SRM VALLIAMMAI ENGINEERING COLLEGE

An Autonomous Institution

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

VI SEMESTER

1920601– MEMS and Nano Science

Regulation – 2019

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(Even Semester)

Prepared by

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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**
1.	Distinguish between Microelectronics and Microsystem.	**BTL 4**	Analyze
2.	Label the components of a Microsystem.	**BTL 1**	Remember
3.	What are the common methods of IC and MEMS fabrication?	**BTL 1**	Remember
4.	List some microsystem products.	**BTL 2**	Understand
5.	Summarize the intrinsic characteristics of MEMS.	**BTL 5**	Evaluate
6.	Categorize the applications of microsystems in automobiles.	**BTL 6**	Create
7.	Which MEMS sensor is deployed in the air-bags of car to sense the crash?	**BTL 2**	Understand
8.	Relate thermal resistance in the case of conduction, convection and radiation.	**BTL 4**	Analyze
9.	Demonstrate the thermal transfer process with neat diagram.	**BTL 3**	Apply
10.	Summarize the advantages and disadvantages of thermal actuation.	**BTL 5**	Evaluate
11.	How are actuators selected for the desired applications?	**BTL 3**	Apply
12.	Distinguish between volumetric thermal and linear expansion coefficient.	**BTL 2**	Understand
13.	Summarize the advantages and disadvantages of piezoelectric sensing and actuation.	**BTL 5**	Evaluate
14.	Point out the assumptions that have been made for calculating the curvature of bending.	**BTL 4**	Analyze
15.	Show the military applications of MEMS.	**BTL 3**	Apply
16.	Define coulomb's law.	**BTL 1**	Remember
17.	Give the principle of electrostatic sensors and actuators.	**BTL 2**	Understand
18.	Define pull-in voltage.	**BTL 1**	Remember
19.	Generalize the role of actuators and sensors in the context of MEMS.	**BTL 6**	Create
20.	Illustrate the piezoelectric effect.	**BTL 3**	Apply
21.	Define MEMS.	**BTL 1**	Remember
22.	List out the basic MEMS materials.	**BTL 1**	Remember
23.	Compare between silicon and GaAs as materials for MEMS	**BTL 4**	Analyze

	device fabrication.				
24.	Describe the method of Micro actuators.			**BTL 2**	Understand
PART-B					
1.	Describe the role of semiconductor materials in the design of MEMS and why it is chosed and also calculate the charge carrier concentration.		**(13)**	**BTL 1**	Remember
2.	**i.**	Analyze the functional relationship between the actuating element and the transduction unit in a Micro actuator.	**(7)**	**BTL 4**	Analyze
	ii.	Classify the energy domains of sensors and actuators.	**(6)**		
3.	Give short notes on:			**BTL 2**	Understand
	i.	Micro motors.	**(8)**		
	ii.	Micro gears.	**(5)**		
4.	Discuss about the sensors used in an automobile engine and power trains.		**(13)**	**BTL 1**	Remember
5.	Illustrate the concept of micro optical devices with an example.		**(13)**	**BTL 3**	Apply
6.	**i.**	Explain thermal bimetallic bending and evaluate the vertical displacement at the free end of the cantilever beam.	**(9)**	**BTL 4**	Analyze
	ii.	Point out the advantages and disadvantages of thermal bimetallic actuation	**(4)**		
7.	**i.**	Illustrate the functional relationship between the actuating element and the transduction unit in a Micro sensor.	**(6)**	**BTL 3**	Apply
	ii.	Demonstrate the working principle of a micro actuator using shape memory alloys.	**(7)**		
8.	**i.**	Tabulate the difference between Microelectronics and MEMS.	**(8)**	**BTL 1**	Remember
	ii.	Give short notes on micro turbines.	**(5)**		
9.	Describe the design and fabrication process of torsional parallel plate capacitive accelerometer.		**(13)**	**BTL 6**	Create
10.	Illustrate the schematic of piezoelectric crystal in a rectangular system and analyze the mathematical description of piezoelectric effects.		**(13)**	**BTL 3**	Apply
11.	With schematic diagram, explain bulk micro machined parallel plate capacitor sensing as differential mode tactile sensor.		**(13)**	**BTL 2**	Understand
12.	**i.**	What are the four possible mechanisms for heat to move from one point to another?	**(5)**	**BTL 1**	Remember
	ii.	Tabulate the characteristics of electrostatic and thermal bimetallic actuation.	**(8)**		
13.	**i.**	Explain the working of any one thermal actuator with neat diagram. Demonstrate the two strategies of lateral thermal actuators.	**(7)**	**BTL 5**	Evaluate
	ii.	Explain in detail the operation of electrostatic micro motor with appropriate sketches.	**(6)**		
14.	**i.**	Consider a piece of silicon under room temperature and thermal equilibrium. The silicon is doped with boron with a doping concentration of 10^{16} atoms/$cm^{3.}$ Find the electron and hole concentrations.	**(6)**	**BTL 4**	Analyze
	ii.	A thermal bimorph is initially flat where metal 1 is on	**(7)**		

		the top and metal 2 is at the bottom. If its coefficient of thermal expansion (α) is such that $\alpha_1 < \alpha_2$, then in what direction should it bend?			
15.	List out the various actuation methods used in MEMS. Explain any one method in detail.		**(13)**	**BTL 4**	Analyze
16.	Discuss the concept of thermal actuation with an example.		**(13)**	**BTL 2**	Understand
17.	Discuss about the properties of the materials used in the fabrication of piezoelectric sensors.		**(13)**	**BTL 2**	Understand
PART – C					
1.	Examine the need of flow rate sensor. Demonstrate the working and fabrication process of piezoelectric flow rate sensor.		**(15)**	**BTL 6**	Create
2.	With suitable diagram, assess the working principle of parallel plate capacitor and the equilibrium position of electrostatic actuator under bias.		**(15)**	**BTL 5**	Evaluate
3.	**i.**	Summarize the applications of microsystems in automotive industries.	**(10)**	**BTL 5**	Evaluate
	ii.	Describe the pull in effect of parallel plate actuators.	**(5)**		
4.	Elaborate the working principle of an ink jet printer based on electro thermal principle.		**(15)**	**BTL 6**	Create
5.	Discuss on direct and indirect effect of piezoelectricity. And explain the concept of cantilever piezoelectric actuator model with neat diagram.		**(15)**	**BTL 5**	Evaluate

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.

PART – A

Q.No	Questions	BT Level	Competence
1.	Define Lithography and Photolithography.	**BTL 2**	Understand
2.	What is micromachining?	**BTL 3**	Apply
3.	Name some positive and negative photo resists.	**BTL 1**	Remember
4.	What is micro fabrication?	**BTL 1**	Remember
5.	Name some special materials used in MEMS.	**BTL 1**	Remember
6.	What is sputtering?	**BTL 3**	Apply
7.	Summarize the important benefits of SOI Wafer.	**BTL 5**	Evaluate
8.	Define dry etching and List the types of etching.	**BTL 1**	Remember
9.	Differentiate CVD and PVD.	**BTL 1**	Remember
10.	Quote the types of thins films used in microsystems.	**BTL 1**	Remember
11.	Compare between silicon and GaAs as materials for MEMS device fabrication.	**BTL 4**	Analyze
12.	Generalize the difference between stiction and anti-stiction methods.	**BTL 6**	Create
13.	Which material is popularly used as the sacrificial layer in surface micro machining process?	**BTL 2**	Understand
14.	Compare and contrast Surface Micromachining and Bulk Micromachining. `	**BTL 4**	Analyze
15.	Summarize the advantages in Surface Micromachining.	**BTL 5**	Evaluate
16.	Prepare a list of material having zero stress.	**BTL 6**	Create

17.	Mention the types of materials used in piezoelectric.		**BTL 2**	Understand
18.	What is 'drive-in' in the process of doping?		**BTL 2**	Understand
19.	Expand APCVD, LPCVD and PECVD.		**BTL 1**	Remember
20.	Infer the classes of deposition used in micromachining.		**BTL 4**	Analyze
21.	Analyze the concept of plasma etching.		**BTL 4**	Analyze
22.	Relate isotropic and anisotropic etching.		**BTL 3**	Apply
23.	Show how Ammonia is used for the deposition of Silicon Nitride on silicon substrate.		**BTL 3**	Apply
24.	Summarize the various microsystem fabrication techniques.		**BTL 2**	Understand
	PART-B			
1.	Examine the Czochralski growth process in single crystal substrate.	**(13)**	**BTL 3**	Apply
2.	List out the various etching process and explain in detail with relevant diagrams.	**(13)**	**BTL 1**	Remember
3.	Summarize the processing steps of photolithography with neat sketch.	**(13)**	**BTL 2**	Understand
4.	Describe about physical vapour deposition with relevant diagrams.	**(13)**	**BTL 1**	Remember
5.	**i.** Explain the principle of plasma etching.	**(7)**	**BTL 1**	Remember
	ii. Describe the wet etching of crystalline silicon with necessary diagrams.	**(6)**		
6.	**i.** Give short notes on diffusion process used in MEMS industry.	**(7)**	**BTL 2**	Understand
	ii. Distinguish between dry and wet etching.	**(6)**		
7.	Compare the MEMS device capabilities within bulk micromachining, surface micromachining and LIGA process.	**(13)**	**BTL 5**	Evaluate
8.	Discuss in detail, how Chemical Vapour Deposition process can be utilized during the fabrication of microsystems.	**(13)**	**BTL 2**	Understand
9.	Show how oxidation principle is used in Micro system fabrication.	**(13)**	**BTL 3**	Apply
10.	**i.** Compare PECVD, APCVD and LPCVD methods.	**(6)**	**BTL 4**	Analyze
	ii. Describe the working principle of Sputtering.	**(7)**		
11.	Discuss the step by step approach of bulk micromachining process.	**(13)**	**BTL 6**	Create
12.	**i.** What are the two types of Chemical Vapour Deposition process? Explain any one in detail.	**(8)**	**BTL 1**	Remember
	ii. Describe the chemical reactions in Chemical Vapour Deposition process.	**(5)**		
13.	Assess the mechanical problems associated with surface micromachining. Explain them.	**(13)**	**BTL 4**	Analyze
14.	Examine about ion implantation technique to produce Microsystems.	**(13)**	**BTL 3**	Apply
15.	Describe the concept of etching process with neat diagrams.	**(13)**	**BTL 2**	Understand
16.	Infer the suitable method for doping a semiconductor.	**(13)**	**BTL 4**	Analyze
17.	Show how surface micromachining is different from Bulk micromachining	**(13)**	**BTL 3**	Apply
	PART – C			
1.	Summarize the fabrication steps involved in the design of	**(15)**	**BTL 5**	Create

	pressure sensor.				
2.	**i.**	Enumerate the facility for thermal oxidation of silicon dioxide.	**(8)**	**BTL 5**	Evaluate
	ii.	Give out the graphical illustration of sputtering process.	**(7)**		
3.	Generalize the procedure of silicon based Micro Electro Mechanical System process.		**(15)**	**BTL 6**	Evaluate
4.	Mention fundamental classes of fabrication technologies. Design a typical micromachining process involving one structural and one sacrificial layer.		**(15)**	**BTL 6**	Create
5.	Compare the mechanical properties of materials used in MEMS.		**(15)**	**BTL 5**	Evaluate

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
1.	Write the major classes of polymers.	**BTL 3**	Apply
2.	Relate factors involved in the performance of optical MEMS.	**BTL 4**	Analyze
3.	List out the polymer materials used in MEMS.	**BTL 1**	Remember
4.	Give the structure of polyimide.	**BTL 2**	Understand
5.	Summarize the properties of elastomers.	**BTL 5**	Evaluate
6.	Summarize the process characteristics of Polydimethylsiloxane.	**BTL 5**	Evaluate
7.	Describe about Liquid Crystal Polymer.	**BTL 1**	Remember
8.	Explain the terms PDMS and PMMA.	**BTL 4**	Analyze
9.	Classify the dimmer variations of Parylene.	**BTL 3**	Apply
10.	Show the advantages of polymers.	**BTL 3**	Apply
11.	Generalize the difference between the properties of plastics and fibers.	**BTL 6**	Create
12.	Examine the foundry process in MEMS.	**BTL 4**	Analyze
13.	Define viscoelastic creep.	**BTL 1**	Remember
14.	What is Parylene?	**BTL 2**	Understand
15.	What is MOEMS?	**BTL 1**	Remember
16.	Give the properties of Teflon.	**BTL 2**	Understand
17.	List the actuators for optical MEMS.	**BTL 1**	Remember
18.	Define optical mirrors.	**BTL 1**	Remember
19.	Generalize the properties of polyimide materials.	**BTL 6**	Create
20.	What are the surface and wetting properties of polymers?	**BTL 2**	Understand
21.	Can liquid crystal polymer be used as a substrate? And Why?	**BTL 4**	Analyze
22.	How polymers are classified according to temperature?	**BTL 5**	Evaluate
23.	Mention some of the properties of polymers.	**BTL 2**	Understand
24.	Show the polyimide structure of SU-8.	**BTL 3**	Apply

PART- B

1.	Give short notes on:		**BTL 2**	Understand
	i. Polyimide	**(7)**		
	ii. LCP	**(6)**		
2.	Generalize the categories and sources in Optical MEMS.	**(13)**	**BTL 3**	Apply

3.	Discuss in detail about Polydimethylsiloxane with case study.		**(13)**	**BTL 2**	Understand
4.	Discuss about the Optical MEMS from micro mirrors to complex systems.		**(13)**	**BTL 2**	Understand
5.	Summarize the fabrication process of silicon accelerometer with Parylene beams.		**(13)**	**BTL 5**	Evaluate
6.	**i.**	Describe the molecular structure and properties of Liquid Crystal Polymer.	**(9)**	**BTL 1**	Remember
	ii.	Describe the molecular structure and properties of Poly methyl methacrylate.	**(4)**		
7.	Explain the following :			**BTL 4**	Analyze
	i.	SU-8	**(6)**		
	ii.	Parylene	**(7)**		
8.	Explain in detail about schematic diagram of LCP polymer flow sensors.		**(13)**	**BTL 4**	Analyze
9.	Illustrate the following:			**BTL 3**	Apply
	i.	Lenses.	**(7)**		
	ii.	Micro mirros.	**(6)**		
10.	Explain about optical applications of MEMS devices.		**(13)**	**BTL 4**	Analyze
11.	Explain the classification, properties and applications of Polyimide.		**(13)**	**BTL 1**	Remember
12.	Examine about pneumatic controlled Polydimethylsiloxane valve.		**(13)**	**BTL 1**	Remember
13.	Discuss in detail about fluorocarbon and PMMA.		**(13)**	**BTL 1**	Remember
14.	Examine the top and cross-sectional view of Parylene surface micro machined membrane with integrated metal resistors.		**(13)**	**BTL 3**	Apply
15.	Design a multimodal polymer based Tactile Sensor.		**(13)**	**BTL 6**	Create
16.	Discuss in detail on foundry process involved in Optical MEMS devices.		**(13)**	**BTL 2**	Understand
17.	Explain the classification, properties and applications of PDMS.		**(13)**	**BTL 3**	Apply
PART- C					
1.	Design a Parylene surface micro machined pressure sensor with fabrication steps.		**(15)**	**BTL 6**	Create
2.	Discuss in detail about the Assembly of 3D MEMS with any one Application**.**		**(15)**	**BTL 6**	Create
3.	Assess the need for actuators and the types of actuators used for active optical MEMS applications		**(15)**	**BTL 5**	Evaluate
4.	Explain the classification, properties and applications of LCP.		**(15)**	**BTL 5**	Evaluate
5.	**i.**	State the Principle and explain the operation of a typical micro mirror.	**(7)**	**BTL 5**	Evaluate
	ii.	Conclude how micro mirror technology is applied in scanning electron micrograph.	**(8)**		

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
1.	List the applications of NEMS.	**BTL 1**	Remember
2.	List the Nano fabrication techniques.	**BTL 2**	Analyze
3.	State the general principle of Nano fabrication.	**BTL 6**	Create
4.	What do you mean by Nanoproduct?	**BTL 1**	Remember
5.	List the applications of Nanoproducts.	**BTL 2**	Understand
6.	What is solar cell?	**BTL 1**	Remember
7.	Distinguish between Quantum wires and Quantum dots.	**BTL 2**	Understand
8.	State the laws of quantum physics.	**BTL 1**	Remember
9.	What is Knudsen number?	**BTL 4**	Analyze
10.	What is match number?	**BTL 1**	Remember
11.	Define rarefied gas.	**BTL 2**	Understand
12.	Assess the important phonon characteristics.	**BTL 5**	Evaluate
13.	Express the Boltzmann transport equation.	**BTL 2**	Understand
14.	Summarize the advantages and disadvantages of Boltzmann transport equation.	**BTL 3**	Apply
15.	Define NEMS.	**BTL 4**	Analyze
16.	Differentiate between MEMS and NEMS.	**BTL 4**	Analyze
17.	What is Nano fabrication?	**BTL 1**	Remember
18.	What is meant by Buckminster fullerenes?	**BTL 1**	Remember
19.	What is quantum confinement?	**BTL 5**	Evaluate
20.	Nano particle of gold is purple in colour. Justify.	**BTL 5**	Evaluate
21.	Mention the benefits of using microfluid platforms.	**BTL 3**	Apply
22.	Relate the Reynolds number and viscosity.	**BTL 4**	Analyze
23.	Write the fabrication methods of MEMS.	**BTL 2**	Understand
24.	What do you mean by Nanoparticles?	**BTL 5**	Evaluate

PART – B

1.		Describe in detail about Quantum Molecular Dynamics and equation of motion.	**(13)**	**BTL 2**	Understand
2.		Discuss about the various applications involved in Nano products and explain any four about it.	**(13)**	**BTL 2**	Understand
3.		Explain in detail about laws of Quantum physics and its Quantum theory.	**(13)**	**BTL 5**	Evaluate
4.	**i.**	What is a Phonon and explain its characteristics.	**(6)**	**BTL 1**	Remember
	ii.	Describe about the relation involved in Phonon Dispersion.	**(7)**		
5.		Derive Boltzmann Transport Equation and generalize its advantages and Disadvantages.	**(13)**	**BTL 6**	Create
6.	**i.**	Distinguish about Particle and Wave Transport	**(5)**	**BTL 4**	Analyze
	ii.	Explain about Accelerometer and Nano nozzles of NEMS	**(8)**		
7.		Discuss in detail about the Nano fabrication methods.	**(13)**	**BTL 1**	Remember
8.	**i.**	What are the problem involved with Nanotechnology Engineering	**(6)**	**BTL 4**	Analyze

	ii. Explain about any two applications in NEMS	**(7)**		
9.	Describe about measurement of Sub micrometer Particle deposition on Silicon Wafers in Cleanroom Environment.	**(13)**	**BTL 1**	Remember
10.	**i.** Discuss briefly about NEMS in wireless Technology	**(6)**	**BTL 2**	Understand
	ii. What are major challenges facing in Nanoscale Engineering?	**(7)**		
11.	Describe the thermal conductivity and identify the issues of Nano structures.	**(13)**	**BTL 1**	Remember
12.	Explain about Nano drug Encapsulation.	**(13)**	**BTL 4**	Analyze
13.	Illustrate about modelling of Knudsen layer effects in micro/nanoscale gas flows.	**(13)**	**BTL 3**	Apply
14.	Illustrate the basic building blocks involved in NEMS technology.	**(13)**	**BTL 3**	Apply
15.	Explain in detail about Fullerenes and its applications.	**(13)**	**BTL 3**	Apply
16.	Describe the schematic diagram of an integrated gas chromatography system.	**(13)**	**BTL 3**	Apply
17.	Discuss the role of nanotechnology in the fabrication of NEMS devices.	**(13)**	**BTL 2**	Understand
PART – C				
1.	Discuss the various fabrication techniques involved in NEMS	**(15)**	**BTL 4**	Analyze
2.	State the modelling of nanoscale heat conduction by Boltzmann transport equation.	**(15)**	**BTL 5**	Evaluate
3.	Explain the role of Engineering Fluids at the Nanoscale.	**(15)**	**BTL 5**	Evaluate
4.	Describe the nanofabrication and its principles involved in nanotechnology.	**(15)**	**BTL 4**	Analyze
5.	Discuss the applications of nanotechnology in various fields.	**(15)**	**BTL 4**	Analyze

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
1.	What is the principle of mechanical milling?	**BTL 2**	Understand
2.	Point out the advantages of top-down approach.	**BTL 4**	Analyze
3.	Analyse self-assembly of nanostructures.	**BTL 4**	Analyze
4.	What is the principle of electron beam lithography?	**BTL 1**	Remember
5.	Generalize the application of self-assembly materials.	**BTL 6**	Create
6.	List any four day to day live commercial applications of nanotechnology.	**BTL 6**	Create
7.	When does contamination arise in Attritor milling?	**BTL 1**	Remember
8.	Identify the category to which sol-gel, MBE, ECAP and laser ablation belong to.	**BTL 1**	Remember
9.	Classify the vapour phase deposition methods.	**BTL 3**	Apply

10.	What do you mean by colloidal routes?	**BTL 2**	Understand
11.	Examine various polymeric materials in Nano precipitation.	**BTL 3**	Apply
12.	Differentiate bottom-up and Top-down approach.	**BTL 1**	Remember
13.	Summarize the applications of milling.	**BTL 5**	Evaluate
14.	Compare the term MBE and MOMBE.	**BTL 5**	Evaluate
15.	Classify the different types of milling.	**BTL 4**	Analyze
16.	Illustrate the principle of atomic layer epitaxy.	**BTL 3**	Apply
17.	What is meant by co-precipitation?	**BTL 2**	Understand
18.	Define sputtering and list its types.	**BTL 1**	Remember
19.	Distinguish between photolithography and electron beam lithography.	**BTL 2**	Understand
20.	State the principle of bottom-up approach with an example.	**BTL 1**	Remember
21.	Analyze which method of process mostly used for synthesis of nano materials.	**BTL 3**	**Apply**
22.	No safety precautions are needed for MBE process. Justify.	**BTL 5**	**Evaluate**
23.	Summarize the advantages and disadvantages of MOCVD.	**BTL 4**	Analyze
24.	Discuss the process of MOMBE.	**BTL 2**	Understand

PART- B

1.	**i.**	Differentiate PVD and CVD.	**(7)**	**BTL 4**	Analyze
	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
3.	Illustrate the schematic representation of vapour phase deposition methods.		**(13)**	**BTL 3**	Apply
4.	Discuss the working of molecular beam epitaxy for producing nanomaterials.		**(13)**	**BTL 2**	Understand
5.	Discuss in detail about Atomic Layer Epitaxy in detail.		**(13)**	**BTL 2**	Understand
6.	Explain the working of e-beam evaporation with neat sketch.		**(13)**	**BTL 5**	Evaluate
7.	Explain in detail about the working of mechanical milling process and mention its merits and demerits.		**(13)**	**BTL 4**	Analyze
8.	Write short notes on:			**BTL 1**	Remember
	i.	Precipitation	**(7)**		
	ii.	Self -assembly	**(6)**		
9.	Enumerate the different chemical methods of synthesis of nanomaterials and state its advantages and disadvantages.		**(13)**	**BTL 3**	Apply
10.	Briefly explain the sputtering and its types.		**(13)**	**BTL 2**	Understand
11.	What are the basic steps in a lithography sequence and explain it? Mention its advantages and disadvantages.		**(13)**	**BTL 1**	Remember
12.	Describe about top down approach in synthesis of nanomaterials.		**(13)**	**BTL 1**	Remember
13.	Write in detail about electron beam lithography (EBL) and generalize its advantages compared with photolithography.		**(13)**	**BTL 6**	Create
14.	Define colloidal routes. Describe in detail about fabrication of nanoparticles by simple colloidal process.		**(13)**	**BTL 1**	Remember
15.	Explain in detail the top down approach with relevant diagrams		**(13)**	**BTL 3**	Apply
16.	Discuss in detail, how Chemical Vapour Deposition process can be utilized during the fabrication of		**(13)**	**BTL 2**	Understand

	nanosystems.			
17.	Describe the MBE growth technique with a sketch.	**(13)**	**BTL 3**	Apply
PART- C				
1.	Describe in detail about strategies involved in the synthesis of self-assembly.	**(15)**	**BTL 6**	Evaluate
2.	Explain the working of MOMBE process with neat sketch.	**(15)**	**BTL 5**	Evaluate
3.	Discuss the role of bottom up approach in nano technology.	**(15)**	**BTL 6**	Create
4.	Explain the schematic diagram of a thermal evaporation system.	**(15)**	**BTL 5**	Create
5.	Explain the applications of nano powders in industry.	**(15)**	**BTL 5**	Create