Shivaji University, Kolhapur

Syllabus For

B. Sc. Part-III
Nanotechnology

to be implemented from the academic year 2018-19

(June 2018) onwards.

SHIVAJI UNIVERSITY, KOLHAPUR
(B. Sc. Nanotechnology)
T. Y. B. Sc., Sem. V
Course Structure

Course No	Title	Lecture	Practical	Examination/ Evaluation of marks/Semester
NT-309T	Nanometrology: Standards And Nanomanufacturing	37	-	50
NT-310T	Nanomechanics	38	-	50
NT-311T	Nano-Optics	37	-	50
NT-312T	Nanomagnetism	38	-	50
NT-313P	Laboratory Course-III	-	60	Annual
NT-314P	Laboratory Course-IV	-	60	Annual

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Course No	Title	Lecture	Practical	Examination/ Evaluation of marks/Semester
NT-313T	Nanostructure and Nanocomposite thin films	37	-	50
NT-314T	Nanocatalysis	38	-	50
NT-315T	Environmental Nanotechnology	37	-	50
NT-316T	Nanobiotechnology	38	-	50
NT-313P	Laboratory Course-III	-	60	100
NT-314P	Laboratory Course-IV	-	60	100

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Paper IX

Title of Paper: Nanometrology: Standards And Nanomanufacturing
Subject Code: NT-309T

Unit I: The Transition, the Need, Nanometrology and Uncertainty **10 L**
Background to Nanometrology,Background to Nanomanufacturing, The Nano Perspective, Nanometrology. Uncertainty, Heisenberg Uncertainty, Quantum Entanglement, Applications.

Unit II:Quantum Metrology and Nanometrology tools **9 L**

Atomic Clocks, the Meter and Time,The Quantum Triangle, The Single-Electron Transistor. Nanometrology tools: Electron Beam and Atomic Force Tools, Spectroscopic Tools,Nanomechanical Tools.

Unit III:Nanometrology and Nanomanufacturing Standards **10 L**
Standards for Nanotechnology, NIST Efforts, IEEE Roadmap for Nanoelectronics

Unit IV:Nanomanufacturing Molecular Assembly **8 L**
Lithographies,Nanomanipulatorsand Grippers, Bottum-Up Manufacturing,Molecular-Scale Assembly Lines.

References:
1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.

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Paper X

Title of Paper: Nanomechanics **Subject Code:** NT-310T

Unit I: Introduction **10L**

Two - atom chain mechanics, interaction potentials, external forces, dynamics motion, Three atom chain. Lattice mechanics, Stress and strain.

Unit II: Linear elasticity relations and Molecular dynamics **10L**

Orthotropic and isotropic materials, crystallines materials.

Molecular dynamics: verlet algorithms, Nordsieck/gear predictor-corrector methods, molecular dynamics applications, nanomachines, wear at the nanometer level.

Unit III: Structure and mechanical properties of carbon nanotubes **10 L**

Structure of carbon nanotubes, mechanical properties of carbon nanotubes.

Nanomechanical measurement techniques and application: AFM measurements: mechanical properties of CNTs, Nanoindantation.

Unit IV: Nano- Microelectromechanical System **8L**

MEMS fabrication techniques, NEMS fabrication techniques, MEMS/NEMS Motion Dynamics, MEMS Devices and applications, NEMS Devices and applications.

References:

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.

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Paper XI

Title of Paper: Nano-Optics **Subject Code:** NT-311T

Unit I:Introduction to Optics and the Surface Plasmon **10L**

Interactions of light with Matter,The Nano Perspective. Surface Plasmon: The Surface Plasmon Resonance, Scattering, Color Generation from Nanoparticles and Nanostructures, Applications of Nanoplasmonics.

Unit II:Quantum Dots **8 L**

The BhorExiton Radius, Tunig the Gap, Luminescence, Applications.

Unit III: Near-Field Microscopies **11 L**

The Diffraction Limit, Near-Field Microscopy, Applications.

Unit IV: Nanophotonics **8 L**

Photonics, Photonic Structures in living systems, Photonic Crystals,Fabrications of Nanophotonic.

References:

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.

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Paper XII

Title of Paper: Nanomagnetism **Subject Code:** NT-312T

Unit I:Introduction **10L**

History, MagneticPhenomena and Their Classical Interpretation, The Nano Perspective.

Unit II:Characteristics of Nanomagnetic Systems **8 L**

Introduction to Nanomagnetism, Characteristics OfNanomagneticmaterials, Magnetiation and Nanostructures, Magnetic in Reduced Dimension Systems: two- Dimensional Systems, One-Dimensional, Zero-Dimensional systems.

Unit III:Physical Properties of Magnetic Nanostructures **11 L**

Sustrate Effects on Structures and Related Properties, Oscillatory Exchange Coupling, Spin-Polarized Tunneling, Magnetoresistivity, Magnetic Moments of 3d Transition Metal Clusters, The Temperature Depending of Magnetic Moments.

Unit IV: Reecent Progress in NanocaleSample Preparation and NanomagnetismApplications **8 L**

Expitaxial Methods,Nanomagnetism Application: Overview. Current Status of Spin-Based Electonics Devices, Sensors, Nanomagnetism for Biomedical Applications.

References:

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
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Paper XIII

Title of Paper:Nanostructure and Nanocomposite thin filmsSubject Code: NT-313T

Unit I:Introduction

Introduction. Classification of Nanostructured, Nanocomposite Tribological Coatings: Nanoscale Multilayer Coatings, Nanocomposite Coatings, Functionally Graded Coatings. Background of Nanostructured Super-Hard Coatings: Nanoscale Multilayer Coatings, Single Layer Nanocomposite Coatings.

Unit II:New Directions for Nanostructured Super-Tough Coatings

Functionally Graded Multilayer Coatings, Functionally Graded Nanocomposite Coatings. Processing Technique and Principles: Plasma Definition, Chemical Vapor Deposition, Physical Vapor Deposition.

Unit III:General Considerations and Practical Aspects of Sputtering Deposition

Reactive Sputtering Deposition Process Stability, Film Structure Control (Structure Zone Models), Sputtering Glow Discharges, Energetic Enhanced Deposition.

Unit IV:Applications of Thin Film

Technological Application of Thin Films, Unbalanced Magnetron Sputtering of Ti-Al-Si-N Coatings. Unbalanced Magnetron Sputtering of Ti-Si-B-C-N Coatings. Pulsed Closed Field Unbalanced Magnetron Sputtering of Cr-Al-N Coatings

References.

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.
3. Nanocoatings: Principles and Practice By stevenabbott and Nigel Holmes,

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Paper XIV

Title of Paper: NanocatalysisSubject Code: NT-314T

Unit I: Introduction to Catalytic and Nanocatalytic materials:
The importance of Catalysis in a modern society, what is catalyst?The nano perspective.

Unit II: Fundamentals of Catalysis
Adsorption of a molecule on a catalyst surface, adsorption theory, surface reaction.

Unit III: Synthesis
Synthesis requirements, example of a Conventional Synthetic technique, Nontraditional methods for preparing nanocatalyst.

Unit IV: Catalyst Characterization
Overview, bulk characterization techniques, surface characterization techniques.

References:
1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.
3. Physical Chemistry of Surfaces , W. Adamson, Wiley Intersciences,(5th edition) 1990.
4. Nanoparticles and Catalysis; D. Astruc, Wiley-VCH, 2008

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Paper XV

Title of Paper: Environmental Nanotechnology **Subject Code:**NT-315T

Unit I: The Environmental (and Technology)
Background,Traditional Methods of Detecting, Environmental Contaminants, Type of Environmental Sensors, Introduction to Environmental Mitigation National Security and Defense.

Unit II: Water and Soil Quality, Monitoring, and Mitigation
Traditional water Treatment, nanomaterial Contamination in Aqueous Environmental, Activated Carbon-A Simple Traditional Nanotechnology, Membranes and separation Technology, Oil Spills ,Chemical and Biological Sensors and Detectors

Unit III: Air Quality,Monitoring,and Mitigation
Gas Separation: Advanced Membrane Technology,CO_2 Mitigation, Hydrogen Production and Purification, Chemical Sensing and Detection

Unit IV: Energy
Solar Energy and Nano, Batteries, Hydrogen Production and Storage, Fuel Cells, Solar Heating and Power generation Epilogue: SAMMS, One More Pass at Hydrogen Storage, Concluding Thoughts

References:
1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
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Paper XVI

Title of Paper: NanobiotechnologySubject Code: NT-316T

Unit I: Introduction to Nanobiotechnology

Definitions, Biotechnology, Bio-Nanotechnology, Biomolecular Nanotechnology, Nanobiotechnology, Biomedical Nanotechnology, Nanobiotechnology. The Biology Immune System: Natural Molecular Recognition, the Innate System, The Adaptive Immune System, White Blood Cell and Antibodies.

Unit I: Using Antibodies in Biosensors: Immunoassays

Antibodies in Molecular Recognition Sensors, Production of Antibodies, Monoclonal Antibodies, Reverse Transcriptase, Recombinant DNA, Antibodies as Selection Tools for Biosensors. Cantilevers as Nano-Biosensors: Sensing Physical Properties, Cantilevers and selective binding, Active Cantilever Sensors, Passive Cantilever Sensors, Surface Effects on Cantilevers, Steric Effects, Surface Free Energy at the Nanoscale.

Unit III: Micro- and Nanosensors and Applications:

Biomedical Cantilever Application, Cantilever Sensor for Cancer Screening, Biotechnology Applications of Cantilevers, Surface Acoustic Wave Nanosensors, Electrochemical Nanosensors. Optical Nanosensors: Photonic Nanosensors, Surface Plasmon Nanosensors, Nanoscale Optical Resonance Grids- Using the Butterfly Wing Effect, Guided- Mode Resonance Sensors, Applications of Guided Mode Sensors.

Unit IV: Nanotechnology for Manipulation of Biomolecules:

Optical Tweezers, Dielectrophoresis, Some Dielectrophoresis Applications, Micro- and Nanofluidics, Biochips, Labs on Chips and Integrated Systems.

References:

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.

Nature of Theory Question Paper for Theory

Q. No. 1 Multiple Choice based objective type (four options for each question be given) 8 Marks
Q. No. 2 Long answer type (Attempt any Two out of three) 16 Marks
Q. No. 3 Short Notes (4 out of 6) 16 Marks
Total 40 Marks

List of Experiments:

Laboratory III

1. Alloy analysis-analysis of Brass metal alloy
2. Redox titration
3. Complexometric titration for estimation of zinc
4. of Hardness of water.
5. Determination of Turbiolity of water sample.
6. Volumetric estimation of Copper and Nickel from the given solution
7. Thermal conductivity -Lee`s method
8. Surface tension of liquid by drop method
9. Thickness of thin film
10. Diffraction due to single slit using sodium/ laser source
11. Diffraction at straight edge
12. Self inductance by Owen`s bridge
13. Resistance of B.G. by half deflection method
14. e/m by Thomson method/ Millikan`s oil drop method
15. Sharpness of resonance in L-C-R series circuit
16. P.O. box- Measurement of resistance of galvanometer (Kelvin`s method)
17. Preparation of superhydrophobicnanocoatings by sol-gel method
18. Environmental Sampling methods and analytical preparations
19. Air pollution monitoring and analysis
20. Determination of total alkalinity and acidity of a water sample.
21. Chemical Oxygen Demand, Dissolved Oxygen and Biological Oxygen Demand
22. Total Hardness, Sulphates , Nitrates and Chlorides
23. Physical Properties of Minerals, ore and Rocks
24. Optical properties of Minerals and Study of crystal systems

Laboratory IV

1. Surface tension by Fergusson`s modified method
2. Diffraction due to cylindrical obstacle
3. Spherical aberration
4. High resistance by leakage
5. Absolute capacity of a condenser (Worsnop and Flint)
6. Polar graph using photo cell/ photo voltaic cell
7. Hystersis curve by CRO.
8. Hall effect
9. Conductometric titration of weak acid V/s weak bases
10. To determine the equivalent conductivity of a weak electrolyte at different concentrations, and hence the dissociation constant of electrolyte.
11. To determine the relative e strength of two acids by conductance measurements.
12. To determine solubility of a sparingly soluble salt in water by conductancemeasurements.
13. To determine the composition of a mixture of acetic acid & hydrochloric acid byConductometric titration.
14. Verification of Ostwalds dilution law & determination of the dissociationconstant of a weak monobasic acid conductometrically.
15. To determine the solubility product of silver chloride using chemical cell.
16. To find the stability constant of the silver ammonia complex.
17. Photoluminescence study of nanomaterials
18. Photocatalytic degradation of dyes
19. Mechanical properties of nanomaterials
20. Determination of partition coefficient of benzoic acid between water and benzene.

Scheme of Practical Examination for B. Sc. Part – III

1. Practical examination will be conducted annually.
2. Practical examination will be conducted for three days per batch.
3. The examination will be conducted in two sessions per day and each session will be of three hours duration.
4. Every candidate should perform total 6 experiments.
5. Study tour up to seven days anywhere in India is compulsory.
6. At least eighty percent practical should be completed by the student
7. The marks distribution for practical is as below. Practical groups Marks

Course	Marks
Laboratory III	75(25 x 3 experiments)
Laboratory IV	75 (25 x 3 experiments)
I) Certified laboratory journal	20
II) Study Tour Report	10
III) Seminar Report / Project Report	20