<table>
<thead>
<tr>
<th>COURSE No.</th>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-601</td>
<td>Introduction to Nanoscience and Nanotechnology</td>
<td>4</td>
</tr>
<tr>
<td>NS-602</td>
<td>Surface, Colloid and Interface Science</td>
<td>4</td>
</tr>
<tr>
<td>NS-603</td>
<td>Introduction to Advance Biology</td>
<td>4</td>
</tr>
<tr>
<td>NS-604</td>
<td>Nanoscience and Environment</td>
<td>4</td>
</tr>
<tr>
<td>NS-605</td>
<td>Application of Computational Methods</td>
<td>3</td>
</tr>
<tr>
<td>NS-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>NS-607</td>
<td>Nanotechnology in Energy Conversion and Storage</td>
<td>4</td>
</tr>
<tr>
<td>NS-608</td>
<td>Nanosensors and Devices</td>
<td>4</td>
</tr>
<tr>
<td>NS-609</td>
<td>Nanostructured Materials and Processing</td>
<td>4</td>
</tr>
<tr>
<td>NS-610</td>
<td>Nanomaterials Synthesis and Characterization Techniques</td>
<td>4</td>
</tr>
<tr>
<td>NS-611</td>
<td>Nanomaterial Lab</td>
<td>2</td>
</tr>
<tr>
<td>NS-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>NS-701</td>
<td>Project Work</td>
<td>20</td>
</tr>
<tr>
<td>NS-702</td>
<td>Literature Review</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COURSE No.</th>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-703</td>
<td>Supramolecular Chemistry and Biology</td>
<td>4</td>
</tr>
<tr>
<td>NS-704</td>
<td>Nanostructures in Biological Systems</td>
<td>4</td>
</tr>
<tr>
<td>NS-705</td>
<td>Carbon Nanostructures &amp; Functionalization</td>
<td>4</td>
</tr>
<tr>
<td>NS-706</td>
<td>Organic and Inorganic Nanomaterials</td>
<td>4</td>
</tr>
<tr>
<td>NS-707</td>
<td>Comprehensive Viva</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>
1\textsuperscript{ST} SEMESTER

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-601</td>
<td>Introduction to Nanoscience and Nanotechnology</td>
<td>4</td>
</tr>
</tbody>
</table>

**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.

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

**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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-602</td>
<td>Surface, Colloid and Interface Science</td>
<td>4</td>
</tr>
</tbody>
</table>

**Unit I**

**Surface Nanoscience:** Introduction to surface active agents. Theory and applications. Types of surfactants. Classification, synthesis of surfactant - Shape, size and structure of surfactants. Micelle, Emulsions, Microemulsions & Gels. Kraft temperature, surfactant geometry and packing.

**Unit II**

**Colloidal Nanoscience:** Introduction to colloidal material, surface properties, origin of colloidal particles, preparation & characterization of colloidal particles. Applications of super hydrophilic hydrophobic surfaces, self-cleaning surfaces. Surface viscosity.

**Unit III**

**Nanoscience and Interface:** Intermolecular Forces, Van der Waals forces (Kessorn, Debye, and London Interactions). Dynamic properties of interfaces. Contact angle. Brownian motion and Brownian Flocculation. Surface free energy.

References:

Introduction to Advance Biology

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

Nanoscience and Environment

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

NS-605 | Application of Computational Methods | 4
---|---|---
1. Development of chemical library and screening of promising compounds using computer assisted drug design (CADD) techniques.
2. Simulation of nanocomposite and analysis using molecular dynamic (MD) simulation.
3. Encapsulation of nanoparticle and interaction studies using molecular simulation.
4. Isolation of DNA and separation using Gel electrophoresis.
5. Isolation of protein and separation using Gel electrophoresis.

NS-606 | Synthesis of Nanomaterials | 4
---|---|---
1. Synthesis of Metal Oxide Nanoparticle.
2. Characterisations using UV visible spectrophotometer, FTIR, X-ray Analysis.

2ND SEMESTER

NS-607 | Nanotechnology in Energy Conversion and Storage | 4
---|---|---

**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**

**Plastic/flexible solar cells:** Organic solar cells, Polymer composites for solar cells, p-n junction, Device fabrication and characterization, Nanomaterials for solar cells, Dye-sensitized solar cells, Organic-inorganic hybrid solar cells, Current status and future prospects.

**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:
Unit I

Unit II

Unit III

References

<table>
<thead>
<tr>
<th>NS-610</th>
<th>Nanomaterials Synthesis and Characterization Techniques</th>
<th>4</th>
</tr>
</thead>
</table>

**Unit I**

**Synthesis and preparation of Nanomaterials:** Synthesis of bulk nanostructured materials - Sol Gel processing - bulk and nano composite materials - Grinding - high energy ball milling – injection moulding - extrusion - melt quenching and annealing.

**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:**


<table>
<thead>
<tr>
<th>NS-611</th>
<th>Nanomaterial Laboratory</th>
<th>2</th>
</tr>
</thead>
</table>

2. Synthesis of Ag and Au nanoparticles and their characterizations

<table>
<thead>
<tr>
<th>NS-612</th>
<th>Seminar</th>
<th>2</th>
</tr>
</thead>
</table>

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**

<table>
<thead>
<tr>
<th>NS-701</th>
<th>Project Work</th>
<th>20</th>
</tr>
</thead>
</table>

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.

| NS-702   | Literature Review | 20 |

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.

4TH SEMESTER

| NS-703   | Supramolecular Chemistry of Nanomaterials | 4 |

**Unit I**

**Supramolecular aspects in Chemistry:** Fundamental understanding, Host-guest complexation chemistry, micelles, polymers, cyclodextrins, functionalization reactions, Introduction to supramolecular catalysis and enzymes, Multifunctional catalysis and simple models, Hydrolytic enzymes.

**Unit II**

**Supramolecular aspects of Biological Systems:** Introduction, Host-guest complexation in molecular biology, DNAs, proteins and enzymes, synthetic molecular receptors, Receptors with molecular theft, Molecular tweezers, Receptor with multiple H-bonding sites, enantioselective molecular recognition, molecular recognition and catalysis, molecular self-assembly, Templating agents in biological systems.

**Unit III**

**Host-Guest Complexation:** Introduction, Nature of supramolecular interactions, Type of host-guest complexes, Structure of complexes, Comparison of structures of non-complexed and complexed hosts, Detail structural comparisons, Correlation of structure with free energies of complexation. Supramolecular devices and nanotechnology.

**References:**

1. Supramolecular Chemistry from Molecules to Nanomaterials, Gale and Steed, 2012.
3. Principles of Biochemistry, Nelson, Cox, Lehninger

| NS-704   | Nanostructures in Biological Systems | 4 |

**UNIT I**

**Nucleic Acid:** Genome structure and organization in prokaryotes and eukaryotes. Structure and function of nucleic acids. Replication, transcription and translation- mechanism, enzymology and regulation. Applications of nanoscience in biological systems - drug targeting, drug delivery and biomedicine.
UNIT II


UNIT III


References:
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


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.