Shivaji University, Kolhapur

Syllabus For

B. Sc. Nanotechnology

S. Y. B. Sc.

to be implemented from the academic year 2017-18

(June 2017) onwards.

SHIVAJI UNIVERSITY, KOLHAPUR
(B. Sc. Nanotechnology course)
S. Y. B. Sc., Sem. III
Course Structure

Course No	Title	Lecture	Practical	Examination/ Evaluation of marks/ Semester
NT-105T	Nano Physics	38	-	50
NT-106T	Nanochemistry	37	-	50
NT-112P	Laboratory Course-II	-	120	--

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Title of Paper: Nano Physics **Subject Code: NT-105T**

Unit I **(L-6)**

Classical Physics at the Nanoscale: Mechanical Frequency, Viscosity, Brownian Motion of Nanoscale Objects, Motion at the Nanoscale.

Unit II **(L-8)**

Basics of Quantum Mechanics, Differential Equations of Wave Mechanics, Background of Quantum Mechanics, Development of New Quantum Theory, Quantum Mechanical Way : The Wave Equations, The Wave Function, Energy Bands, Metals, Insulators and Semiconductors.

Unit III **(L-13)**

Introduction to Optics, Interactions of Light with Matter, Surface Plasmon Resonance, Scattering, Color Generation from Nanoparticles and Nanostructures, Quantum Dots: Tuning the Gap, Luminescence; Photonics, Photonic Structures in Living Systems, Photonic Crystals, Fabrication of Nanophotonic Crystals.

Unit IV **(L-11)**

Magnetic Phenomena and Their Classical Interpretation, Characteristics of Nanomagnetic Systems, Introduction to Nanomagnetism, Characteristics of Nanomagnetic Materials. Magnetization and Nanostructures, Magnetism in Reduced Dimensional Systems, Physical Properties of Magnetic Nanostructures.

References:

1. Science at the Nanoscale, Chin Wee Shong, Sow ChorngHaur, Andrew T S Wee, Pan Stanford Publishing Pte. Ltd., Singapore, 2010
2. Introduction to Nanoscience, S. M. Lindsay, Oxford university press, New York, 2010
3. Introduction to Micro- and Nanooptics, Jürgen Jahns and Stefan Helfert, WILEY-VCH Verlag GmbH & Co. KGaA, Germany, 2012
4. Advanced Physics of Electron Transport in Semiconductors and Nanostructures, Massimo V. Fischetti, William G. Vandenberghe, Springer International Publishing, Switzerland 2016
5. Fundamental of Nanotechnology, Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta, CRC Press, 2009
6. Nano Materials, A. K. Bandyopadhyay, New Age international (P) Limited Publisher, New Delhi, 2008

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Title of Paper: Nanochemistry **Subject Code: NT-106T**

Unit I: Nanoelectrochemistry of Carbon **10 L**

Carbon electrodes: Introduction to carbon nanotube, graphene, graphite and doped nanocarbons. Carbon surface chemistry and redox reactions. Carbon nanoelectrodes: CNT, graphene nanoelectrodes. Electrochemical behavior of electrodes at nanoscale. Carbon thin films as nanoelectrodes. Applications of carbon nanoelectrodes.

Unit II: Batteries **9 L**

Introduction to batteries. Types of batteries: Primary battery and Secondary battery. Electrochemical energy storage: Cell reaction, laws, parameters. Introduction to various batteries: lead acid battery, Ni/Cd battery, Ni/metal hydride battery, lithium ion battery. Introduction to fuel cells.

Unit III: Nanocatalysis **10 L**

Introduction to catalysis and nanocatalysis. Catalytic and Nanocatalytic materials. Fundamentals of catalysis: adsorption theory and surface reactions. Conventional synthetic techniques. Catalyst characterization: Bulk characterization and surface characterization techniques.

Unit IV: Chemical Interactions at the Nanoscale **8 L**

Introduction to bond and its types. Intermolecular and intramolecular bonding. Electrostatic interaction. Hydrogen bonding, Van der Waals attractions, Hydrophobic effect. Bonding considerations at the nanoscale.

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. Nanoelectrochemistry, CRS Press, Taylor and Francis Group, Michael V. Mirkin and Shigeru Amemiya.

SHIVAJI UNIVERSITY, KOLHAPUR
(B. Sc. Nanotechnology course)
S. Y. B. Sc., Sem. IV
Course Structure

Course No	Title	Lecture	Practical	Examination/ Evaluation of marks/Semester
NT-107T	Introduction to Nanoelectronics	38	-	50
NT-108T	Nanobiotechnology	37	-	50
NT-112P	Laboratory Course-II	-	120	100

SHIVAJI UNIVERSITY, KOLHAPUR
(B. Sc. Nanotechnology)
S. Y. B. Sc., Sem. IV
Syllabus

Title of Paper: Introduction to Nanoelectronics **Subject Code: NT-107T**

Unit I: Digital Integrated Circuits **10L**

Digital integrated circuits: Logic levels, propagation delay time, power dissipation fan-out and fan-in, noise margin, logic families and their characteristics Diode–transistor logic (DTL), Transistor–transistor logic (TTL), Emitter-coupled logic (ECL) and Complementary metal–oxide–semiconductor logic (CMOS) integrated circuits and their performance comparison, open collector and tristate gates and buffers.

Unit II: Introduction to CMOS Integrated Circuits **10L**

Manufacturing CMOS Integrated Circuits: The Silicon Wafer, Photolithography technique, Some Recurring Process Steps, Simplified CMOS Process Flow, Packaging Integrated Circuits: Package Materials, Interconnect Levels, Thermal Considerations in Packaging, Perspective — Trends in Process Technology, Short-Term Developments and Long Term Developments.

Unit III: Nanoelectronic Devices-I **10 L**

Introduction: P-type metal–oxide–semiconductor (PMOS), N-type metal–oxide–semiconductor logic (NMOS), and CMOS, Resonant-tunneling diodes: The physics underlying the resonant-tunneling effect, Quantitative characteristics of the resonant-tunneling effect, Sequential tunneling, Negative differential resistance under resonant tunneling. Field-effect transistors: Devices controlled by the field effect, The Field-effect transistor (FET) family devices, and introduction to Nanowire FETs and single electron transistors.

Unit IV: Nanoelectronic Devices-II **8L**

Light-emitting diodes and lasers: Photon absorption and emission, Interband emission and absorption in semiconductors, Laser diodes, Light-emitting diodes. Introduction to Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS), Advantages of NEMS over MEMS, Introduction to Quantum-dot cellular automata.

References:

1. Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Prentice-Hall of India
2. Modern Digital Electronics, R. P. Jain, Tata McGraw Hill
3. Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications: Mitin VV, Kochelap VA, Stroscio MA, Cambridge University Press.

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Title of Paper: Nanobiotechnology **Subject Code: NT-108T**

Unit I: Biomolecules: (10L)

Fundamental concepts of biomolecules and their importance in living system, Proteins, Amino acids as building blocks, their types. Nucleic acids- DNA, RNA, their functions, Carbohydrates- Monosaccharides, disaccharides, oligosaccharides, polysaccharide, lipids and fats as biomolecules and Biopolymers. nucleotides and fatty acids as building blocks of biomolecules, Concept of biomolecules as nano-assemblies (10L)

Unit II: Immune system: (8L)

Overview of immune system, innate and adaptive immunity, cells and organs of immune system, hematopoiesis, cells of the immune system, organs of the immune system, systematic evolution of immune system. Antigen: Introduction to the concept of immunogenicity, antigenecity, Antibody: Basic structure of antibody, antibody classes and biological activities.

Unit III: Signalling at cell surface: (7L)

Signaling molecules and cell-surface receptors, intracellular signal transduction, G protein–coupled receptors that activate or inhibit adenylyl cyclase, regulate ion channels, phospholipase c. Activation of gene transcription by G protein–coupled receptors.

Unit IV: Biomedical applications: (12L)

Concept of disease, metabolic disorder, Introduction to cancer, concept of drugs, drawbacks of conventional drug delivery/administration system. Importance of targeted drug delivery system. Essential components of targeted drug delivery system. Biological Nanomaterials: Introduction to concept of biopolymers; Copolymer, Block Copolymers, Micelles, Dendrimers, Hydrogels and their applications. Supramolecular structures; DNA wires and Dendrimers. Importance and application of biologically synthesized nanomaterials. Biomedical applications of gold and silver and other metal nanoparticles and nano materials. Methods of testing antimicrobial activity- well diffusion method, paper disc method, contact inhibition method. Other biomedical applications of nanomaterials.

References:

1. Nanotechnology; Principals and Practices by Sulabha K. Kulkarni, (2009 Revised edition), Capital Publishing company, New Delhi.
2. Biological Nanostructures and Application of Nanostructures in Biology by Michael A. Stroscio and Mitra Dutta (2004) , Kulwer Academic Publishers,
3. Biochemistry: 7th Edition, (2012), Jeremy Berg, LubertStryer, W.H.Freeman and company, NY
4. R. Ian Freshney. Culture of Animal cells, 5rd Edition, 2010. A John Wiley & Sons, Inc., Publications, USA.
5. E. E. Conn and P. K. Stumpf, Out lines of Biochemistry, John Wiley & Sons, New York.
6. L. Lehninger, Principles of Biochemsitry, CBS Publishers and Distributors.
7. Molecular Biology of the Cell Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, Peter New York and London: Garland Science;
8. Molecular Cell Biology 4th ed., Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E., New York: W. H. Freeman & Co., 1999. The Cell- A Molecular Approach
9. Immunology 5th ed Janis Kuby, W.H.Freeman& Co Ltd; 5th Revised edition.
10. Essential Immunology, Ivan M. Roit (1994)– Blackwell Scientific Pub, Oxford.
11. Cellular and Molecular Immunology, 3rd ed, Abbas, Saunders; 7 edition (11 June 2011)

Title: Laboratory Course II **Subject Code: NT-112P**

List of Experiments for B.Sc. Nanotechnology

S. Y. B.Sc. (Sem. III & IV)

Sr. No.	Name of the Experiments
1.	Demonstrations of Nanotechnology software
2.	Synthesis of Ag nanoparticles by chemical route.
3.	Study of Langmuir adsorption isotherm by activated charcoal.
4.	Synthesis of Cu nanoparticles using Citric acid.
5.	Semiconductor band gap measurement
6.	Acid catalyzed iodination of acetone.
7.	Synthesis of TiO_2 nanoparticles by hydrothermal method
8.	Synthesis of silver nanoparticles by using biological method
9.	Synthesis of ZnO nanorods by hydrothermal method
10.	Study of Fuel Cell
11.	Synthesis of CdS by SILAR method
12.	Electrodeposition of Copper and Copper Oxide
13.	Chemical bath deposition of NiO
14.	Structural properties of nanomaterials by XRD
15.	Analysis of surface morphology by AFM
16.	Morphological study by SEM
17.	Optical properties of FTO nanocoatings
18.	Optical properties of ITO nanocoatings
19.	Simulation study of metal-oxide semiconductor field-effect transistor (MOSFET)
20.	Simulation study of Nanowires MOSFET
21.	Simulation study of RTD
22.	Design and simulation of AND, OR, and NOT gates using Quantum-dot cellular automata
23.	Design and simulation of NAND and NOR gates using Quantum-dot cellular automata
24.	Design and simulation of XOR gate using Quantum-dot cellular automata
25.	Estimation of reducing sugar by DNSA methods
26.	Analysis of salivary amylase activity
27.	Qualitative analysis of amino acids by TLC
28.	Estimation of proteins by Biurete or Lawry method
29.	Biogenic synthesis of gold/silver nanoparticles using plant extract
30.	Characterization of synthesized nanoparticles
31.	Testing of antibacterial activity of gold/silver nanoparticles by well diffusion /paper disc method
32.	Testing of antifungal activity of gold/silver nanoparticles by well diffusion /paper disc method

References:

1. Nanoelectronic Online Simulation Platform: https://nanohub.org/
2. Quantum dot cellular automata simulation tools: http://qcadesigner.soft112.com/ and http://qcadesigner.software.informer.com/2.0/
3. Principles and Techniques of Biochemistry and Molecular Biology,7th edition, (2010), Wilson K.M., Walker J.M., Cambridge University Press, UK
4. Biochemical spectroscopy. Vol 46 of Methods in Enzymology. (1995) Kenneth Sauer. Academic Press, USA.
5. Analytical Biochemistry, 3rd edition, (1998), David Holmes, H.Peck , Prentice Hall, UK.