SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

Approved by AICTE, Affiliated to Anna University, Chennai, Accredited by NBA,
'A' Grade Accreditation by NAAC & ISO 9001:2015 Certified Institution

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

VI SEMESTER

1920601 – MEMS and Nano Science

Regulation - 2019

Academic Year 2024 - 2025 (Even Sem)

Prepared by

Mr. P. Tamilmani, Assistant Professor / EIE

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SUBJECT : 1920601 – MEMS and Nano Science

SEM/YEAR : VI/III

UNIT I - OVERVIEW OF MEMS AND MICROSYSTEMS

Introduction to MEMS and Microsystems, Need for Miniaturization, MEMS and Microsystem products: Micro gears - Micro turbines – Micromotors - Micro optical devices. Microsystems and Microelectronics, Application of Microsystems in Automotive Industries: Safety - Engine and power trains - Comfort and convenience, Microactuation: Actuation using thermal forces - actuation using shape memory alloys - Actuation using piezoelectric effect - Actuation using Electrostatic forces.

PART – A

Q.No.	Questions	BT Level	Competence	Course Outcome
1.	Distinguish between Microelectronics and Microsystem.	BTL 2	Understand	CO 1
2.	Label the components of a Microsystem.	BTL 1	Remember	CO 1
3.	What are the common methods of IC and MEMS fabrication?	BTL 1	Remember	CO 1
4.	List some microsystem products.	BTL 2	Understand	CO 1
5.	What is the need for miniaturization?	BTL 2	Understand	CO 1
6.	Identify the applications of microsystems in automobiles.	BTL 1	Remember	CO 1
7.	Which MEMS sensor is deployed in the air-bags of car to sense the crash?	BTL 2	Understand	CO 1
8.	Relate thermal resistance in the case of conduction, convection and radiation.	BTL 2	Understand	CO 1
9.	Demonstrate the thermal transfer process with neat diagram.	BTL 2	Understand	CO 1
10.	Summarize the advantages and disadvantages of thermal actuation.	BTL 2	Understand	CO 1
11.	How are actuators selected for the desired applications?	BTL 2	Understand	CO 1
12.	Distinguish between volumetric thermal and linear expansion coefficient.	BTL 2	Understand	CO 1

13.	Summarize the advantages and disadvantages of piezoelectric sensing and actuation.	BTL 2	Understand	CO 1
14.	Point out the assumptions that have been made for calculating the curvature of bending.	BTL 2	Understand	CO 1
15.	Identify the military applications of MEMS.	BTL 1	Remember	CO 1
16.	Define coulomb's law.	BTL 1	Remember	CO 1
17.	Write the principle of electrostatic sensors and actuators.	BTL 1	Remember	CO 1
18.	Define pull-in voltage.	BTL 1	Remember	CO 1
19.	Generalize the role of actuators and sensors in the context of MEMS.	BTL 2	Understand	CO 1
20.	State piezoelectric effect.	BTL 1	Remember	CO 1
21.	Define MEMS.	BTL 1	Remember	CO 1
22.	List out the basic MEMS materials.	BTL 1	Remember	CO 1
23.	Compare between silicon and GaAs as materials for MEMS device fabrication.	BTL 2	Understand	CO 1
24.	Summarize diffefrent methods of Micro actuation.	BTL 2	Understand	CO 1
	PART-B			
1.	Illustrate intelligent microsystem with neat block diagram. **(13)**	BTL 3	Apply	CO 1
2.	Explain typical MEMS and microsystem products in detail. **(13)**	BTL 3	Apply	CO 1
3.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Micro motors. **(7)**			
	(ii) Micro gears. **(6)**			
5.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Micro turbines. **(7)**			
	(ii) Micro-optical components. **(6)**			
6.	Infer the application of microsystem in automobile for the following:	BTL 4	Analyze	CO 1
	(i) Engine and power train. **(7)**			
	(ii) Safety. **(6)**			
7.	Infer the application of microsystem in automobile for the following:	BTL 4	Analyze	CO 1
	(i) Comfort and convenience. **(7)**			
	(ii) Vehicle diagnostics and health monitoring. **(6)**			
8.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Chemical sensor. **(7)**			

	(ii) Acoustic wave sensor. **(6)**			
9.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Biomedical sensor. **(7)**			
	(ii) Biosensors. **(6)**			
10.	Explain the principle of optical sensors and thermal sensors in detail. **(13)**	BTL 4	Analyze	CO 1
11.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Actuation using Thermal forces. **(7)**			
	(ii) Actuation using shape-memory alloys. **(6)**			
12.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Actuation using Electrostatic forces. **(7)**			
	(ii) Actuation using Piezoelectric crystals. **(6)**			
13.	List out the various actuation methods used in MEMS. Explain any one method in detail. **(13)**	BTL 4	Analyze	CO 1
14.	Write short notes on:	BTL 3	Apply	CO 1
	(i) Microvalves. **(7)**			
	(ii) Micropumps. **(6)**			
15.	Explain typical arrangement and schematic structure of a microacelerometer. **(13)**	BTL 4	Analyze	CO 1
16.	Explain micro inertia sensor and dual-axial-motion sensor. **(13)**	BTL 4	Analyze	CO 1
17.	Explain different microchannels with noncircular cross sections in microfluidics with neat sketch. **(13)**	BTL 4	Analyze	CO 1
	PART-C			
1.	Point out the applications of microsystems in automotive industries. **(15)**	BTL 4	Analyze	CO 1
2.	Point out the applications of microsystems in Aerospace industry and Health care industries. **(15)**	BTL 4	Analyze	CO 1
3.	Point out the applications of microsystems in industrial products, consumer products & Tele-communications. **(15)**	BTL 4	Analyze	CO 1
4.	Explain gripping froces in a microgripper with its schematic diagram and comb-drive actuator in detail. **(15)**	BTL 3	Apply	CO 1
5.	Analyze the evolution of microfabrication and compare microelectronics with microsystems. **(15)**	BTL 4	Analyze	CO 1

UNIT II - MICROSYSTEM FABRICATION PROCESS

Photolithography, Ion Implantation, Diffusion, Oxidation: Thermal oxidation-Oxidation by color, Chemical Vapour Deposition, Physical Vapour Deposition: Sputtering, Etching: Chemical- Plasma, Micromachining: Bulk Micromachining - Surface Micromachining.

Q.No.	Questions	BT Level	Competence	Course Outcome
1.	Define Lithography and Photolithography.	BTL 1	Remember	CO 2
2.	What is micromachining?	BTL 2	Understand	CO 2
3.	Name some positive and negative photo resists.	BTL 1	Remember	CO 2
4.	What is micro fabrication?	BTL 2	Understand	CO 2
5.	Name some special materials used in MEMS.	BTL 1	Remember	CO 2
6.	What is sputtering?	BTL 2	Understand	CO 2
7.	Summarize the important benefits of SOI Wafer.	BTL 2	Understand	CO 2
8.	Define dry etching and List the types of etching.	BTL 1	Remember	CO 2
9.	Differentiate CVD and PVD.	BTL 2	Understand	CO 2
10.	Quote the types of thins films used in microsystems.	BTL 1	Remember	CO 2
11.	Compare between silicon and GaAs as materials for MEMS device fabrication.	BTL 2	Understand	CO 2
12.	Generalize the difference between stiction and anti-stiction methods.	BTL 2	Understand	CO 2
13.	Which material is popularly used as the sacrificial layer in surface micro machining process?	BTL 2	Understand	CO 2
14.	Compare and contrast Surface Micromachining and Bulk Micromachining. `	BTL 2	Understand	CO 2
15.	Summarize the advantages in Surface Micromachining.	BTL 2	Understand	CO 2
16.	Identify the material having zero stress.	BTL 1	Remember	CO 2
17.	Mention the types of materials used in piezoelectric.	BTL 2	Understand	CO 2
18.	What is ‘drive-in’ in the process of doping?	BTL 2	Understand	CO 2
19.	Expand APCVD, LPCVD and PECVD.	BTL 1	Remember	CO 2
20.	Identify the classes of deposition used in micromachining.	BTL 1	Remember	CO 2
21.	Write the concept of plasma etching.	BTL 1	Remember	CO 2
22.	Compare isotropic and anisotropic etching.	BTL 2	Understand	CO 2
23.	Show how Ammonia is used for the deposition of Silicon Nitride on silicon substrate.	BTL 2	Understand	CO 2

24.	Summarize the various microsystem fabrication techniques.	BTL 2	Understand	CO 2
	PART-B			
1.	Examine the Czochralski growth process in single crystal substrate. **(13)**	BTL 3	Apply	CO 2
2.	Explain the steps involved in photolithography with neat sketch. **(13)**	BTL 4	Analyze	CO 2
3.	Examine about ion implantation technique to produce Microsystems. **(13)**	BTL 3	Apply	CO 2
4.	Explain diffusion process in MEMS with neat sketch. **(13)**	BTL 3	Apply	CO 2
5.	Explain oxidation process in Micro system fabrication. **(13)**	BTL 3	Apply	CO 2
6.	Explain Chemical Vapour Deposition process with neat sketch. **(13)**	BTL 3	Apply	CO 2
7.	Explain how Chemical Vapour Deposition process can be utilized during the fabrication of microsystems in detail. **(13)**	BTL 4	Analyze	CO 2
8.	Explain physical vapour deposition with relevant diagrams. **13)**	BTL 3	Apply	CO 2
9.	**(i)** Compare PECVD, APCVD and LPCVD methods. **(7)**	BTL 4	Analyze	CO 2
	(ii) Explain the working principle of Sputtering. **(6)**			
10.	Explain the process of deposition by epitaxy with neat sketch. **(13)**	BTL 3	Apply	CO 2
11.	Explain etching process in microsystem fabrication with neat diagrams. **(13)**	BTL 3	Apply	CO 2
12.	**(i)** Explain the principle of plasma etching. **(7)**	BTL 3	Apply	CO 2
	(ii) Explain the wet etching of crystalline silicon. **(6)**			
13.	Explain dry etching process with necessary diagram. **(13)**	BTL 3	Apply	CO 2
14.	Explain major fabrication steps in the LIGA process in detail. **(13)**	BTL 3	Apply	CO 2
15.	Examine the step by step approach of bulk micromachining process. **(13)**	BTL 3	Apply	CO 2
16.	Analyze the mechanical problems associated with surface micromachining. Explain them. **(13)**	BTL 4	Analyze	CO 2
17.	Examine how surface micromachining is different from Bulk micromachining with examples. **(13)**	BTL 3	Apply	CO 2
	PART-C			
1.	Examine the fabrication steps involved in the design of pressure sensor. **(15)**	BTL 3	Apply	CO 2
2.	Analyze the graphical illustration of sputtering process. **(15)**	BTL 4	Analyze	CO 2
3.	Illustrate the procedure of silicon based Micro Electro Mechanical System process. **(15)**	BTL 3	Apply	CO 2
4.	Design a typical micromachining process involving one structural and one sacrificial layer. **(15)**	BTL 4	Analyze	CO 2
5.	Compare the mechanical properties of materials used in MEMS in detail. **(15)**	BTL 4	Analyze	CO 2

UNIT III - POLYMERS AND OPTICAL MEMS

Polymers in MEMS : Polyimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon, Optical MEMS : Lenses and Mirrors – Actuators for Active Optical MEMS, Assembly of 3D MEMS – Foundry process.

PART – A

Q.No.	Questions	BT Level	Competence	Course Outcome
1.	Write the major classes of polymers.	BTL 1	Remember	CO 3
2.	Indicate the factors involved in the performance of optical MEMS.	BTL 1	Remember	CO 3
3.	List out the polymer materials used in MEMS.	BTL 1	Remember	CO 3
4.	Give the structure of polyimide.	BTL 2	Understand	CO 3
5.	Summarize the properties of elastomers.	BTL 2	Understand	CO 3
6.	Summarize the process characteristics of Polydimethylsiloxane.	BTL 2	Understand	CO 3
7.	Write about Liquid Crystal Polymer.	BTL 1	Remember	CO 3
8.	Expand the terms PDMS and PMMA.	BTL 1	Remember	CO 3
9.	Identify the dimmer variations of Parylene.	BTL 1	Remember	CO 3
10.	Show the advantages of polymers.	BTL 2	Understand	CO 3
11.	Generalize the difference between the properties of plastics and fibers.	BTL 2	Understand	CO 3
12.	What is foundry process in MEMS?	BTL 1	Remember	CO 3
13.	Define viscoelastic creep.	BTL 1	Remember	CO 3
14.	What is Parylene?	BTL 1	Remember	CO 3
15.	What is MOEMS?	BTL 1	Remember	CO 3
16.	Give the properties of Teflon.	BTL 2	Understand	CO 3
17.	List the actuators for optical MEMS.	BTL 1	Remember	CO 3
18.	Define optical mirrors.	BTL 1	Remember	CO 3
19.	Generalize the properties of polyimide materials.	BTL 2	Understand	CO 3
20.	What are the surface and wetting properties of polymers?	BTL 2	Understand	CO 3
21.	Can liquid crystal polymer be used as a substrate? And Why?	BTL 2	Understand	CO 3
22.	How polymers are classified according to temperature?	BTL 2	Understand	CO 3
23.	Mention some of the properties of polymers.	BTL 2	Understand	CO 3

24.	Show the polyimide structure of SU-8.	BTL 2	Understand	CO 3
	PART – B			
1.	Write short notes on:	BTL 3	Apply	CO 3
	(i) Polyimide **(7)**			
	(ii) LCP **(6)**			
2.	Explain Polydimethylsiloxane in detail and specify its applications. **(13)**	BTL 3	Apply	CO 3
3.	Analyze the molecular structure and properties of Liquid Crystal Polymer. **(13)**	BTL 4	Analyze	CO 3
4.	Write short notes on:	BTL 3	Apply	CO 3
	(i) SU-8 **(7)**			
	(ii) Parylene **(6)**			
5.	Explain in detail about schematic diagram of LCP polymer flow sensors. **(13)**	BTL 4	Analyze	CO 3
6.	Illustrate the fabrication process of silicon accelerometer with Parylene beams. **(13)**	BTL 3	Apply	CO 3
7.	Explain the classification, properties and applications of Polyimide. **(13)**	BTL 4	Analyze	CO 3
8.	Explain the classification, properties and applications of fluorocarbon. **(13)**	BTL 4	Analyze	CO 3
9.	Explain the classification, properties and applications of PMMA. **(13)**	BTL 4	Analyze	CO 3
10.	Explain the classification, properties and applications of LCP. **(13)**	BTL 4	Analyze	CO 3
11.	Analyze the categories and sources in Optical MEMS. **(13)**	BTL 4	Analyze	CO 3
12.	Explain actuators for active optical MEMS with neat sketch. **(13)**	BTL 3	Apply	CO 3
13.	Explain Optical MEMS from micro mirrors to complex systems. **(13)**	BTL 4	Analyze	CO 3
14.	Write short notes on:	BTL 3	Apply	CO 3
	(i) Micro lenses. **(7)**			
	(ii) Micro mirrors. **(6)**			
15.	Explain about optical applications of MEMS devices with examples. **(13)**	BTL 4	Analyze	CO 3
16.	Design a Parylene surface micro machined pressure sensor with fabrication steps. **(13)**	BTL 4	Analyze	CO 3
17.	Design a multimodal polymer based Tactile Sensor. **(13)**	BTL 4	Analyze	CO 3
	PART – C			
1.	Explain the assembly of 3D MEMS with any one Application**.** **(15)**	BTL 4	Analyze	CO 3
2.	Explain foundry process involved in optical MEMS devices. **(15)**	BTL 4	Analyze	CO 3

3.	Point out the need for actuators and the types of actuators used for active optical MEMS applications. **(15)**	BTL 4	Analyze	CO 3
4.	Examine the top and cross-sectional view of Parylene surface micro machined membrane with integrated metal resistors. **(15)**	BTL 3	Apply	CO 3
5.	Explain the micro mirror technology in scanning electron micrograph. **(15)**	BTL 5	Evaluate	CO 3

UNIT IV - INTRODUCTION TO NANOSCALE ENGINEERING

General Principle of Nano Fabrication, Nano products, Applications of Nano products, Quantum physics, Fluid flow in submicrometers and nanoscales: Rarefied Gas – Knudsen and match numbers – Modleing of micro and nanoscale gas flow, Heat Conduction at Nanoscale, Challenges in Nanoscale Engineering, New materials for NEMS.

PART - A

Q.No.	Questions	BT Level	Competence	Course Outcome
1.	List the applications of NEMS.	BTL 1	Remember	CO 4
2.	List the Nano fabrication techniques.	BTL 1	Remember	CO 4
3.	Write the principle of Nano fabrication.	BTL 1	Remember	CO 4
4.	What do you mean by Nanoproduct?	BTL 2	Understand	CO 4
5.	List the applications of Nanoproducts.	BTL 1	Remember	CO 4
6.	What is solar cell?	BTL 1	Remember	CO 4
7.	Distinguish between Quantum wires and Quantum dots.	BTL 2	Understand	CO 4
8.	State the laws of quantum physics.	BTL 1	Remember	CO 4
9.	What is Knudsen number?	BTL 1	Remember	CO 4
10.	What is match number?	BTL 1	Remember	CO 4
11.	Define rarefied gas.	BTL 1	Remember	CO 4
12.	Identify the important phonon characteristics.	BTL 1	Remember	CO 4
13.	Write the Boltzmann transport equation.	BTL 1	Remember	CO 4
14.	Summarize the advantages and disadvantages of Boltzmann transport equation.	BTL 2	Understand	CO 4
15.	Define NEMS.	BTL 1	Remember	CO 4
16.	Differentiate between MEMS and NEMS.	BTL 2	Understand	CO 4
17.	What is Nano fabrication?	BTL 1	Remember	CO 4
18.	What is meant by Buckminster fullerenes?	BTL 1	Remember	CO 4

19.	What is quantum confinement?	BTL 1	Remember	CO 4
20.	Why nano particle of gold is purple in colour?	BTL 2	Understand	CO 4
21.	Mention the benefits of using microfluid platforms.	BTL 2	Understand	CO 4
22.	Relate the Reynolds number and viscosity.	BTL 2	Understand	CO 4
23.	Write the fabrication methods of MEMS.	BTL 1	Remember	CO 4
24.	What do you mean by Nanoparticles?	BTL 2	Understand	CO 4
	PART – B			
1.	Illustrate major steps involved in nanofabrication. **(13)**	BTL 3	Apply	CO 4
2.	Analyze various applications involved in Nano products and explain any two in detail. **(13)**	BTL 3	Apply	CO 4
3.	Write short note on:	BTL 4	Analyze	CO 4
	(i) Buckminsterfullerene. **(7)**			
	(ii) Nano dots. **(6)**			
4.	Explain in detail about Fullerenes and its applications. **(13)**	BTL 3	Apply	CO 4
5.	Write short note on:	BTL 3	Apply	CO 4
	(i) Carbon Nano Tubes. **(7)**			
	(ii) Nanowires. **(6)**			
6.	Analyze the major impacts of nanotechnology in Electronics, Computing and Data Storage. **(13)**	BTL 4	Analyze	CO 4
7.	Analyze the major impacts of nanotechnology in **(i)** Health and Medicine. **(7)** **(ii)** Materials and Manufacturing. **(6)**	BTL 4	Analyze	CO 4
8.	Analyze the major impacts of nanotechnology in **(i)** Energy and Environment. **(7)** **(ii)** Transportation. **(6)**	BTL 4	Analyze	CO 4
9.	Examine the engineering analysis in nanoscale in detail. **(13)**	BTL 3	Apply	CO 4
10.	Examine stress analysis of solids in nanoscale and molecular dynamics in nanoscale structure. **(13)**			CO 4
11.	Examine molecular Heat Transmission and molecular gas dynamics in nanoscale.	BTL 3	Apply	CO 4
12.	Explain the measurement of thermal conductivity in conductor, semiconductor and insulators in nano scale. **(13)**	BTL 3	Apply	CO 4
13.	Explain 3-Omega method for the measurement of thermal conductivity for semiconductors and dielectric materials in nano scale. **(13)**	BTL 4	Analyze	CO 4

14.	With schematic diagram, explain the major components of Scanning Thermal Microscope. **(13)**	BTL 3	Apply	CO 4
15.	Explain fluid flow in sub-micrometers and nanoscales in detail. **(13)**	BTL 4	Analyze	CO 4
16.	**(i)** Analyze the problems involved with Nanotechnology Engineering. **(7)**	BTL 4	Analyze	CO 4
	(ii) Analyze the applications of NEMS. **(6)**			
17.	Illustrate the basic building blocks involved in NEMS technology. **(13)**	BTL 3	Apply	CO 4
	PART-C			
1.	Point out the future outlook of Nanotechnology and Negative social impacts. **(15)**	BTL 4	Analyze	CO 4
2.	Analyze the challenges in Nanoscale Engineering. **(15)**	BTL 4	Analyze	CO 4
3.	Explain nanofabrication and its principles involved in nanotechnology. **(15)**	BTL 3	Apply	CO 4
4.	Point out the applications of nanotechnology in various fields. **(15)**	BTL 4	Analyze	CO 4
5.	Examine the new materials for NEMS in brief. **(15)**	BTL 3	Apply	CO 4

UNIT V - PATTERNING AND PREPARATION METHODS

Bottom up Synthesis – Top down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE, Patterning : Introduction to optical/UV electron beam and X-ray Lithography systems and processes. Clean rooms: specifications and design, air and water purity, requirements for particular processes.

PART – A

Q.No.	Questions	BT Level	Competence	Course Outcome
1.	What is the principle of mechanical milling?	BTL 2	Understand	CO 5
2.	List the advantages of top-down approach.	BTL 1	Remember	CO 5
3.	What do you mean by self-assembly of nanostructures?	BTL 2	Understand	CO 5
4.	What is the principle of electron beam lithography?	BTL 1	Remember	CO 5
5.	Generalize the application of self-assembly materials.	BTL 2	Understand	CO 5
6.	List any four day to day live commercial applications of nanotechnology.	BTL 1	Remember	CO 5
7.	When does contamination arise in Attritor milling?	BTL 2	Understand	CO 5
8.	Identify the category to which sol-gel, MBE, ECAP and laser ablation belong to.	BTL 1	Remember	CO 5
9.	Classify the vapour phase deposition methods.	BTL 2	Understand	CO 5
10.	What do you mean by colloidal routes?	BTL 2	Understand	CO 5

11.	Identify various polymeric materials in Nano precipitation.	BTL 1	Remember	CO 5
12.	Differentiate bottom-up and Top-down approach.	BTL 2	Understand	CO 5
13.	Summarize the applications of milling.	BTL 2	Understand	CO 5
14.	Compare the term MBE and MOMBE.	BTL 2	Understand	CO 5
15.	Classify the different types of milling.	BTL 2	Understand	CO 5
16.	Write the principle of atomic layer epitaxy.	BTL 1	Remember	CO 5
17.	What is meant by co-precipitation?	BTL 1	Remember	CO 5
18.	Define sputtering and list its types.	BTL 1	Remember	CO 5
19.	Distinguish between photolithography and electron beam lithography.	BTL 2	Understand	CO 5
20.	State the principle of bottom-up approach.	BTL 1	Remember	CO 5
21.	Which method of process mostly used for synthesis of nano materials?	BTL 2	Understand	CO 5
22.	State the principle of top-down approach.	BTL 1	Remember	CO 5
23.	Summarize the advantages and disadvantages of MOCVD.	BTL 2	Understand	CO 5
24.	Summarize the advantages and disadvantages of MOMBE.	BTL 2	Understand	CO 5
	PART – B			
1.	**(i)** Differentiate PVD and CVD. **(7)**	BTL 3	Apply	CO 5
	(ii) Write notes on Sputtering and mention its advantages and drawbacks. **(6)**			
2.	Explain in detail the bottom up approach with relevant diagrams. **(13)**	BTL 4	Analyze	CO 5
3.	Illustrate the schematic representation of vapour phase deposition methods. **(13)**	BTL 3	Apply	CO 5
4.	Explain molecular beam epitaxy for producing nanomaterials. **(13)**	BTL 3	Apply	CO 5
5.	Explain Atomic Layer Epitaxy with neat sketch. **(13)**	BTL 3	Apply	CO 5
6.	Explain the working of e-beam evaporation with neat sketch. **(13)**	BTL 3	Apply	CO 5
7.	Explain in detail about the working of mechanical milling process and mention its merits and demerits. **(13)**	BTL 3	Apply	CO 5
8.	Write short notes on:	BTL 3	Apply	CO 5
	(i) Precipitation. **(7)**			
	(ii) Self-assembly. **(6)**			
9.	Analyze different chemical methods of synthesis of nanomaterials and state its advantages and disadvantages. **(13)**	BTL 4	Analyze	CO 5
10.	Briefly explain the process of sputtering and its types. **(13)**	BTL 3	Apply	CO 5
11.	What are the basic steps in a lithography sequence and explain it? Mention its	BTL 3	Apply	CO 5

	advantages and disadvantages. **(13)**			
12.	Explain top down approach in synthesis of nanomaterials. **(13)**	BTL 3	Apply	CO 5
13.	Write in detail about electron beam lithography (EBL) and list its advantages compared with photolithography. **(13)**	BTL 3	Apply	CO 5
14.	Define colloidal routes. Explain in detail about fabrication of nanoparticles by simple colloidal process. **(13)**	BTL 3	Apply	CO 5
15.	Explain in detail the top down approach with relevant diagrams. **(13)**	BTL 3	Apply	CO 5
16.	Analyze how Chemical Vapour Deposition process can be utilized during the fabrication of nanosystems. **(13)**	BTL 4	Analyze	CO 5
17.	Explain the MBE growth technique with a sketch. **(13)**	BTL 3	Apply	CO 5
	PART - C			
1.	Analyze strategies involved in the synthesis of self-assembly. **(15)**	BTL 4	Analyze	CO 5
2.	Explain the working of MOMBE process with neat sketch. **(15)**	BTL 3	Apply	CO 5
3.	Analyze the role of bottom up approach in nano technology. **(15)**	BTL 4	Analyze	CO 5
4.	Explain the schematic diagram of a thermal evaporation system. **(15)**	BTL 3	Apply	CO 5
5.	Analyze the applications of nano powders in industry. **(15)**	BTL 4	Analyze	CO 5