Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in

Nanoscience and Nanotechnology

(Faculty of Science & Technology)

F.Y.B.Sc.
(Nanoscience and Nanotechnology)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: B.Sc. (Nanoscience and Nanotechnology)

Preamble:

The curriculum for the B. Sc. (Nanoscience and Nanotechnology) programme is designed to cater to the requirement of Choice Based Credit System following the University Grants Commission (UGC) guidelines. In the proposed structure, due consideration is given to Core and Elective Courses (Discipline specific - Nanoscience and Nanotechnology), along with Ability Enhancement (Compulsory and Skill based) Courses. Furthermore, continuous assessment is an integral part of the CBCS, which will facilitate systematic and thorough learning towards better understanding of the subject. The systematic and planned curricula from first year to the third year (comprised of six semesters) shall motivate the student for pursuing higher studies in Nanoscience and Nanotechnology and inculcate enough skills for becoming an entrepreneur.

Objectives:

- To foster scientific attitude, provide in-depth knowledge of scientific and technological concepts of Nanoscience and Nanotechnology.
- To enrich knowledge through problem solving, minor/major projects, seminars, tutorials, review of research articles/papers, participation in scientific events, study visits, etc.
- To familiarize with recent scientific and technological developments.
- To create foundation for research and development in Nanoscience and Nanotechnology.
- To help students to learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
- To train students in skills related to research, education, industry, and market.
- To help students to build-up a progressive and successful career in Nanoscience and Nanotechnology.

Structure of the Course:

Subject Name	Year	Semester	Course Type	Course Code	Course Name	Credit
Nanoscience and Nanotechnology	1	I	Compulsory Course	NS-111	Fundamentals of Nanoscience	2
				NS-112	Materials Science	2
				NS-113	Nanoscience and Nanotechnology Laboratory-IA	1.5
		II	Compulsory Course	NS-121	Chemical and Biological Techniques for synthesis of nanomaterials.	2
				NS-122	Basic Characterization Techniques	2
				NS-123	Nanoscience and Nanotechnology Laboratory-IB	1.5
	2	III	Compulsory Course	NS-231	Physical Techniques for synthesis of Nanomaterials	2
				NS-232	Properties of Nanomaterials (Physical, chemical, Optical and Magnetic)	2
				NS-233	Nanoscience and Nanotechnology Laboratory-2A	2
			Ability Enhancement Compulsory Course	NS-2310	Environment -I	2
				NS-2311	Language-I	2
		IV	Compulsory Course	NS-241	Organic and polymer science of nanomaterials	2
				NS-242	Advanced Techniques for Characterization of Nanomaterials	2
				NS-243	Nanoscience and Nanotechnology Laboratory-2B	2
			Ability Enhancement Compulsory Course	NS-2410	Environment –II	2
				NS-2411	Language-II	2
	3	V		NS- 351	Polymer and Composites	2
				NS- 352	Nanophysics	2
				NS- 353	Nanobiotechnology	2
				NS- 354	Carbon Based Nanomaterials	2
				NS- 355	Energy Conversion Devices and Applications	2
				NS- 356	Elective I (Select any One)- Environmental nanotechnology and applications.	2
				NS- 357	Nanoscience and Nanotechnology Laboratory-3A	2

				NS- 358	Nanoscience and Nanotechnology Laboratory-3B	2
				NS- 359	Project	2
			Skill Enhancement Course	NS-3510	Maintenance and Repairing of Laboratory equipment – I	2
				NS- 3511	Household Electrification, Maintenance and repairing - I	2
		VI		NS- 361	Polymer Hetero-structure and their applications	2
				NS- 362	Functional Nanomaterials	2
				NS- 363	Applications of Nanobiotechnology	2
				NS- 364	Nanoelectronics	2
				NS- 365	Energy Storage Devices and Applications	2
				NS- 366	Elective II (Select any One) Photo catalysis for environmental pollution control	2
				NS- 367	Nanoscience and Nanotechnology Laboratory-4A	2
				NS- 368	Nanoscience and Nanotechnology Laboratory-4B	2
				NS- 369	Project	2
			Skill Enhancement Course	NS-3610	Maintenance and Repairing of Laboratory Equipment – II	2
				NS- 3611	Household Electrification, Maintenance and Repairing- II	2

SEMISTER-I

Course code and title: NS-111: Introduction to Nanoscience

Lectures: 36 **(Credits-02)**

1. **Introduction** **(9 Lectures)**
   Nano and Nature, Nanoscopiccolours (Butterfly wings), Bioluminescence (Fireflies), Tribology (Geckos Sticky feet, lotus-leaf effect etc.) in nature, the development of nanoscale science: Size scale, Nanotechnology timeline, pre-18th Century; 19th Century, 20th Century, 21th Century.
2. **Generation of Nanotechnology** **(7 Lectures)**
   Classification of Nanomaterials, OD, 1D, 2D and 3D types of nanomaterials (Quantum dots, Quantum wires, Carbon Nano Tubes, Bucky balls, Quantum confinement (Quantum size effect), Fullerences etc.)
3. **Nanometrology** **(8 Lectures)**
   Background to Nanometrology, Background to nanomanufacturing, the nano perspective, The Quantum triangle, Nanomechanical tools, Standards for Nanotechnology, IEEE Road map for Nanoelectronics, Introduction to MEMS & NEMS
4. **Electromagnetic Nanoengineering** **(12 Lectures)**
   Electronics and Nanoelectronics, Microelectronics, Nanoscale electronics, The Surface Plasmon resonance, Colour generation from Nanoparticles and nanostructures, Application of nanoplasmonics, Introduction to Nanophotonics, Introduction to Nanobiotechnology

Reference Books

1. Fundamentals of Nanotechnology, CRC press, by G.L. Hornyak, J.J. Moone, H.F. Tihhale, J. Dutta

Course code and title: NS-112: Materials Science

Lectures: 36 **(Credits-02)**

1. Structure and Bonding **(09-Lectures)**

Arrangements of atoms in solids, two dimension crystal structure, three dimension crystal structure, Bonding in solids, Bonding and antiboding states, Electronic structure of solids.

2. Different types of Solids **(09-Lectures)**

Single phase alloys, Semiconductors, insulators and oxide materials, Composites, Polymers, Porous materials, Aerogels, Core-Shell particles

3. Phase Diagram **(09-Lectures)**

Basic term system, Surrounding, Component, Coordinates, Phase equilibrium, Phase diagram definition, Lever rule, Gibb's Phase rule, Phase diagram of suger- water and NaCl-water. Types of Phase diagram, Pb-Sn phase diagram

4. Crystal Structure **(09-Lectures)**

Lattice, Basis, Crystallographic planes and directions. Simple, bcc and fcc crystal structure.

Books/References

1. Materials science and Engineering -V. Raghvan.
2. Elements of Materials science and Engineering - H. Vanvlach (4^{th} Edition)
3. Nanotechnology - S.K. Kulkarni (3^{rd} Edition).

Course code and title: NS-113: Nanoscience and Nanotechnology Laboratory 1A

Practical: 08 **(Credits-1.5)**

Sr. No	Title of the experiment
1	To study the working of UV-Visible spectrophotometer.
2	Synthesis of Silver nanoparticles by using biological method.(Mango leaves)
3	To study the Absorption spectrum of Silver nanoparticles.(mango leaves extract)
4	Synthesis of Silver nanoparticles by Chemical Route.
5	Synthesis of Silver nanoparticles by using biological method.(Curry leaves)
6	To study the Absorption spectrum of Silver nanoparticles.(Curry leaves plant extract)
7	To study the Absorption spectrum of $FeCl_3$ solution.
8	To study the X-ray diffraction pattern.
	Activities
1	Demonstration of Hydrothermal method.
2	Demonstration of Spray Pyrolysis method.

Note: Any four experiments from each section be conducted during the semester, with a total of 10 experiments.

SEMISTER-II

Course code and title: NS-121 Chemical and Biological technique for synthesis of nanomaterial

Lectures: 36 **(Credits-02)**

1. Synthesis of Nanomaterial (Chemical Method) **(08 Lectures)**,

Colloids and colloids in solution, Nucleation and growth of nanoparticles, Synthesis of metal and semiconductor nanoparticle by colloidal routes, Langmuis- Blodgett (L-B) method, sol-gel method.

2. Synthesis of nanomaterial (chemical Methods): **(9 Lectures)**

Hydrothermal synthesis, Solvothermal synthesis, Sonochemical Synthesis, Solvothermal synthesis, Sonochemical Synthesis methods, Microwave synthesis, Synthesis using micro-reactor or Lab-or-chip spray pyrolysis, successive ionic Layer adsorption and reaction(SILAR), Electrodeposition,

3. Synthesis of nanomaterial (Chemical Methods) **(9 Lectures)**

Chemical vapour deposition, Metallorganic chemical vapour deposition (MOCVD), Plasma enhanced chemical vapour deposition(PECVD), Vapour-Liquid- Solid(ULS) method, Metal Oxide frameworks(MoF), Kirkindall effect and method.

4. Synthesis of nanomaterial (Biological methods) **(10 Lectures)**

Introduction, Synthesis using microorganisms, Synthesis using plant extract, Use of proteins, Templates like DNA, S-tayer synthesis of nanoparticles using DNA.

Reference Books:

1. Hari Singh Nalwa, "Encyclopedia of Nanotechnology", USA 2011
2. James A. Schwarz, Cristian I. Contescu, Karol Putyera, "Dekker encyclopedia of nanoscience and nanotechnology" CRC Press, 2004.
3. Introduction to Nanoscience and Nanotechnology, CRC Press, G. L. Hornyak, H. F. Tibbals, J. Dutta, J. J. Moore
4. Nanotechnology: Principles and practices, 3rd Edition, Sulabha K. Kulkarni, Capital Publishing Company

Course code and title: NS-122 Introduction to Characterization Techniques

Lectures: 36 **(Credits-02)**

1. Nonradiative and nonelectron characterization methods (08-Lectures)

Particle spectroscopy, Thermodynamic methods, Particle sizedetermination, Surface area and Porosity, Other important characterization methods.

2. Spectroscopic Methods (08-Lectures)

UV-Vis absorption and emission spectroscopy, Infra red, Photoluminescence and Electroluminescence methods.

3. Electron Probe Methods (10-Lectures)

Types of characterization methods, Optics and Resolution, The nano perspectives, Electron interaction with matter, Scanning electron microscopy and electron probe microanalysis, Transmission electron microscopy, Other important electron probe methods.

4. Chemical Characterization (10-Lectures)

Introduction to volumetric analysis, Methods of expressing concentrations, Primary and Secondary standard solution, Indicators, Acid base indicators, Acid- Base titration, Discuss titration with respect to newtralization and equivalence point of determination and limitation.

References:

1. Nanotechnology :Technology Revolution of 21st Century by Rakesh Rathi, published by S.Chand.
2. Introduction to Nanoscience, by Stuart Lindsay.
3. Introduction to Nanomaterials and nanotechnology by VladimirPokropivny, RynnoLohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov
4. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.
5. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
6. Nano Essentials- T.Pradeep/TMH
7. Bharat Bhusan, "Springer Handbook of Nanotechnology", springer, Newyork, 2007
8. Hari Singh Nalwa, "Encyclopedia of Nanotechnology", USA 2011
9. James A. Schwarz, Cristian I. Contescu, Karol Putyera, "Dekker encyclopedia of nanoscience and nanotechnology" CRC Press, 2004.
10. Analytical chemistry by G.D. Christian, 6th edition.
11. Vogel's textbook of quantitative analysis, 6th edition. – J. Mendham, R.C. Denney and all.
12. Quantitative organic analysis, 4th edition. –A.J. Vogel, ELRA

Course code and title: NS-123 Nanoscience and Nanotechnology Laboratory 1B

Practical: 08 **(Credits-1.5)**

Sr No	Title of the experiment
1	Synthesis of Silver nanoparticles by using biological method.(Guava leaves)
2	To study the Absorption spectrum of Silver nanoparticles.(Guava leaves extract)
3	Deposition of Lead sulphide thin film by chemical bath deposition.
4	Synthesis of Silver nanoparticles by using biological method.(Chikku leaves)
5	To study the Absorption spectrum of Silver nanoparticles.(Chikku leaves extract)
6	Deposition of Cadmium sulphide thin film by chemical bath deposition.
7	Analysis of graphene using Raman Spectroscopy.
8	To study of Characterization technique.(SEM/TEM)
Activities	
1	Demonstration of Screen printing technique.
2	Demonstration of Chemical Bath deposition

Note: Any four experiments from each section be conducted during the semester.

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