

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR – 603 203

DEPARTMENT OF CHEMISTRY

QUESTION BANK



VII SEMESTER

OCH101 - Nanomaterials and Applications

Regulations 2023

Academic Year 2026-27

Prepared by: Dr. L. Devaraj Stephen/Associate Professor and Dr. N. Jayaprakash/Assistant Professor

**UNIT I - PROPERTIES OF NANOMATERIALS**

Definition – importance of nano structured materials - size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials. Surface area - band gap energy and its applications. Photochemistry and electrochemistry of nanomaterials –ionic properties of nanomaterials- Nanocatalysis. Green Materials – biomaterials, biopolymers and bioplastics.

S.No	PART-A (2 Marks)	BTL	Competence	CO
1.	Define nanomaterials.	1	Remembering	CO1
2.	Why are nanostructured materials important?	2	Understanding	CO1
3.	What is meant by the size effect in nanomaterials?	1	Remembering	CO1
4.	How does particle size affect the thermal properties of nanomaterials?	2	Understanding	CO1
5.	What is surface area-to-volume ratio?	1	Remembering	CO1
6.	Why do nanomaterials have high reactivity?	2	Understanding	CO1
7.	Define band gap energy.	1	Remembering	CO1
8.	How does reducing particle size affect the electrical properties of nanomaterials?	2	Understanding	CO1
9.	Explain how the band gap energy changes with particle size.	2	Understanding	CO1
10.	Mention any two applications of band gap engineering in nanomaterials.	1	Remembering	CO1
11.	How does particle size influence the optical properties of nanomaterials?	2	Understanding	CO1
12.	What are the magnetic properties of nanomaterials? Give any two examples.	1	Remembering	CO1
13.	Define surface area-to-volume ratio.	1	Remembering	CO1
14.	Why do nanomaterials possess a high surface area?	2	Understanding	CO1
15.	Define photochemistry of nanomaterials.	1	Remembering	CO1
16.	What is electrochemistry of nanomaterials? Mention its applications.	1	Remembering	CO1
17.	What are the ionic properties of nanomaterials?	1	Remembering	CO1
18.	Define nanocatalysis.	1	Remembering	CO1
19.	What are green materials? Give examples.	1	Remembering	CO1
20.	Distinguish biomaterials, biopolymers, and bioplastics.	2	Understanding	CO1



S.No	Part-B		BTL	Competence	CO
1.	(i)	Define nanomaterials and explain the importance of nanostructured materials.	3	Applying	CO1
	(ii)	Compare the properties of bulk materials and nanomaterials.	3	Applying	CO1
2.		Analyze the size-dependent properties of nanomaterials with suitable examples.	4	Analyzing	CO1
3.		What is band gap energy? Explain the variation of band gap energy with particle size and discuss its technological applications.	3	Applying	CO1
4.		Evaluate the effect of size reduction on the thermal, electrical, electronic, mechanical, optical, and magnetic properties of nanomaterials.	4	Analyzing	CO1
5.		Elucidate the photochemistry of nanomaterials. Discuss its principles and applications in environmental, medical, and energy-related fields.	3	Applying	CO1
6.		Describe the electrochemical properties of nanomaterials. Examine their role and applications in batteries, supercapacitors, fuel cells, and sensors.	4	Analyzing	CO1
7.	(i)	Discuss the ionic properties of nanomaterials.	3	Applying	CO1
	(ii)	Explain how ionic nanoscale dimensions influence conductivity and mention its practical applications.	3	Applying	CO1
8.		What is nanocatalysis? Investigate the principle, advantages, mechanism, and industrial applications of nanocatalysts.	4	Analyzing	CO1
9.		Examine in detail: (a) Surface area of nanomaterials (b) Band gap energy and its applications (c) Nanocatalysis	4	Analyzing	CO1
10.		What are green materials? Analyze biomaterials, biopolymers, and bioplastics, providing suitable examples, properties, advantages, and applications for each.	4	Analyzing	CO1

UNIT II - SYNTHESIS OF NANOMATERIALS

Bottom-up and top-down approach to obtain nanomaterials. Chemical methods: co-precipitation methods, sol-gel technique, photochemical synthesis. Physical methods: high energy ball milling, PVD methods, gas phase condensation and magnetron sputtering.

S.No	Part-A	BTL	Competence	CO
1.	Define the bottom-up approach in nanomaterial synthesis.	1	Remembering	CO2
2.	Differentiate between bottom-up and top-down approaches for nanomaterial synthesis.	2	Understanding	CO2
3.	What is meant by the bottom-up approach?	1	Remembering	CO2
4.	Explain the principle of the co-precipitation method.	2	Understanding	CO2
5.	Explain how pH and temperature influence the co-precipitation synthesis of nanoparticles.	2	Understanding	CO2
6.	Define the sol-gel technique and state the two key steps involved.	1	Remembering	CO2
7.	How does photochemical synthesis produce nanoparticles?	2	Understanding	CO2
8.	Explain the advantages of photochemical synthesis over conventional chemical methods for nanoparticle production.	2	Understanding	CO2
9.	What is High-energy ball milling? State which approach it belongs to.	1	Remembering	CO2
10.	Explain the limitations of high-energy ball milling in producing nanomaterials.	2	Understanding	CO2
11.	Define Physical Vapour Deposition (PVD) and name two techniques under it.	1	Remembering	CO2
12.	Explain how Physical Vapour Deposition (PVD) is used for nanomaterial preparation.	2	Understanding	CO2
13.	What is gas phase condensation?	1	Remembering	CO2
14.	Explain how inert gas pressure affects the size of nanoparticles produced by gas phase condensation.	2	Understanding	CO2
15.	Define magnetron sputtering.	1	Remembering	CO2
16.	State why magnets are used in the magnetron sputtering process.	1	Understanding	CO2
17.	Explain the advantages of magnetron sputtering over thermal evaporation for thin film deposition.	2	Understanding	CO2
18.	State two chemical methods and two physical methods used for nanomaterial synthesis.	1	Remembering	CO2
19.	Explain why chemical methods generally produce nanoparticles with better size uniformity than physical methods.	2	Understanding	CO2
20.	Explain why the sol-gel technique is preferred for producing metal oxide thin films in solar cell applications.	1	Remembering	CO2



S.No	Part-B		BTL	Competence	CO
1.	(i)	Analyze the bottom-up and top-down approaches for the synthesis of nanomaterials.	4	Analyzing	CO2
	(ii)	Compare the advantages, limitations, and suitable applications of the bottom-up and top-down approaches.	4	Analyzing	CO2
2.		Illustrate the co-precipitation method for the synthesis of nanomaterials with a neat flow diagram. Discuss its applications.	3	Applying	CO2
3.		Infer the sol-gel technique for synthesizing nanomaterials. Explain the various stages involved and highlight its advantages and applications.	4	Analyzing	CO2
4.		Demonstrate the photochemical synthesis of nanomaterials with suitable chemical reactions. Explain how reaction parameters influence nanoparticle formation.	3	Applying	CO2
5.		Analyze the principle, working, advantages, limitations, and applications of the high-energy ball milling method used for nanomaterial synthesis.	3	Applying	CO2
6.		Illustrate the Physical Vapour Deposition (PVD) method with a neat diagram. Explain the deposition process and discuss its industrial applications.	3	Applying	CO2
7.	(i)	Implement the gas-phase condensation technique to prepare nanomaterials. Explain its principle and working mechanism	4	Analyzing	CO2
	(ii)	Organize the advantages, applications and disadvantages of the gas-phase condensation technique.	4	Analyzing	CO2
8.		Describe the magnetron sputtering technique with a neat schematic diagram. Explain its working principle and applications in thin-film fabrication.	4	Analyzing	CO2
9.		Discuss the following: (a) Applications of sol-gel method (b) Applications of high-energy ball milling method	3	Applying	CO2
10.		Illustrate in detail the sol-gel synthesis for producing nanomaterials.	4	Analyzing	CO2

UNIT III - STRUCTURAL CHARACTERISTICS

Introduction, principles, instrumentation and applications of powder X-ray diffraction, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, nanoindentation, small angle X-ray and neutron scattering and BET analysis method.

S.No	Part-A	BTL	Competence	CO
1.	State Bragg's Law and explain the meaning of each term in the equation.	2	Understanding	CO3
2.	List any two applications of powder X-ray diffraction in nanomaterials.	1	Remembering	CO3
3.	Draw and label the basic components of a powder X-ray diffraction instrument.	1	Remembering	CO3
4.	How is constructive interference differentiated from destructive interference in XRD?	2	Understanding	CO3
5.	Define Scanning Electron Microscopy (SEM). Mention its applications.	1	Remembering	CO3
6.	Name the major components of a Scanning Electron Microscope.	1	Remembering	CO3
7.	State any two applications of SEM in nanomaterial analysis.	1	Remembering	CO3
8.	Define Transmission Electron Microscopy (TEM). How does it differ from SEM?	2	Understanding	CO3
9.	Mention any two advantages of TEM in nanomaterial characterization.	1	Remembering	CO3
10.	What information is obtained from TEM images?	1	Remembering	CO3
11.	What is Scanning Probe Microscopy (SPM)? Name any two types of SPM.	1	Remembering	CO3
12.	Define nanoindentation. What property of a material is commonly measured using this technique?	2	Understanding	CO3
13.	State the working principle of the nanoindentation technique.	2	Understanding	CO3
14.	What is Small-Angle X-ray Scattering (SAXS)? Mention its significance in nanomaterial characterization.	1	Remembering	CO3
15.	What is Small-Angle Neutron Scattering (SANS)? State its advantages.	1	Remembering	CO3
16.	Expand BET and state its principle.	2	Understanding	CO3
17.	What is the purpose of BET surface area analysis?	2	Understanding	CO3
18.	Mention any two assumptions of the BET theory.	1	Remembering	CO3
19.	List any two applications of the BET method in the characterization of nanomaterials.	1	Remembering	CO3
20.	Differentiate between Atomic Force Microscopy (AFM) and Scanning Tunnelling Microscopy (STM).	2	Understanding	CO3



S.No	Part-B		BTL	Competence	CO
1.	(i)	Explain the principle, instrumentation, working, and applications of Powder X-ray Diffraction (PXRD).	3	Applying	CO3
	(ii)	Discuss how XRD is used to determine the crystal structure and crystallite size of nanomaterials.	3	Applying	CO3
2.		Describe the Principle and instrumentation of Scanning Electron Microscopy (SEM).	3	Applying	CO3
		Explain the image-formation process, advantages, limitations, and applications of SEM in nanomaterial characterisation.	3	Applying	CO3
3.		Examine the working principles, construction, operation, advantages, limitations, and applications of Atomic Force Microscopy (AFM).	4	Analyzing	CO3
4.		Analyze the working principle of Scanning Tunnelling Microscopy (STM). Explain its instrumentation, advantages, limitations, and applications in nanotechnology.	4	Analyzing	CO3
5.	(i)	Discuss the principle, construction, and working of Transmission Electron Microscopy (TEM).	3	Applying	CO3
	(ii)	Explain its applications in determining the structural characteristics of nanomaterials.	4	Analyzing	CO3
6.		Investigate the principles, assumptions, experimental procedure, BET (Brunauer–Emmett–Teller) equation, and applications of BET surface area analysis in nanomaterial characterisation.	4	Analyzing	CO3
7.	(i)	Evaluate the principle and instrumentation of Nanoindentation.	4	Analyzing	CO3
8.	(ii)	Elucidate the procedure for measuring hardness and elastic modulus of nanomaterials and mention its applications.	4	Analyzing	CO3
8.		Analyze the principle, instrumentation, working, advantages, limitations, and applications of Small-Angle X-ray Scattering (SAXS).	4	Analyzing	CO3
9.		Compare SEM and TEM with respect to principle, instrumentation, image formation, resolution, sample preparation, advantages, limitations, and applications.	4	Analyzing	CO3
10.		Discuss the principle, instrumentation, working and applications of Small-Angle Neutron Scattering (SANS).	3	Applying	CO3

**UNIT IV - NANOCOMPOSITES**

Introduction, the importance of nanocomposites, binary and ternary nanocomposites. Synthesis, properties and applications of metal-metal oxide and metal oxide-metal oxide nanocomposites, biodegradable polymer-based nanocomposites, thermoplastic nanocomposites, nylon-6 nanocomposites, clay polymer nanocomposites.

S.No	Part-A	BTL	Competence	CO
1.	Define the term "nanocomposite" and state the typical size range of its dispersed phase.	1	Remembering	CO4
2.	Explain the role of nanoparticles in improving the properties of nanocomposites.	2	Understanding	CO4
3.	What is meant by a binary nanocomposite?	1	Remembering	CO4
4.	Differentiate between binary and ternary nanocomposites.	2	Understanding	CO4
5.	Define ternary nanocomposites.	1	Remembering	CO4
6.	Explain why nanocomposites are preferred over conventional composites.	2	Understanding	CO4
7.	Name two common chemical synthesis methods used to fabricate metal-metal oxide nanocomposites.	1	Remembering	CO4
8.	Discuss the significance of metal-metal oxide nanocomposites in catalysis.	2	Understanding	CO4
9.	What are metal-metal oxide nanocomposites?	1	Remembering	CO4
10.	Explain the advantages of metal oxide-metal oxide nanocomposites.	2	Understanding	CO4
11.	What are biodegradable polymer-based nanocomposites?	1	Remembering	CO4
12.	Describe the synthesis principle of biodegradable polymer-based nanocomposites.	2	Understanding	CO4
13.	Define thermoplastic nanocomposites.	1	Remembering	CO4
14.	Explain the importance of thermoplastic nanocomposites in engineering applications.	2	Understanding	CO4
15.	What is a Nylon-6 nanocomposite?	1	Remembering	CO4
16.	Discuss how nanofillers enhance the properties of Nylon-6 nanocomposites.	2	Understanding	CO4
17.	What are clay polymer nanocomposites?	1	Remembering	CO4
18.	Explain the characteristics of clay polymer nanocomposites.	2	Understanding	CO4
19.	Describe any two applications of nanocomposites in modern technology.	2	Understanding	CO4
20.	Why are clay-polymer nanocomposites highly favoured in the food packaging industry?	2	Understanding	CO4



S.No	Part-B		BTL	Competence	CO
1.	(i)	Explain the concept and the importance of nanocomposites.	4	Analyzing	CO4
	(ii)	Distinguish binary and ternary nanocomposites with suitable examples.	4	Analyzing	CO4
2.		Examine the components, classification, preparation methods, properties, advantages, and applications of binary nanocomposites with suitable examples.	3	Applying	CO4
3.		Illustrate the components, need, preparation methods, properties, advantages, and applications of binary nanocomposites with suitable examples.	3	Applying	CO4
4.		Organize the synthesis, properties, and applications of metal–metal oxide nanocomposites with suitable examples.	4	Analyzing	CO4
5.		Demonstrate the synthesis methods, properties, and applications of metal oxide–metal oxide nanocomposites.	4	Analyzing	CO4
6.	(i)	Interpret the preparation, properties and uses of biodegradable polymer-based nanocomposites.	3	Applying	CO4
	(ii)	Explain how the incorporation of nanofillers enhances their properties for biomedical and environmental applications.	3	Applying	CO4
7.		Explain the preparation, properties, advantages, and engineering applications of thermoplastic nanocomposites.	4	Analyzing	CO4
8.		Describe the preparation, structure, properties, and applications of clay polymer nanocomposites.	4	Analyzing	CO4
9.		Explain the preparation, properties, advantages, and applications of Nylon-6 nanocomposites, accompanied by a neat schematic diagram.	4	Analyzing	CO4
10.		Apply your knowledge of nanocomposite synthesis to explain the components, preparation methods, properties, advantages, and applications of binary nanocomposites with suitable examples.	3	Applying	CO4

**UNIT V - APPLICATIONS OF NANOMATERIALS**

Introduction, applications of nanomaterials in renewable energy generation, drug delivery, cosmetics, tissue engineering, bioinformatics, nanomedicine, molecular motors, bioelectronics & spintronics, textiles, cosmetics, agriculture & food technology, high integrated circuits, information technology, defence and aerospace. Practice of nanoparticles for environmental remediation and water treatment.

S.No	Part-A	BTL	Competence	CO
1.	Define the term 'nanomaterial' in terms of its dimensional scale.	1	Remembering	CO5
2.	Explain how the high surface-area-to-volume ratio of nanomaterials improves the efficiency of solar cells.	1	Remembering	CO5
3.	State two primary advantages of using nanoparticles in drug delivery systems.	2	Understanding	CO5
4.	Define nanomedicine.	2	Understanding	CO5
5.	Distinguish between active and passive targeting in nanomedicine.	1	Remembering	CO5
6.	Explain the role of nanomaterials in tissue engineering.	1	Remembering	CO5
7.	Identify the specific nanomaterial used in modern sunscreens for UV protection and state its role.	2	Understanding	CO5
8.	What is bioelectronics?	2	Understanding	CO5
9.	Explain how nanomaterials are used in cosmetic products.	1	Remembering	CO5
10.	What is the primary function of a nanomaterial scaffold in tissue engineering?	2	Understanding	CO5
11.	Explain the role of nanomaterials in tissue engineering.	1	Remembering	CO5
12.	What are molecular motors?	2	Understanding	CO5
13.	List two applications of nanotechnology in smart agriculture.	1	Remembering	CO5
14.	Describe the significance of nanotechnology in agriculture and food technology.	2	Understanding	CO5
15.	Explain how nanocomposite films improve the shelf-life of packaged food.	1	Remembering	CO5
16.	What are nano-fertilizers?	1	Remembering	CO5
17.	Name a carbon-based nanomaterial expected to replace silicon in next-generation field-effect transistors (FETs).	2	Understanding	CO5
18.	Summarize how stealth technology utilises nanomaterials for military applications.	1	Remembering	CO5
19.	Identify a commonly used nanomaterial in photocatalytic water purification.	1	Remembering	CO5
20.	Define 'nanoremediation'.	2	Understanding	CO5



S.No	Part-B		BTL	Competence	CO
1.	(i)	Explain the role of nanomaterials in renewable energy generation. Discuss their applications in solar cells with suitable examples.	3	Applying	CO5
	(ii)	Discuss the applications of nanomaterials in fuel cells, hydrogen production, and energy storage devices with suitable examples.	4	Analyzing	CO5
2.		Illustrate the applications of nanomaterials in drug delivery, nanomedicine, and tissue engineering. Explain how nanotechnology has improved modern healthcare with suitable examples.	3	Applying	CO5
3.		Describe the applications of nanomaterials in cosmetics, textiles, and agriculture & food technology. Highlight their advantages and recent developments.	4	Analyzing	CO5
4.		Discuss the applications of nanomaterials in high-integrated circuits, information technology, defence, and aerospace, with suitable examples.	3	Applying	CO5
5.		Illustrate the role of nanoparticles in environmental remediation and water treatment. Explain the mechanisms involved in pollutant removal with suitable examples.	3	Applying	CO5
6.	(i)	Demonstrate the working principle and applications of molecular motors, bioelectronics, and spintronics.	4	Analyzing	CO5
	(ii)	Discuss their significance in advanced biomedical and electronic devices.	4	Analyzing	CO5
7.		Apply your knowledge of nanotechnology to explain the use of nanomaterials in bioinformatics, molecular motors, and nanomedicine. Discuss their advantages with suitable examples.	4	Analyzing	CO5
8.		Summarize the applications of nanomaterials in renewable energy, environmental remediation, and water treatment, emphasising their role in sustainable development.	4	Analyzing	CO5
9.		Compare the applications of nanomaterials in drug delivery, cosmetics, textiles, and agriculture & food technology, highlighting their benefits and limitations.	3	Applying	CO5
10.		Explain the applications of nanomaterials in cosmetics, textiles, and agriculture & food technology. Discuss their advantages and recent advancements.	3	Applying	CO5