**ANNA UNIVERSITY, CHENNAI**

**NON- AUTONOMOUS COLLEGES**

**AFFILIATED TO ANNA UNIVERSITY**

# M. TECH. NANOSCIENCE AND TECHNOLOGY

**REGULATIONS 2025**

## PROGRAMME OUTCOMES (POs):

| PO | Programme Outcomes |
|---|---|
| **PO1** | An ability to independently carry out research /investigation and development work to solve practical problems |
| **PO2** | An ability to write and present a substantial technical report/document. |
| **PO3** | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program |

## PROGRAMME SPECIFIC OUTCOMES(PSOs):

| PSO | Programme Specific Outcomes |
|---|---|
| **PSO1** | Students will be able to independently carry out research, investigations, and development activities aimed at solving real-world practical problems within their specialization. |
| **PSO2** | Students will demonstrate the ability to prepare, write, and present comprehensive technical reports, showcasing mastery of the subject matter beyond the undergraduate level. |

**ANNA UNIVERSITY, CHENNAI**

**POST GRADUATE CURRICULUM (NON.AUTONOMOUS AFFILIATED INSTITUTIONS)**

**Programme:** M.Tech. Nanoscience and Technology **Regulations:** 2025

**Abbreviations:**

**BS** – Basic Science (Mathematics)
**ES –** Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**) & Emerging Technology (**ET**))
**SD** – Skill Development
**SL** – Self Learning
**OE** – Open Elective

**L** – Laboratory Course
**T** – Theory
**LIT** – Laboratory Integrated Theory
**PW** – Project Work
**TCP –** Total Contact Period(s)

### Semester I

| S. No. | Course Code | Course Title | Type | Periods per week | | | TCP | Credits | Category |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | |
| 1. | NT25101 | Mathematical Modeling and Simulation | T | 3 | 1 | 0 | 4 | 4 | ES (PC) |
| 2. | NT25102 | Quantum Mechanics | T | 3 | 0 | 0 | 3 | 3 | ES (PC) |
| 3. | NT25103 | Physics and Chemistry of Materials | T | 3 | 0 | 0 | 3 | 3 | ES (PC) |
| 4. | NT25104 | Biological Nanostructures | T | 3 | 1 | 0 | 4 | 4 | ES (PC) |
| 5. | NT25105 | Computation and Simulation Laboratory | L | 0 | 0 | 4 | 4 | 2 | ES (PC) |
| 6. | NT25106 | Nanomaterial Synthesis Laboratory | L | 0 | 0 | 4 | 4 | 2 | ES (PC) |
| 7. | NT25107 | Technical Seminar | - | 0 | 0 | 2 | 2 | 1 | SD |
| **Total Credits** | | | | | | | **24** | **19** | |

## Semester II

| S. No. | Course Code | Course Title | Type | Periods per week | | | TCP | Credits | Category |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | |
| 1. | | Imaging Techniques for Nanotechnology | T | 3 | 0 | 0 | 3 | 3 | ES (PC) |
| 2. | | Physiochemical Characterization of Nanomaterials | T | 3 | 0 | 0 | 3 | 3 | ES (PC) |
| 3. | | Synthesis of Nanomaterials | T | 3 | 0 | 0 | 3 | 3 | ES (PC) |
| 4. | | Programme Elective I | T | 3 | 0 | 0 | 3 | 3 | ES (PE) |
| 5. | | Industry Oriented Course I | - | 1 | 0 | 0 | 1 | 1 | SD |
| 6. | | Materials Structural Characterization Laboratory | | 0 | 0 | 4 | 4 | 2 | ES (PC) |
| 7. | | Physicochemical characterization Laboratory | | 0 | 0 | 4 | 4 | 2 | ES (PC) |
| 8. | | Self Learning Course | --- | - | - | - | - | 1 | - |
| 9. | | Industrial Training | --- | --- | --- | --- | --- | 2 | SD |
| **Total Credits** | | | | | | | **21** | **20** | |

## Semester III

| S. No. | Course Code | Course Title | Type | Periods per week | | | TCP | Credits | Category |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | |
| 1. | | Programme Elective II | T | 3 | 0 | 0 | 3 | 3 | ES (PE) |
| 2. | | Programme Elective III | T | 3 | 0 | 0 | 3 | 3 | ES (PE) |
| 3. | | Programme Elective IV | T | 3 | 0 | 0 | 3 | 3 | ES (PE) |
| 4. | | Open Elective | T | 3 | 0 | 0 | 3 | 3 | OE |
| 5. | | Industry Oriented Course II | --- | 1 | 0 | 0 | 1 | 1 | SD |
| 6. | | Project Work I | --- | 0 | 0 | 12 | 12 | 6 | SD |
| **Total Credits** | | | | | | | **25** | **19** | |

## Semester IV

| S. No. | Course Code | Course Title | Type | Periods per week | | | TCP | Credits | Category |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | |
| 1. | | Project Work II | --- | 0 | 0 | 24 | 24 | 12 | SD |
| **Total Credits** | | | | | | | **24** | **12** | |

## Programme Elective Courses (PE)

| S. No. | Course code. | Course title | Periods per week | | | Total contact periods | Credits |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| 1. | | Lithography and Nanofabrication | 3 | 0 | 0 | 3 | 3 |
| 2. | | Nanocomposite Materials | 3 | 0 | 0 | 3 | 3 |
| 3. | | Nanoelectronics and Sensors | 3 | 0 | 0 | 3 | 3 |
| 4. | | Nanotechnology in Tissue Engineering | 3 | 0 | 0 | 3 | 3 |
| 5. | | Nanotechnology in Agriculture and Food Industry | 3 | 0 | 0 | 3 | 3 |
| 6. | | Nanomaterials for Energy and Environment | 3 | 0 | 0 | 3 | 3 |
| 7. | | Nano Biophotonics | 3 | 0 | 0 | 3 | 3 |
| 8. | | Nano Biosensors | 3 | 0 | 0 | 3 | 3 |
| 9. | | Advanced Drug Delivery System | 3 | 0 | 0 | 3 | 3 |
| 10. | | Processing and Properties of Nanostructured Materials | 3 | 0 | 0 | 3 | 3 |
| 11. | | MEMS and NEMS | 3 | 0 | 0 | 3 | 3 |
| 12. | | Semiconductor Nanostructures | 3 | 0 | 0 | 3 | 3 |
| 13. | | Nano-toxicology | 3 | 0 | 0 | 3 | 3 |
| 14. | | Nanotechnology in Health Care | 3 | 0 | 0 | 3 | 3 |
| 15. | | Entrepreneurship | 3 | 0 | 0 | 3 | 3 |

# Semester I

| NT25101 | Mathematical Modeling and Simulation | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Course Objectives:**

This course will help the students to

- Acquire the knowledge of solving system of linear equations using an appropriate numerical method.
- Approximate the functions using polynomial interpolation numerical differentiation and integration using interpolating polynomials.
- Acquire the knowledge of numerical solution of ordinary differential equation by single and multi step methods.
- Obtain the solution of boundary value problems in partial differential equations using finite differences.
- Study simulation and Monte-Carlo methods and their applications.

**Matrices and Linear Systems of Equations:** Solution of Linear Systems : Cramer's Rule, Gaussian elimination and Gauss Jordon methods, Cholesky decomposition method, Gauss Seidel iteration method, Eigenvalue problems : Power method with deflation for both symmetric and non symmetric matrices and Jacobi method for symmetric matrices.

**Activity:** Solve linear systems of equation using MATLAB.

**Interpolation, Differentiation and Integration:** Lagrange's interpolation, Newton's divided differences, Hermite's interpolation, Newton's forward and backward differences, Numerical differentiation, Numerical integration: Trapezoidal and Simpson's rules, Gaussian quadrature : 2 and 3 point rules.

**Activity:** Solve Interpolation, Differentiation and Integration of equation using MATLAB.

**Differential Equations and Partial Differential Equations:** Initial value problems for first and second order ODEs : Single step methods, Taylor's series method, Euler's and modified Euler's methods, Runge, Kutta method of fourth order, Multi step methods - Boundary value problems : Finite difference approximations to derivatives, Finite difference method of solving second order ODEs .Classification of second order PDE's, Finite difference approximations to partial derivatives, Elliptic equations : Solution of Laplace and Poisson equations, One dimensional parabolic equation, Bender Schmidt method

**Activity:** Solve Differential Equations and Partial Differential Equations of equation using MATLAB.

**Simulation Andmonte Carlo Methods:** Random numbers: Random number algorithms and generators, Estimation of areas and volumes by Monte Carlo techniques, Numerical integration, Computing volumes, Simulation: Loaded Die Problem, Birthday problem, Buffon's needle problem, Two dice problem and Neutron shielding problem

| |
|---|
| **Activity:** Solve Simulation Andmonte Carlo Methods Equations of equation using MATLAB. |
| **Weightage:** Continuous Assessment: 40%, End Semester Examinations: 60% |
| **Assessment Methodology:** Quiz (20%), Assignments (30%) and Internal Examinations (50%) |
| **References:** <br>1. Burden, R. L., & Faires, J. D. (2016). Numerical analysis. Cengage Learning.<br>2. Cheney, W., & Kincaid, D. (2014). Numerical mathematics and computing. Cengage Learning.<br>3. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2014). Numerical methods for scientific and engineering computation. New Age International Pvt. Ltd.<br>4. Landau, D. P., & Binder, K. (2009). A guide to Monte Carlo simulations in statistical physics. Cambridge University Press.<br>5. Maki, D. P., & Thompson, M. (2011). Mathematical modelling with computer simulation. Cengage Learning.<br>6. Sastry, S. S. (2012). Introductory methods of numerical analysis. PHI Learning Pvt. Ltd.<br>7. Taha, H. A. (2018). Operations research. Pearson Education India. |

| | **Description of CO** | **PO** | **PSO1** | **PSO2** |
|---|---|---|---|---|
| CO1 | Explain the numerical methods required for solving chemical engineering problems | PO1(3), PO2(2) | 3 | 2 |
| CO2 | Solve the differential equations of chemical engineering processes | PO1 (3), PO2(2), PO4(2) | 2 | 3 |
| CO3 | Apply Interpolation & optimization methods to solve equations arising from chemical engineering processes | PO1 (3), PO2(2), PO4(2) | 2 | 1 |
| CO4 | Apply integration & differentiation numerical methods to solve chemical processes. | PO1 (3), PO2(2), PO4(2) | 2 | 2 |

| NT25102 | Quantum Mechanics | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objective:**

- To learn basics of Quantum mechanics.
- To know more about time dependent and independent Schrodinger equation and approximation methods.
- To know the concept of Quantum computation

**Basics of Quantum Mechanics:** Wave-particle duality, group velocity, Phase velocity, De-Broglie wavelength, Uncertainty principle and Schrödinger equation.

**Activity: Double-Slit Simulation** – Use PhET simulation to observe electron interference. Calculate de Broglie wavelength for different particles (electron, proton, neutron).

**Time Dependent and Time Independent Schrödinger Equation:** Solutions of the one-dimensional Schrödinger equation for free particle, particle in a box, particle in a infinitely deep well potential, linear harmonic oscillator, Particle in a three dimensional box, density of states, free Electron theory of metals, The spin half problem and properties of Pauli spin matrices.

**Activity: Particle in a Box Plotting** – Solve and plot the wavefunctions and energy levels for a 1D infinite potential well using Python or Excel.

**Approximate Methods:** Time independent and time dependent perturbation theory for non-degenerate and degenerate energy levels, the variational method, WKB approximation, adiabatic approximation, sudden approximation.

**Activity: Variational Method Practice** – Use a trial wavefunction to estimate the ground state energy of a harmonic oscillator. Compare with exact value.

**Quantum Computation:** Concept of quantum computation, Quantum Q-bits, Introduction to nuclear spin, quantum confinement, quantum devices, single electron devices.

**Activity: Quantum Circuit Simulation** – Use IBM Quantum Lab or Qiskit to create a simple quantum circuit (e.g., apply Hadamard + CNOT gates) and observe qubit behavior.

**Weightage:** Continuous Assessment: 40%, End Semester Examinations: 60%

**Assessment Methodology:** Quiz (20%), Assignments (30%), Internal Examinations (50%)

**References:**


1. Beiser, A. (2009). *Modern physics*.
2. Bransden, B. H., & Joachain, C. J. (2000). *Quantum mechanics*.
3. Eisberg, R., & Resnick, R. (1985). *Quantum physics of atoms, molecules, solids, nuclei, and particles*.

4. Ghatak, A. (2004). *Quantum physics: Theory and applications*. Springer.
5. Shankar, R. (2000). *Principles of quantum mechanics*.
6. Cohen-Tannoudji, C., Diu, B., & Laloë, F. (1997). *Quantum mechanics* (Vols. 1 & 2).


| | **Description of CO** | **PO** | **PSO1** | **PSO2** |
|---|---|---|---|---|
| CO1 | Explain basic quantum concepts like wave-particle duality and uncertainty principle. | PO1(3), PO2(2) | 2 | 3 |
| CO2 | Solve Schrödinger equations for different quantum systems. | PO1 (3), PO2(2), PO4(2) | 2 | 1 |
| CO3 | Apply approximation methods to estimate energy levels in quantum systems. | PO1 (3), PO2(2), PO4(2) | 3 | 2 |
| CO4 | Describe the basics of quantum computation and simulate simple quantum circuits. | PO1 (3), PO2(2), PO4(2) | 2 | 2 |

| NT25103 | Physics and Chemistry of Nanomaterials | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To gain knowledge on Physical and chemical aspects of Nanomaterials.
- To know about diffusion and surface defects, nanostructures and Nano systems

**Physics Aspects:** Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials, surface area and aspect ratio- band gap energy- quantum confinement size effect.

**Activity:** Calculate & Compare Band Gap Energy — Use sample data or simulation to calculate band gap energy for nanoparticles of different sizes. Plot size vs band gap and explain quantum confinement effect.

**Chemistry Aspects :** Photochemistry and Electrochemistry of nanomaterials–Ionic properties of nanomaterials, Nanocatalysis-Nanoscale heat transfer-Electron transport in transition metals and semi conducting nanostructures.

**Activity:** Analyze Nanocatalysis Reaction — Study a case (real or simulated) of nanoparticle-catalyzed dye degradation. Identify how ionic properties and surface area influence catalytic efficiency.

**Surface Defects and Diffusion in Nanostructures:** Classifications of nanomaterials, Zero dimensional, one-dimensional, and two-dimensional nanostructures, Kinetics in nanostructured materials-multi layer thin films and super lattice-clusters of metals, semiconductors, and nanocomposites, Fick's Law, mechanisms of diffusion-influence of pressure and temperature, Kirkendall effect-surface defects in nanomaterials, effect of microstructure on surface defects-interfacial energy.

**Activity:** Diffusion Rate Estimation — Using Fick's laws, calculate diffusion rates in a thin film nanostructure at different temperatures and pressures. Discuss the role of surface defects and Kirkendall effect.

**Nanosystems:** Nanoparticles through homogeneous and heterogeneous nucleation, Growth controlled by surface and diffusion process, Oswald ripening process, influence of reducing agents solid state phase segregation, Mechanisms of phase transformation, grain growth and sintering, precipitation in solid solution-Hume-Rothery rule.

**Activity:** Nucleation & Growth Simulation — Model homogeneous vs heterogeneous nucleation and Ostwald ripening through graphical or computer simulation tools. Relate growth control to reducing agents and sintering.

**Weightage:** Continuous Assessment: 40%, End Semester Examinations: 60%

**Assessment Methodology:** Quiz (20%), Assignments (30%), Internal Examinations (50%)

**References:**


1. Kolasinski, K. W. (2002). *Surface science: Foundations of catalysis and nanoscience*. Wiley.
2. Cao, G. (2004). *Nanostructures & nanomaterials: Synthesis, properties & applications*. Imperial College Press.
3. Gersten, J. I. (2001). *The physics and chemistry of materials*. Wiley.
4. Edelstein, A. S., & Cammarata, R. C. (1998). *Nanomaterials: Synthesis, properties and applications*. Institute of Physics Publishing.
5. Yang, S., & Shen, P. (2000). *Physics and chemistry of nanostructured materials*. Taylor & Francis.
6. Ozin, G. A., & Arsenault, A. C. (2005). *Nanochemistry: A chemical approach to nanomaterials*. Royal Society of Chemistry.
7. Atkins, P., & Julio, P. (n.d.). *Physical chemistry*.


| | **Description of CO** | **PO** | **PSO1** | **PSO2** |
|---|---|---|---|---|
| CO1 | Explain size-dependent physical properties and quantum confinement effects in nanomaterials. | PO1(3), PO2(2) | 3 | 2 |
| CO2 | Describe chemical behaviors of nanomaterials including photochemistry, electrochemistry, and nanocatalysis. | PO1 (3), PO2(2), PO4(2) | 2 | 2 |
| CO3 | Analyze surface defects, diffusion mechanisms, and their impact on nanostructured materials. | PO1 (3), PO2(2), PO4(2) | 1 | 2 |
| CO4 | Understand nanosystem formation processes such as nucleation, growth, phase transformations, and sintering. | PO1 (3), PO2(2), PO4(2) | 2 | 2 |

| NT25104 | Biological Nanostructures | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Course Objectives:**

- Impart knowledge on the nanostructures and nanoscale phenomenon in cells.
- To understand the different three-dimensional DNA nanostructures and their uses.
- Familiarize the concepts involved in protein corona with reference to protein nanoparticles and enzyme nanotechnology.
- Acquaint with the glyco-metal, glyco-carbon nanoparticles and their fate.
- Explain the synthesis and applications of lipid-based nanostructures

**Cellular Nanostructures:** Cellular elements in developing functional nanostructures and nanomaterials, Nanopatterning, Cytoskeletal nanomechanics, Bacterial and viral nanostructured materials, Plant-derived nanostructures: types, evolution and applications, Phytochemicals in the genesis of nanoparticles.

**Activity: Microscopy Image Identification -** Analyze electron microscope images of plant-derived and bacterial nanostructures. Identify key features and discuss their biological functions.

**DNA Nanoarchitecture:** Genome structure and organization in prokaryotes and eukaryotes, Structure and function of nucleic acids, The Central Dogma of life, DNA tile assembly, brick assembly, 3D DNA nanostructures, Organic and inorganic DNA nanostructures, DNA aptamer and DNA origami, DNA varieties: A, B, and Z, Applications of DNA nanostructures.

**Activity:** Build a Paper DNA Origami Model - Use simple paper folding and cutting to create a basic DNA origami shape. Discuss how DNA's structure allows for such precise assembly.

**Protein and Enzyme Nanoparticles:** Proteins: Structure, classification and functions, Protein nanoparticles: Designing, synthesis strategy, ligands used and their applications, Enzymes and Enzyme nanoparticles: properties, structure: Preparation, immobilization, kinetic properties and applications of enzyme nanoparticles in day-day to life, Synzymes, ribozymes

**Activity:** Immobilization Simulation - Design a virtual experiment to immobilize enzymes on nanoparticles and predict how immobilization affects enzyme activity.

**Nanoparticles of Other Biomolecules:** Classification, Structure Properties and Functions of Lipids and Carbohydrates-Preparation and applications of biopolymers, Chitosan, cellulose, liposomes. Glycoconjugate nanoparticles, Types and advantages of Biolipid Nanostructures- Structure, function and significance of Membranous nanostructures and their role in cellular traffic.

**Activity:** Biopolymer Comparison Table - Compare properties and applications of chitosan, cellulose, and liposomes in a table format. Highlight their roles in drug delivery or tissue engineering.

| |
|---|
| **Weightage:** Continuous Assessment: 40%, End Semester Examinations: 60% |
| **Assessment Methodology:** Quiz (20%), Assignments (30%), Internal Examinations (50%) |

**References:**


1. Barnard, A. S., & Guo, H. (Eds.). (2012). *Nature's nanostructures*. CRC Press.
2. Stroscio, M. A., & Dutta, M. (2004). *Biological nanostructures and applications of nanostructures in biology: Electrical, mechanical and optical properties*. Kluwer Academic Publishers.
3. Iglič, A., Drobne, D., & Kralj-Iglič, V. (2015). *Nanostructures in biological systems: Theory and applications*. CRC Press.
4. Mendes, P. M., Yeung, C. L., & Preece, J. A. (2007). Bio-nanopatterning of surfaces. *Nanoscale Research Letters, 2*(8), 373–384.
5. Häfeli, U. O., Arshady, R., & Kono, K. (2006). Smart nanoparticles in nanomedicine—the MML series. *Smart Nanoparticles in Nanomedicine*, 77.
6. Durán, N., Silveira, C. P., Durán, M., & Martinez, D. S. T. (2011). Mechanistic aspects in the biogenic synthesis of extracellular metal nanoparticles by peptides, bacteria, fungi, and plants. *Applied Microbiology and Biotechnology, 90*(5), 1609–1624.
7. Nelson, D. L., & Cox, M. M. (2012). *Lehninger principles of biochemistry* (5th ed.). W. H. Freeman.
8. De Robertis, E. D. P. (2010). *Cell & molecular biology* (8th ed.). Lippincott Publishers.
9. Lewin, B. (2007). *Genes* (9th ed.). CBS Publishers and Distributors.
10. Ki, Y. (2015). *3D DNA nanostructure*. Humana Press.
11. Bujold, K. E., Lacroix, A., & Sleiman, H. F. (2018). DNA nanostructures at the interface with biology. *Chem, 4*(3), 495–521.
12. Niemeyer, C. M., & Adler, M. (2002). Nanomechanical devices based on DNA. *Angewandte Chemie International Edition, 41*(20), 3779–3783.
13. Hawkins, M. J., Soon-Shiong, P., & Desai, N. (2008). Protein nanoparticles as drug carriers in clinical medicine. *Advanced Drug Delivery Reviews, 60*(8), 876–885.
14. Pundir, C. S. (2015). *Enzyme nanoparticles: Preparation, characterization, properties and applications*. William Andrew.
15. Aelman, C. (2013). *Peptide materials: From nanostructures to applications*. Wiley.
16. Sasso, L. (2012). *Self-assembled peptide nanostructures: Advances and applications in nanobiotechnology*. Pan Stanford Publishing.
17. Stine, K. J. (2015). *Carbohydrate nanotechnology*. Wiley.

18. Reichardt, N. C., Martín-Lomas, M., & Penadés, S. (2013). Glyconanotechnology. *Chemical Society Reviews, 42*(10), 4358–4376.
19. Tresset, G. (2009). The multiple faces of self-assembled lipidic systems. *PMC Biophysics, 2*(1), 1–25.
20. Gordillo-Galeano, A., & Mora-Huertas, C. E. (2018). Solid lipid nanoparticles and nanostructured lipid carriers: A review emphasizing on particle structure and drug release. *European Journal of Pharmaceutics and Biopharmaceutics, 133*, 285–308.

**E-resource**
https://nptel.ac.in/courses/118/106/118106019

| | Description of CO | PO | PSO1 | PSO2 |
|---|---|---|---|---|
| CO1 | Explain cellular nanostructures and their functions. | PO1(3), PO2(2) | 3 | 2 |
| CO2 | Describe DNA-based nanostructures and uses. | PO1 (3), PO2(2), PO4(2) | 2 | 1 |
| CO3 | Explain protein and enzyme nanoparticle design and applications. | PO1 (3), PO2(2), PO4(2) | 2 | 3 |
| CO4 | Recognize biomolecule-derived nanoparticles and their roles. | PO1 (3), PO2(2), PO4(2) | 2 | 2 |

| NT25105 | **Computation and Simulation Laboratory** | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objective:**

- To introduce the fundamentals of research design and methodology, data collection and analysis techniques
- To provide a comprehensive understanding of intellectual property rights and patents.

**List of Experiments:**

1. Numerical programme to plot the first four Eigen functions of a one - dimensional rectangular potential well with infinite potential barrier.
2. Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using numerical programme.
3. Toy model in molecular electronics: IV characteristics of a single level molecule
4. To determine the lattice constant and lattice angles for atomically resolved STM image of HOPG (Highly Oriented Pyrolytic Graphite using offline Scanning Probe Imaging Processor (SPIP) Software.
5. To determine the surface roughness of raw and processed AFM images of glass, silicon and films made by different methods using offline SPIP software.
6. Simulation of I-V Characteristics for a single Junction circuit with a single quantum Dot using MOSES 1.2 Simulator.
7. Study of Single Electron Transistor using MOSES1.2 Simulator.
8. Simple Mathematical Operation, Basic Command in MATLAB, 2D lot, 3D plot, curve fitting interpolation, Simulink, introduction, physics with Simulink
9. Equations modelling for circular motion, circular motion in Simulink, electronics in Simulink, introduction to logic gates, logical gates in Simulink

**Weightage:** Continuous Assessment: 60%, End Semester Examinations: 40%

**Assessment Methodology:** Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

**Equipment Required:**
Glassware for reactions and spot tests, Ostwald/Ubbelohde viscometer,

| | Description of CO | PO | PSO1 | PSO2 |
|---|---|---|---|---|
| CO1 | Apply numerical methods to solve quantum and nanoscale device problems. | PO1(3), PO2(2) | 3 | 2 |
| CO2 | Analyze nanoscale data using microscopy and simulation software. | PO1 (3), PO2(2), PO4(2) | 2 | 1 |
| CO3 | Utilize MATLAB and SPIP software for analysis of atomic-scale structures and surface properties. | PO1(3), PO2(2) | 1 | 1 |

| NT25106 | **Nanomaterial Synthesis Laboratory** | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- Experiment various nanomaterial synthesis techniques and characterize the materials by different instrumental analysis methods.

**List of Experiments**

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol; Mie formalism; Estimation of size by curve fitting
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap Estimation
3. Microwave assisted polymerization synthesis of ZnO nanowires
4. Sol gel synthesis of metal oxide (ZnO,$TiO_2$,CdO) nanoparticles:
5. Sol-gel spin coating route to $SnO_2$ nano thin films: surface roughness measurement by AFM
6. Electro spraying route to carbon nanofibers: surface morphology by SEM
7. Hydrothermal synthesis of ZnS Nano rods: Nano rods formation by SEM analysis
8. Mechanical ball milling technique to oxide ceramics preparation: crystallite size measurement by XRD.

**Weightage:** Continuous Assessment: 60%, End Semester Examinations: 40%

**Assessment Methodology:** Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

| | Description of CO | PO | PSO1 | PSO2 |
|---|---|---|---|---|
| CO1 | Demonstrate the synthesis of metal and metal oxide nanoparticles using diverse chemical and physical methods. | PO1(3), PO2(2) | 3 | 2 |
| CO2 | Apply various analytical techniques like UV-Vis spectroscopy, SEM, AFM, and XRD for nanoparticle characterization. | PO1(3), PO2(2), PO4(2) | 2 | 2 |
| CO3 | Interpret optical and structural properties of nanomaterials to assess their size, morphology, and band gap. | PO1(3), PO2(2), PO4(2) | 1 | 2 |