019, Royal society of chemistry, ISBN: 9781788010900.
	E-Books
5	Smart materials, Harvey, James A. Handbook of materials selection, 2002, John Wiley & Sons Canada, Limited, ISBN: 9780471359241.
6	Engineering Chemistry, Suba Ramesh, Vairam, Ananda Murthy, 2011, Wiley India, ISBN: 9788126519880.
7	Energy storage and conversion devices; Supercapacitors, batteries and hydroelectric Cells Editor: Anurag Gaur, 2021, CRC Press, ISBN: 9781000470512.
8	An overview of advanced nanomaterials for sensor applications, Rohilla D, Chaudhary S, Umar A. Engineered Science publisher. 2021, 16:47-70. DOI: 10.30919/es8d552.

Laboratory Component

List of Experiments

1. Estimation of copper in the E-waste.
2. Determination of pKa of a weak acid using pH sensor.
3. Potentiometric estimation of iron.
4. Colorimetric estimation of copper from PCBs.
5. Conductometric estimations.
6. Flame photometric estimation of sodium.
7. Determination of viscosity coefficient.
8. Electroplating of copper.
9. Preparation of polyaniline for sensor application (Demonstration experiment).
10. Preparation of semiconducting TiO_2 nanoparticles for DSSC applications (Demonstration experiment).
11. Determination of band gap of semiconducting material using UV-vis spectrophotometer (Demonstration experiment).
12. Study the surface morphology of nanomaterials using scanning electron microscopy (Demonstration experiment).
13. Thin films fabrication using PECVD and sputtering technique (Demonstration Experiment).
14. Fabrication of coin cell super capacitor prototype (Demonstration experiment).
15. Synthesis of iron oxide nanomaterials using solution combustion synthesis.
16. Green synthesis of nanomaterials.

CONTINUOUS INTERNAL EVALUATION		
ASSESSMENT AND EVALUATION PATTERN Theory & quizzes questions are to be framed using Bloom's Taxonomy Levels - Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating		
WEIGHTAGE	**CIE (50%)**	**SEE (50%)**
A. QUIZZES: Each quiz is evaluated for 10 marks		
Quiz-I for 10 Marks	**10**	*****
Quiz-I for 10 Marks		
B. TESTS: Each test will be conducted for 50 Marks adding up to 100 marks. Final test marks will be reduced to 30		
Test – I for 50 Marks	**30**	*****
Test – II for 50 Marks		
C. EXPERIENTIAL LEARNING:	**30**	*****
PRACTICAL	**30**	*****
TOTAL MARKS FOR THE COURSE	**100**	**100**

Plan for Experiential Learning: (Conduction and Evaluation)

1. Identification of the topic through literature survey/Review article/case studies
2. Phase-I Presentation.
3. Phase-II Presentation along with model/ prototype/Poster/Report/Video demonstration.

Faculty In-charge: Dr. Swetha S M

Verified by: HoD Chemistry