Course Title: **SOFT NANO TECHNOLOGY**

Paper:I

Credit Units: 3

Level: PG (Pre-Ph.D)

Credit Distribution of the course		
Lecture (L)	Tutorial (T)	Practical (P)
3	0	0

Course Objectives:

The fabrication of large-area polymer structures with feature sizes from a few microns to the molecular level is crucial for various technologies, including molecular electronics, flexible displays, optical sensors, super adhesives, self-cleaning surfaces, and tissue engineering scaffolds. The meso scale, bridging molecular and macroscopic worlds, allows the observation of both molecular interactions and macroscopic effects, leading to new phenomena. Successful applications depend on accessible patterning techniques that produce defect-free structures over large areas with precise characterization.

Pre-requisites: Post Graduation or 4 years graduate with Research

Course Contents/Syllabus:

Descriptors/Topics	**Weightage (%)**
Unit I: Fundamentals of Nanomaterials and Surface Science	
Introduction, History of Nanomaterials, Top-down and Bottom-up Approaches for Nanomaterial Synthesis, Nanocomposites and Bulk Nanoscale Structures, Introduction to Patterning of Thin Films, Applications of Nano-Patterned Films and Surfaces, Basic Concepts of Wetting: Cassie and Wenzel Regimes, Basic Concepts of Surface Tension.	**35**
Unit II: Quantum Effects, Fabrication Techniques, and Photolithography	
Carbon Nanotubes Introduction, Zero-Dimensional: Quantum Dots, One-Dimensional: Nanowires, Nanorods, Nanotubes, Nanofibres, Effect of Quantum Size on Magnetic, Optical, Electrical, Catalytic, and Other Properties, Surface-to-Volume Ratio and Its Effects on Properties, Different Nano-Fabrication Regimes Including Self-Assembly and Micelle Formation, Introduction to	**40**

Photolithography, Discussion on Photolithography: Photoresists, Spin Coating, Exposure, and Development	
Unit III: Advanced Lithography and Atomic Force Microscopy	
Nano Imprint Lithography, Soft Lithography: Introduction and Different Techniques, Basic Concepts of Atomic Force Microscopy, Different Imaging Modes of Atomic Force Microscopy	**25**

Course Outcomes (COs)

CO1: Understand fundamentals of nanomaterials, synthesis methods, and surface science.

CO2: Learn quantum effects and their impact on nanomaterial properties.

CO3: Explore nano-fabrication techniques, including self-assembly and photolithography.

CO4: Understand advanced lithography methods for nano-patterning.

CO5: Study the principles and imaging modes of Atomic Force Microscopy.

CO6: Apply nano-patterning techniques for real-world technological applications.

Pedagogy for Course Delivery:

The course will be delivered in the form of lectures and discussions.

Assessment/ Examination Scheme:

Evaluation scheme and mode will be as per the guidelines notified by the Siddharth University, Kapilvastu, Siddharth Nagar

Recommended Books

1. Alternative Lithography", C. M. Sotomayor Torres (Ed.), Kluwer Academic Press, 2003.

2. Creating Micro and Nano Patterns on Polymeric Materials", A del Campo and E. Arzt (Ed), Wiley, 2011.

3. "Micro Fluidics and Micro Scale Transport Process", Suman Chakraborty (Ed), CRC Press, 2013

Course Title: **SUPRAMOLECULAR CHEMISTRY**

Paper: II

Credit Units: 3

Level: PG (Pre-Ph.D)

Credit Distribution of the course		
Lecture (L)	Tutorial (T)	Practical (P)
3	0	0

Course Objectives: Molecular recognition is responsible for many biological functions besides it is useful in materials research. Supramolecular chemistry is based on molecular recognition and its consequences like biological sensors molecular-scale information processing drug design and so on. This chemistry is also of relevance in the synthesis of nanostructures thin films hydrogen and carbon dioxide storage detection of explosives. In short it is useful in fundamental science as well as several areas of applied research.

Pre-requisites: Post Graduation or 4 years graduate with Research

Course Contents/Syllabus:

Descriptors/Topics	**Weightage (%)**
Unit I: **Fundamentals of Supramolecular Chemistry and Molecular Recognition**	
Introductory remarks and relevance of study, The original meaning of "Supramolecular Chemistry" and its evolution, Various intermolecular interactions and the meaning of molecular recognition, Concepts of positive and negative cooperativity, Definition of Host-Guest Chemistry, Structure synthesis properties and applications of, Crown Ethers, Cryptands, Cyclodextrins, Zeolites properties and applications, Clathrate Hydrates and their applications, Applications of Supramolecular Chemistry in various fields	**35**
Unit II: Thermodynamics Macrocyclic Systems and Molecular Baskets	
Thermodynamic treatment of molecular recognition, Introduction of supramolecular synthons, Synthesis of macrocycles, Thermodynamic and kinetic template effects, Macrocyclic effects and stability crown ethers and lariat crown ethers, Macrocyclic effects thermodynamic and kinetic stability of complexes, Calixarenes and the art of molecular basket making, Conformational flexibility of calixarenes at room temperature and their binding characteristics, Hybrids of	**40**

calixarenes and their uses, Cucurbiturils of different sizes and their characteristics, Use of cucurbiturils in chemical reactions, Cyclodextrins and their structural characteristics as supramolecular reaction vessels	
Unit III: **Advanced Supramolecular Structures and Applications**	
Macrobicyclic cryptands structural characteristics synthesis strategy and methodology, Rigidity and conformational lability of cryptands layer effects, Synthesis of cryptands and cryptates of cations and anions and the cryptate effects, Mononuclear and multinuclear cryptates of transition metal ions and their uses in homogeneous catalysis, Cyclophanes and cryptophanes inclusion of non-polar organic molecules and other properties, Spherands synthesis and metal binding properties, Dendrimers and their structural characteristics, Synthesis of dendrimers by divergent and convergent methods, Binding properties of dendrimers and mimicry of metalloproteins' active sites catalysis, Interlocked structures of different designs pseudo rotaxanes rotaxanes molecular shuttles, Metal helicates catenanes catenates trefoil knots, Synthesis of these complex structures via metal templating and π-π stacking interactions	**25**

Course Outcomes (COs)

CO1: Understand the fundamentals of supramolecular chemistry and molecular recognition.

CO2: Learn about host-guest interactions and their applications in various fields.

CO3: Explore the thermodynamics and kinetics of supramolecular systems.

CO4: Study macrocyclic systems, including crown ethers, calixarenes, and cucurbiturils.

CO5: Analyze the synthesis and applications of cryptands, dendrimers, and interlocked structures.

CO6: Apply supramolecular chemistry concepts in catalysis, nanotechnology, and material science.

Pedagogy for Course Delivery:

The course will be delivered in the form of lectures and discussions.

Assessment/ Examination Scheme:

Evaluation scheme and mode will be as per the guidelines notified by the Siddharth University, Kapilvastu, Siddharth Nagar

Recommended books

1. Supramolecular Chemistry" – *Jonathan W. Steed and Jerry L. Atwood*
2. Supramolecular Chemistry: From Concepts to Applications" – *Stefan Kubik*
3. Supramolecular Chemistry: Fundamentals and Applications" – *Paul D. Beer, Timothy J. Barendt, and Jason J. Davis*
4. Supramolecular Chemistry: Concepts and Perspectives" – *Jean-Marie Lehn*