



Savitribai Phule Pune University
(Formerly University of Pune)

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

Semester –I

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-21

Paper title: Solid State Physics

Unit 1 - The Crystalline State [12 Lectures]

Crystalline and amorphous solid; Crystal lattice, Unit Cell and Bravais lattice; Plane lattice and their symmetries; Miller Indices and Interplanar distance; Crystal Structures (SC, FCC, BCC) and their example; Concept of reciprocal lattice; Problems.

Unit 2 - X -ray Diffraction and Other Characterization Techniques 12 Lectures]

X-ray diffraction by crystals; Laue theory, Interpretation of Laue equation; Bragg's law and Bragg's Diffraction condition in direct and reciprocal lattice; Ewald's construction, Debye Scherrer method; Atomic scattering factor and Structural scattering factor; Experimental methods of x-ray diffraction; Problems.

Unit 3 - Free electron theory of Metals [12 Lectures]

The free electron model; Energy levels and Density of orbital in 1D and 3D; The Fermi Dirac distribution, Fermi Energy and Fermi level.; Origin of energy gap; Energy bands in Solids, Effective mass of electron (with derivation); Heat capacity of the electron gas; Problem.

Unit 4 - Conduction in Semiconductors [12 Lectures]

Electrons and Holes in an Intrinsic Semiconductor; Conductivity, Carrier concentrations, Donor and Acceptor impurities; Charge densities in a Semiconductor; Fermi level in extrinsic semiconductors; Diffusion and Carrier lifetime; The continuity equation; Problems.

Reference Books:

1. Introduction to Solid State Physics: C. Kittel
2. Solid State Physics: A.J. Dekkar
3. Introduction to Solids: L.V. Azaroff
4. Solid State Physics: S.L. Gupta, V. Kumar.
5. Solid State Physics: S.L. Kakani, C. Hemrajan
6. Solid State Physics: C.M. Kachhava
7. Solid State Physics: R.L. Singhal, Kedar Nath, Ram Nath & Co.

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-22

Paper title: Quantum Mechanics

Unit 1 - Origin of Quantum Mechanics –I [12 Lectures]

Historical Background a) Review of Black body radiation b) Review of photoelectric effects; Wave particle duality ; Matter waves - De Broglie hypothesis - Davisson and Germer experiment.

Unit 2 - Origin of Quantum Mechanics –II [12 Lectures]

Concept of wave packet, phase velocity, group velocity and relation between them; Heisenberg's uncertainty principle with thought experiment. - Electron diffraction experiment, different forms of uncertainty.

Unit 3 - The Schrodinger equation- I [12 Lectures]

Wave function and its physical interpretation; Schrodinger time dependent equation; Schrodinger time independent equation (Steady state equation); Requirements of wave function.

Unit 4 - The Schrodinger equation -II [12 Lectures]

Probability current density, equation of continuity, and its physical significance; Definition of an operator in Quantum mechanics. - Eigen function and Eigen values; Expectation value – Ehrenfest's theorem.

Reference Books:

1. Quantum Mechanics of Atoms, Molecules, Solids, Nuclei and particles. - By R. Eisberg and R. Resnik Published by Wiley.
2. Quantum Mechanics. - By Gupta, Kumar and Sharma Published by J. Prakash Nath and Co. Meeral.
3. Concepts of Modern physics. - By A. Beiser Published by Mc. Grawthill. Chapter 2,3,5,6.
4. Introduction to Quantum Mechanics. - By D. Griffiths Published by Prentice Hall.
5. Quantum Mechanics. - By Ghatak and Lokanathan Published by Mc. Millan.
6. Quantum Mechanics.- By L. I. Schiff.
7. Quantum Mechanics. - By Powell and Crasemann, Addison-Wesley Pub. Co.
8. Quantum Mechanics an accessible introduction - Robert Scherrer Pearson - Addison Wesley

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-23

Paper title: Thermodynamics

Unit 1 - Temperature

[12 Lectures]

Macroscopic point of view; Microscopic point of view; Temperature concept; Measurement of temperature; Different types of thermometers; Thermocouple; Problems

Unit 2 - Thermodynamic System

[12 lectures]

Thermodynamic state of a system ; Thermodynamic equilibrium (thermal, mechanical and chemical); Thermal Equilibrium ; Zeroth law of Thermodynamics ; Quasi-static process; pV diagram; Work dependence on path; Problems

Unit 3- Heat

[12 lectures]

Work and Heat; Internal Energy of System-Concept of heat ; First law of Thermodynamics; Heat transfer (Conduction, convection and radiation); Heat capacity; Problems

Unit 4- Equation of State

[12 lectures]

The Ideal Gas Equation; Indicator Diagram; Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric; Adiabatic relations of system for perfect gas; Work done during Isothermal and Adiabatic changes; Reversible and Irreversible changes; Problems

Reference Books:

1. Physics, 4th Edition, Volume I, Resnick, Halliday, Krane JOHN WILEY & SONS (SEA) PTE LTD.
2. Heat and Thermodynamics Mark. W. Zemansky, Richard H. Dittman Seventh Edition, McGraw-Hill International Editions.
3. Thermal Physics (Heat & Thermodynamics) A.B. Gupta, H.P. Roy Books and Allied (P) Ltd, Calcutta.
4. Heat and Thermodynamics Brijlal, N. Subrahmanyam S. Chand & Company Ltd, New Delhi
5. Thermodynamics and Statistical Physics J.K. Sharma, K.K. Sarkar, Himalaya Publishing House
6. Concept of Physics H.C. VermaBharatiBhavan Publishers.
7. Statistical and Thermal Physics, Michael J. R. Hoch, CRC Press

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-24

Paper title: Advanced Electronics (VLSI and Sensors)

Unit 1 - Power Amplifiers- I

[12 Lectures]

Difference between voltage and power amplifier, Comparison of small signal and large signal amplifiers: with respect to gain, efficiency, and distortion. Classification of power amplifiers on the basis of conduction: class-A, class-B, class-AB, class-C. Class-A amplifier: resistive load/transformer coupled load, efficiency calculation

Unit 2 - Power Amplifiers- II

[12 Lectures]

Class B amplifier: Push-pull amplifier concept, complimentary symmetry class-B push pull amplifier, crossover distortion, class AB push pull amplifier. Concept and working of differential amplifier. Configurations of differential amplifier: Single ended, double ended. Differential and Common mode gains, Use of constant current source and its effect on CMRR.

Unit 3 - Data Converters -I

[12 Lectures]

Digital to analog converters: weighted resistive network, R-2R ladder network, D/A accuracy and resolution,

Unit 4 - Data Converters -II

[12 Lectures]

Analog to Digital converters: Simultaneous conversion, counter method, Tracking method, successive approximation method, Single slope, dual slope, A/D accuracy and resolution.

Reference Books:

1. Electronic Principles by Malvino A.P TMH
2. Operational amplifiers and linear Integrated Circuits by Gaykawad R. PHP
3. Operational amplifier by Clayton G.B. ELBS 4. Electronic devices and circuits by Millman, Halkias McGrawHill
4. Electronic devices and circuits by Boylestead PHP
5. Principles of Electronics by Meheta V.K. S.Chand and Company
6. Principles of Electronics by B.L. Thereja S.Chand and Company
7. Kamran Eshraghian, Douglas A Puknel and Sholeh Eshraghian, "Essentials of VLSI.
8. "Circuits and Systems," prentice Hall of India, New Delhi, 2005.
9. Neil H.E West and Kamran Eshraghian, "Principles of CMOS VLSI Design: A system perspective ", Addison-Wesley, 2nd Edition, 2004.

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-25

Paper title: Synthesis of Nanomaterial's: Physical, Chemical, Biological

Unit 1 - Introduction to Nanoscience

[12 Lectures]

Nano and Nature: Nanoscopic colours (Butterfly wings), Bioluminescence (fireflies), Tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc) in nature.

The development of nanoscale science: size scale, Nanotechnology Timeline: Pre-18th Century: 19th Century, 20th Century, 21st Century.

Generations of nanotechnology. Classification of nanomaterials: 0D, 1D, 2D and 3D and types of nanomaterials (Quantum Dots, Quantum Wires, Carbon Nano Tubes, Bucky Balls, Nanocomposites etc.)

Unit 2 - Synthesis of Nanomaterial's: (Physical Methods)

[12 Lectures]

Mechanical methods, methods based on evaporation, sputter deposition, Chemical vapour deposition (CVD), Electric arc deposition, Ion beam techniques (ion implantation), Molecular beam epitaxy.

Unit 3 - Synthesis of Nanomaterial's: (Chemical Methods)

[12 Lectures]

Colloids and colloids in solutions, Nucleation and growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal routes, Langmuir-Blodgett (L-B) Method, sol-gel method, Hydrothermal synthesis, sonochemical methods.

Unit 4 - Synthesis of Nanomaterial's: (Biological Methods)

[12 Lectures]

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

Reference Books:

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 Vladimir Pokropivny, Rynno Lohmus, 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, New York, 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. Introduction to Nanoscience and Nanotechnology, CRC Press, G. L. Hornyak, H. F. Tibbals, J. Dutta, J. J. Moore
11. Nanotechnology: Principles and practices, 3rd Edition, Sulabha K. Kulkarni, Capital Publishing Company

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-26

Paper title: Instrumentation for Characterization

Unit 1 - Electron Probe Methods

[12 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

Unit 2 - Scanning Probe Microscopy methods

[12 Lectures]

Atomic force microscopy, Scanning tunnelling microscopy, atom-probe methods, other important scanning probe methods.

Unit 3 -Spectroscopic methods

[12 Lectures]

UV-Vis absorption and emission spectroscopy, Infrared and Raman Spectroscopy, X-ray methods.

Unit 4 -Nonradiative and nonelectron characterization methods [12 Lectures]

Particle spectroscopy, thermodynamic methods, particle size determination, surface area and porosity, other important characterization methods

Reference Books:

1. Nanotechnology: Technology Revolution of 21st Century by RakeshRathi, published by S. Chand.
2. Introduction to Nanoscience, by Stuart Lindsay.
3. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, 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.

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-27

Paper title: Cell Biology

Unit 1 - Scope of nanotechnology in life sciences [06 Lectures]

Targeted drug delivery, Imaging techniques, Cancer treatment, Nanoparticles as carrier for genetic material, Nanotechnology in agriculture – Fertilizers and pesticides, Nanobiosensors, Nanotechnology and Tissue Engineering and Regeneration.

Unit 2 - Introduction to cell biology [07 Lectures]

Definition, Cell as structural and functional unit of life, Generalized prokaryotic and eukaryotic cell: size, shape and structure. Plant cell: Parenchyma cells, Collenchyma cells, Animal cell: different types of cells primarily derived from ectoderm (Skin cell, nerve cell), Mesoderm (Blood and immune cells), endoderm (secretory exocrine and endocrine cells).

Unit 3 - Plasma membrane [08 Lectures]

Unit membrane concept, Models: Lipid membrane, Protein-Lipid (Danielli-Dawson) and Fluid Mosaic, Membrane receptors, Modifications: Microvilli, Desmosomes and Plasmodesmata, Transport: Passive and Active. Pinocytosis, Phagocytosis and secretion.

Unit 4 - Cell organelles [12 Lectures]

Occurrence and ultrastructure and function of Endoplasmic reticulum, Golgi complex, Lysosomes and peroxisomes, Mitochondria, Chloroplast.

Unit 5 - Nucleus [05 Lectures]

Size, shape, number and position, Ultrastructure of nuclear membrane and pore complex, Nucleolus: general organization, chemical composition and functions, Nuclear sap/ nuclear matrix, Nucleocytoplasmic interactions.

Unit 6 - Microtubules and microfilaments [05 Lectures]

Ultrastructure, Location, biochemical composition and functions.

Unit 7 - Extra cellular matrix [05 Lectures]

Cell to cell and cell matrix adhesions

List of Reference books:

1. Raplh et al, "Nanoscale Technology in Biological Systems", CRC Press, 2005.
2. C.M. Niemeyer & C.A. Mirkin, "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley VCH Verlag GMBH & Co, 2004.
3. T. Pradeep, "Nano: The essentials", McGraw – Hill, 2007
4. J.J. Davis, Dekker, "Encyclopedia of Nanoscience and nanotechnology"
5. Natalie P. Praetories and Tarun K. Mandal, Recent Patents on Drug Delivery & Formulation 5 Y. Lu, S.C. Chen, Advanced Drug Delivery Reviews.

6. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, "Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact", Wiley – VCH, 2005.
7. Molecular cell Biology, Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
8. Molecular and cellular Biology, Stephen L. Wolfe, Wadsworth Publishing company, 1993.
9. Molecular Biology of the cell, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Garland Science, 5th Ed. 2007
10. Cell and molecular biology, 1988, De Robertis EDP and De Robertis EME, Molt Saunders Inc.
11. Cell and molecular biology, 1996, G.Carp John Waley, USA.
12. The Cell – A Molecular Approach ,Cooper & Hausman ,2004 Sinauer Associates Inc, 6th Ed, 2013
13. Culture of animal cells, R.I. Freshney 4th edn.

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-28

Paper title: Practical-I

1. Synthesis of TiO_2 nanotubes by electrochemical anodization
2. Synthesis of silver nanoparticles by chemical method
3. Synthesis of silver nanoparticles by using biological method
4. Synthesis of silver nanowires by self seeding polyol method
5. Synthesis of ZnO nanorods by hydrothermal method
6. Synthesis of CdSe quantum dots by hot injection method
7. Synthesis of Graphene oxide by modified Hummers method
8. Synthesis of Polyaniline nanofibers by CBD method
9. Synthesis of nanofibers by electrospinning method
10. Electrodeposition of MnO_2

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-29

Paper title: Practical-II

1. Code conversion using logic gates – binary to gray , gray to binary
2. 3 bit synchronous counter using flip flops
3. Decimal to BCD encoder using logic gates
4. Study of RAM
5. Study of 4- Bit Arithmetic Unit using IC 74181
6. DAC using R-2R ladder network
7. ADC using IC 0808/IC 7109/IC 741/IC 324
8. Temperature controller using PT 100 / thermocouple / thermistor temperature sensors 3.
Object counter (two digit)
9. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter
10. LVDT

S. Y. B.Sc. (Nanoscience and Nanotechnology) (Semester-I)

Paper Code: NTT-30

Paper title: Practical-III

1. Study of prokaryotic and eukaryotic cell with the help of suitable material (1)
2. Study of any 3- cell organelles from electron micrographs (1)
3. Observation of human cheek epithelial cells. (1)
4. Cell types of plants - maceration of various tissue explants and identification of xylem vessels, tracheids, stomata, root hair etc. (1)
5. Staining of mitochondria using janus green stain in suitable material. (1)
6. Isolation of nuclei from chicken/goat liver and counting of nuclei (2)
7. Study of mitosis (onion root tip) and meiosis (grasshopper testis/ Tradescantia)– preparation of slides and identification of different stages (2)
8. Observation of programmed cell death in suitable animal or plant materialmaterial. (1)
9. Cell viability assay by trypanblue exclusion method. (1)
10. Culture of Bacteria in liquid medium and agar plates. (1)