Shivaji University, Kolhapur

Syllabus For

B. Sc. Nanotechnology

F. Y. B. Sc.

to be implemented from the academic year 2016-17

(June 2016) onwards.

1. **Minimum Eligibility Requirement for B. Sc. Nanotechnology Course**

Duration: 3 years **Course Code: BSc-NT**

Passed 10+2 or equivalent Examination securing a minimum of 45% marks in the aggregate in the subjects Physics, Chemistry plus any one of the following: Maths, Biology , Geology, Computer Science, Informatics practices and Geography and must have passed in each of the concerned three subjects (as supported by the Certificate issued by the Examining body). The minimum eligibility criteria for candidates under reserved category is 40%.

2. **Passing Marks for B. Sc. Nanotechnology**

A minimum of 35% marks in both theory and practical is required for passing. **Other rules are applicable as per the General B. Sc. Course of Shivaji University, Kolhapur.**

3. **Recruitment and Qualifications of Faculty**

Masters in Nanoscience/Nanotechnology/Integrated B. Sc.-M. Sc. Nanoscience and Technology with 55% marks (or an equivalent grade in a point scale wherever grading system is followed). NET/SLET/SET is not required since M. Sc. Nanoscience/Nanotechnology/Integrated B. Sc.-M. Sc. Nanoscience and Technology is under section 3.0.0 (sub section 3.3.2) of **"UGC Regulations on Minimum Qualifications for Appointment of Teachers and Other Academic Staff in Universities and Colleges and Measures for the Maintenance of Standards in Higher Education, 2010"**UGC (2nd amendment) Regulations, 2013 and UGC (3rd amendment) Regulations, 2016. Eligibility shall be considered as per the revised regulations. You may visit the UGC website: www.ugc.ac.in for more details.

Other rules and regulations will be as per UGC Regulations, 2010.

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(B. Sc. Nanotechnology course)
F. Y. B. Sc., Sem. I
Course Structure

Course No	Title	Lecture	Practical	Examination/Evaluation of marks/Semester
NT-101T	Introduction to nanoscience and Nanotechnology Paper-I	37	-	50
NT-102T	Physico-Chemical, Biologicalaspects of Nanoscience and Nanotechnology Paper-II	38	-	50
NT-111P	Laboratory Course-I (Annual)	-	60	-

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Course Structure

Course No	Title	Lecture	Practical	Examination/Evaluation of marks/Semester
NT-103T	Synthesis Techniques Paper-III	37	-	50
NT-104T	Basic Characterization Techniques Paper IV	38	-	50
NT-111P	Laboratory Course-I	-	60	50

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Syllabus
Paper I

Title of Paper: Introduction to Nanoscience and Nanotechnology Subject Code: NT-101T

Unit I: Fundamentals ofNanoscience and Nanotechnology 10 L

Definitions, Relationship and Differences. Nano and Nature: NanoscopicColours (Butterfly Wings), Bioluminescence (Fireflies), Tribiology (Geckos sticky feet, lotus leaf effect). Introduction to hydrophilic and hydrophobic materials. Nanotechnology timeline, Pre-18^{th} Century, 19^{th} Century, 20^{th} Century and 21^{st} Century. Future perspectives of nanoscience and nanotechnology.

Unit II:Nanoscale Science 9 L

Interconversion of units. Introduction to surface area to volume ratio and aspect ratio. Difference between surface area to volume ratio of bulk materials and nanomaterials (sphere, hollow sphere, rods, hollow rods, cubes and hollow cubes) and related numerical problems. Difference in aspect ratio of bulk wire and nanowire and related numerical problems. Nanomaterials and wavelength of light.

Unit III:Classification of Nanomaterials 10 L

Introduction to dimensional growth process. Classification of nanomaterials into 0D, 1D, 2D and 3D. Relationship between dimension and shape of nanomaterials (Quantum dots, Quantum wires, Carbon nanotubes, Bucky balls, Fullerenes). Introduction to size effect on electronic and optical properties (Quantum confinement).

Unit IV:Introduction to Self-assembled Biological Nanomaterials in Nature 8 L

Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus).

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 II

Title of Paper: Physico-Chemical, Biologicalaspects of Nanoscience and Nanotechnology

Subject Code: NT-102T

Unit I:Fundamentals ofAtomic Structure and Bonding 11 L

Bohr's atomic structure, Bohr's atomic radii, comparative size of nanomaterials and atomic size, electronic configuration, energy levels of shells and related numerical problems on excitation of electrons from lower to higher energy level. Concept of quantization of energy. Arrangement of atoms in solids (two dimension crystal structures and three dimension crystal structure). Bonding in solids (MOT), bonding and antibonding states. Electronic structures of solids.

Unit II:Crystal Structure 9 L

Lattices, basis of crystallographic planes and direction. Simple *bcc*, and *fcc* crystal structures.

Unit III: Types of Solid and Phase Diagram 10 L

Single Phase alloys, Semiconductors, insulators and oxide materials. Basic terms involved in phase diagram: system, surrounding, component, co-ordinates, phase equilibrium, phase diagram. Lever rule, Gibb's phase rule, phase diagram of Pb-Sn system.

Unit IV: Terminology and Techniques in Nanobiotechnology 8 L

Definitions, Scopes and applications of Biotechnology, Nanobiotechnology, Biomolecular Nanotechnology, Biomedical Nanotechnology, Green Nanotechnology. Fundamentals and introduction to techniques such as mechanical extraction, physical methods of homogenization, centrifugation, dialysis, electrophoresis and chromatography techniques for purification of biomolecules and microsopy.

References:

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

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Paper III

Title of Paper: Synthesis Techniques **Subject Code: NT-103T**

Unit I:Basics of Fabrication Methods **10L**

Top-Down fabrication methods –Types of Top-Down fabrication methods (mechanosynthesis, thermal, high energy, chemical fabrication and lithography-concepts with examples only).
Bottom-Up fabrication methods-Types of Bottom-Up fabrication methods (gaseous-phae, liquid-phase, solid-phase, template synthesis-concepts with examples only).
Nano perspective of the fabrication methods.

Unit II:Chemical Synthesis-I **8 L**

i) Combustion: Chemical etching of silicon ii) Basic concepts of Chemical-Mechanical polishing.
iii) Anodization and Electropolishing: Chemical reactions of electrodeposition of aluminum.

Unit III: Chemical Synthesis-II **11 L**

Introduction to molecular self-assembly (MSA), Template synthesis, Sol-gel methods, metal reduction, emulsion polymerization, block copolymerization, electrodeposition with examples and reactions involved.

Unit IV: Biological Synthesis **8 L**

Biological synthesis of Nanoparticles, Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents, Bacteria, fungi and plants as sources of reducing and capping agents and for biogenic synthesis of nanomaterials. Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, DNA based Nano structures, Protein based Nano structures

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. Nanotechnology-S. K. Kulkarni (3rd Edition)

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Paper IV

Title of Paper: Basic Characterization Technique **Subject Code: NT-104T**

Unit I:Introduction to Nanotools **10L**

Types of characterization methods: Electron probe methods, Scaning Probe methods, Spectroscopic methods and Nonradiative and Nonelectron methods (classification and concepts only). Optics and resolution (formula and calculations).

Unit II:Fundamentals of Spectroscopy I **10L**

Electromagnetic radiation and range (problems on interconversion of wavelength to frequency and energy). Relationship between electromagnetic radiation range and spectroscopy. Fundamentals and working principle of UV-Visible spectroscopy, difference between absorbance and surface plasmon resonance (SPR), principle of Fourier-Transformation, fundamentals and working principle of FT-IR, application in functional group determination of organic compounds (-OH, -COOH, $-NH_2$, -NH-, -O-).

Unit III: Fundamentals of Spectroscopy II **10 L**

Emission spectroscopy: Fundamentals and working principle of spectrofluorometer, concept of singlet and triplet electronic state, definition of fluorescence and phosphorescence through Jablonski diagram. Distinction between radiative and nonradiative emissions. Definition of luminescence and basic types (chemiluminiscence).

Unit IV: Tools inNanobiotechnology **8L**

Fundamentals of Microscopy, types of microscopes, light microscope, compound microscope, bright field and dark phase microscopy, inverted microscope, Confocal microscopy. Applications of microscopy in nanobiotechnology.

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. Nanotechnology-S. K. Kulkarni (3rd Edition)
4. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash (4th Edition), Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Nature of question papers for each semester

Q no	Discription	Total Marks	Compulsory Marks
Q 1	**Multiple choice question (10/10)**	10	10
Q2	**Solve any TWO of the following** (Three sub-questions each of ten Marks out of these three Two should be solved)	30	20
Q3	**Solve any FOUR of the following** SIX short answer sub-questions each of five marks out of these six, FOUR should be solved	30	20
	TOTAL MARKS	70	50

Title: Laboratory Course I **Subject Code: NT-11P**

List of Experiments for B.Sc. Nanotechnology

F.Y.B.Sc. (Sem I &II)

Sr.No.	Name of the Experiments
1.	Reduction of Ag^{+} by glucose (Tollen's Test for reducing sugar).
2.	Reduction of Cu^{2+} by aldehydes (Fehling's Test).
3.	Synthesis of Ag nanoparticles using sodium borohydride (Creighton's method).
4.	Synthesis of Au nanoparticles using citric acid (Lee –Meisel method)
5.	Determination of density of colloidal Ag/Au nanoparticles using specific gravity bottle (5 ml).
6.	Measurements of conductivity of KCl solution at different concentration.
7.	Volumetric acid base titration using pH meter.(Strong acid vs Strong base , Weak acid vs Strong base)
8.	Determination of viscosity of polymer by using viscometer.
9.	Diffraction grating by LASER.
10.	Determination of surface tension of a liquid by drop weight method.
11.	Error analysis.
12.	I-V characteristics of solar cells.
13.	Demonstration of nano TiO_2 dye sensitized solar cell. – NVIS kit
14.	Demonstration of nanotechnology. – NVIS kit
15.	Use of multimeter to measure resistance/Inductance/diode/transistor.
16.	Validation of Lambert's-Beer's law using $CuSO_4$ solution.
17.	Calculation of total number of atom's and surface atom's present in a nano-partical of a given size. (Theoretical)
18.	Calculation of surface area to volume ratio of 1D solid and hollow nanostructure. (Theoretical).
19.	Calculate the ballistic I-V characteristics for conventional MOSFETs, Nanowires MOSFETs and Carbon Nanotube MOSFETs (FETToy)
20.	Introduction to Nanobiotechnology lab equipments- Calorimeter, pH meter, Weighing balance, Hot Air Oven, Water Bath, Autoclave, Laminar Air Flow, -20 ^{o}C deep freezer, Thermal cycler machine (PCR machine), Gel Electrophoresis system, PAGE system, power supply/unit, Centrifuge, water distillation unit etc
21.	Preparation of stock solutions and Buffer Solution, Stock Solution, such as Acetate Buffer pH 4.8, phosphate buffer pH 9.6, Phosphate Buffer saline pH 7.2, Saline solution pH 7.0
22.	Preparation of Plant extract (Organic and aqueous), Crushing, grinding, maceration, homogenization, Filtration, Centrifugation, cold percolation extraction, hot extraction, using Sohxlet apparatus