<table>
<thead>
<tr>
<th>COURSE No.</th>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST-601</td>
<td>Introduction to Nanoscience and Nanotechnology</td>
<td>4</td>
</tr>
<tr>
<td>NST-602</td>
<td>Surface, Colloid and Interface Science</td>
<td>4</td>
</tr>
<tr>
<td>NST-603</td>
<td>Introduction to Advance Biology</td>
<td>4</td>
</tr>
<tr>
<td>NST-604</td>
<td>Nanoscience and Environment</td>
<td>4</td>
</tr>
<tr>
<td>NST-605</td>
<td>Application of Computational Methods</td>
<td>3</td>
</tr>
<tr>
<td>NST-606</td>
<td>Synthesis of Nanomaterials</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COURSE No.</th>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST-607</td>
<td>Nanotechnology in Energy Conversion and Storage</td>
<td>4</td>
</tr>
<tr>
<td>NST-608</td>
<td>Nanosensors and Devices</td>
<td>4</td>
</tr>
<tr>
<td>NST-609</td>
<td>Nanostructured Materials and Processing</td>
<td>4</td>
</tr>
<tr>
<td>NST-610</td>
<td>Nanomaterials Synthesis and Characterization Techniques</td>
<td>4</td>
</tr>
<tr>
<td>NST-611</td>
<td>Nanomaterial Lab</td>
<td>2</td>
</tr>
<tr>
<td>NST-612</td>
<td>Seminar</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COURSE No.</th>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST-701</td>
<td>Mechanical Processing and Properties of Nanomaterials</td>
<td>4</td>
</tr>
<tr>
<td>NST-702</td>
<td>Nanostructures in Biological Systems</td>
<td>4</td>
</tr>
<tr>
<td>NST-703</td>
<td>Advanced Nanomaterials for Nanotechnology</td>
<td>3</td>
</tr>
<tr>
<td>NST-704</td>
<td>Research Methodology</td>
<td>4</td>
</tr>
<tr>
<td>NST-705</td>
<td>Product Design, Management Techniques and Entrepreneurship</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COURSE No.</th>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST-706</td>
<td>Project Work</td>
<td>18</td>
</tr>
<tr>
<td>NST-707</td>
<td>Literature Review</td>
<td>10</td>
</tr>
<tr>
<td>NST-708</td>
<td>Comprehensive Viva</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>
1ST SEMESTER

NST-601 Introduction to Nanoscience and Nanotechnology 4

Unit I
Background to Nanoscience: Defination of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties.

Unit II
Types of nanostructure and properties of nanomaterials: One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.

Unit III
Application of Nanomaterial: Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application.

References:
1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.

NST-602 Surface, Colloid and Interface Science 4

Unit I

Unit II

Unit III

References:

<table>
<thead>
<tr>
<th>NST-603</th>
<th>Introduction to Advance Biology</th>
<th>4</th>
</tr>
</thead>
</table>

**Unit I**


**Unit II**


**Unit III**

**Molecular Biology:** Biological nanomachines and genetic material: Nucleic acid structure; functional elements of DNA, Genome organization, DNA polymerases: DNA pol I, DNA pol II and DNA pol III, helicases- ligases- topoisomerases, recombinase- transposase - mitotic spindle and chromosome separation; RNA polymerases, RNA pol I, RNA pol II and RNA pol III. DNA Templated Electronics, Single Biomolecule Manipulation for Bioelectronics, DNA as a semiconductor.

References:
2. Principles of Biochemistry, Nelson, Cox, Lehninger

<table>
<thead>
<tr>
<th>NST-604</th>
<th>Nanoscience and Environment</th>
<th>4</th>
</tr>
</thead>
</table>

**Unit I**

**Environment Related Case Studies on Nanomaterials:** Screening of nanomaterials for understanding potential effects to human health and the environment. Mapping of the environmental fate of nanomaterials. Relationships between key properties of nanomaterials and their environmental fate, transport, transformation, bio-distribution, toxicity.

**Unit II**

**Environmental Pollution by Nanoparticles:** Health impact, safety and toxicological effects transport of nanomaterials in soil/sediments. Study of physical and chemical properties of nanomaterials influencing their behavior in the environment and in biological systems.

**Unit III**

**Application of Nanotechnology:** Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their
applications in water purification, Nanotoxicology. Use of nanoparticles for environmental remediation and water treatment. Case studies and Regulatory needs.

References:
1. Environmental Chemistry for a Sustainable World, Volume 1: Nanotechnology and Health Risk Editors: Lichtfouse, Schwarzbauer, Robert

<table>
<thead>
<tr>
<th>NST-605</th>
<th>Application of Computational Methods</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Development of chemical library and screening of promising compounds using computer assisted drug design (CADD) techniques.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Simulation of nanocomposite and analysis using molecular dynamic (MD) simulation.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Encapsulation of nanoparticle and interaction studies using molecular simulation.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Isolation of DNA and separation using Gel electrophoresis.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Isolation of protein and separation using Gel electrophoresis.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NST-606</th>
<th>Synthesis of Nanomaterials</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Synthesis of Metal Oxide Nanoparticle using different techniques.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Characterisations using UV visible spectrophotometer, FTIR, X-ray Analysis.</td>
<td></td>
</tr>
</tbody>
</table>

2ND SEMESTER

<table>
<thead>
<tr>
<th>NST-607</th>
<th>Nanotechnology in Energy Conversion and Storage</th>
<th>4</th>
</tr>
</thead>
</table>

Unit I
Renewable Energy: Energy conversion process. Introduction to Semiconductor physics, Conducting and semiconducting materials, Semiconductor nanostructures, Electronic structure and physical process, material aspect of solar cells, Thin film solar cells, Solar cell characteristics and characterization techniques, Nano-, micro-, and poly crystalline and amorphous Si for solar cells, Si deposition techniques.

Unit II

Unit III
Fuel Cells: Polymer membranes for fuel cells, Acid/alkaline fuel cells, design of fuel cells, Carbon Nanotubes for energy storage, Hydrogen Storage in Carbon Nanotubes, Use of nanoscale catalysts to save energy and increase the industrial productivity.

References

NST-608 Nanosensors and Devices 4

Unit I

Unit II

Unit III
Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors, Materials for biosensor applications, Fabrication of biosensor devices, Detection in Biosensors – fluorescence, absorption, electrochemical methods, Techniques used for microfabrication, Future direction in biosensor research.

References

NST-609 Nanostructured Materials and Processing 4

Unit I

Unit II

Unit III
One dimensional and Two dimensional nanostructures: Nanowires and Nanotubes: Evaporation-condensation - Vapor- liquid - solid (VLS) - surface and bulk diffusion – kinetics – growth of various nanowires –control of size –precursors and catalysts - single- and multi-wall CNT - Si nanowires – density and diameter – doping in nanowires
References:

**NST-610** | Nanomaterials Synthesis and Characterization Techniques | 4

Unit I
**Diffraction analyses:** X-ray diffraction, powder diffraction, lattice parameters, structure analyses, strain analyses, phase identification, particle size analyses using - Scherer’s formula - X-ray photoelectron spectroscopy (XPS)- Auger electron spectroscopy (AES).

Unit II

Unit III
**Spectroscopic techniques:** Infra red spectroscopy (IR) – Rotational & Vibrational - UV-visible - Raman Spectroscopy- Photoluminescence (PL)– Cathodeluminescence (CL).

References:
1. Ghuzang G.Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004
3. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley, 1977

**NST-611** | Nanomaterial Laboratory | 2

2. Synthesis of Ag and Au nanoparticles and their characterizations

**NST-612** | Seminar | 2

Each candidate shall present a seminar on recent topics in a departmental seminar during a period not exceeding 15 minutes. Performance of the candidates in the seminar shall be evaluated jointly by Examiners.
3RD SEMESTER

NST-701  Mechanical Processing and Properties of Nanomaterials  4

Unit I
Processing of Polymers: Engineering plastics – Pellets and sheets – Glass transition temperature of polymers – Melt flow index – Polymer processing tools and process conditions - injection moulding, thermoforming, vacuum and pressure assisted forming.

Unit II

Unit II
Processing of Structural and Functional Nanomaterials: Properties required of nanocrystalline materials used for structural, energy, environmental, textile and catalytic applications; processing techniques; techniques for retaining the nanocrystalline structure in service.

References

NST-702  Nanostructures in Biological Systems  4

UNIT I

UNIT II
UNIT III


References

NST-703 | Advanced Nanomaterials for Nanotechnology | 4

UNIT I


UNIT II

Thermoelectric Materials: Concept of phonon, Thermal conductivity specific heat, exothermic and endothermic processes, Different types of thermoelectric materials, Bulk properties, One dimensional and composite thermoelectric materials, Applications.

UNIT III


References

NST-704 | Research Methodology | 4

UNIT I

Application of statistical concept/procedures, data, diagrammatic representation of data, probability, measure of sensual tendency, measure of dispersion, skewness and kurtosis, normal distribution, sampling.

UNIT II

Testing of hypothesis test, analysis of variance, covariance, principle component analysis, experimental design, completely randomized block design, randomized block design, lattice square design, one and two ways analysis of variance, follow up test, non-parametric procedures, writing of research projects.
UNIT III
Windows and Linux operating systems, programming fundamentals, compilation and running of program, storing data, elementary numerical methods, graph plotting. Computation of different parameters from physical equations related to the nanotechnology.

References:


| NST-705 | Product Design, Management Techniques and Entrepreneurship | 4 |

UNIT I
Product Design and Development: Concept generation, Product Architecture, Industrial Design Process, Management of Industrial design Process and assessing the quality of Industrial Design, Establishing the product specification, Product selection criteria, Product development process, Manufacture design, Economics of Product development projects, Economic analysis and financial models

UNIT II

UNIT III
Entrepreneurial Competence & Environment: Concept of Entrepreneurship, Entrepreneurship as a career, Personality Characteristic a successful Entrepreneur, Knowledge and skill required for an Entrepreneur, Business environment, Entrepreneurship Development Training, Centre and State government policies and Regulations.

References:

5. Hisrich, —Entrepreneurship, Tata Mc Grew Hill, New Delhi, 2001

4TH SEMESTER

| NST-706 | Project Work | 20 |

Each candidate shall carry out some investigative research work under the supervision of one or more mentor(s), who may be Teacher/Guest Teacher of University/Scientist of any recognized research institute. The work may be carried out either in the University itself or in any recognized research institute, with the approval of the appropriate authority of the University. Duration of the work shall be eight weeks (approximately 200 hours). The findings of the project work should be submitted in the form of a dissertation for evaluation by a Board of Examiners followed by a presentation through a seminar.
The candidates shall carry out review work on literatures published in the last five years on a special topics assigned to them by the guide. They can also choose a topic of their choice and approved by the guide. They should submit the review to the course coordinator and the performance of the candidates shall be evaluated by the committee including the guide.

Comprehensive viva-voce examination shall be conducted jointly by the external and internal Examiners. Short questions on the theoretical principles, experimental methodologies and instrumentations etc. of the different experiments included in the entire practical/project syllabus of semesters-I, -II, -III and -IV may be asked. Maximum time for viva-voce examination of a candidate shall not normally exceed 15 minutes.