**B.Sc Physics**
**Semester VI**
**Elective – IV (a): Nanomaterials and its Applications**
**Subject Code: PC1764**

| No of hours per week | No of credits | Total no of hours | Marks |
|---|---|---|---|
| 5 | 4 | 75 | 100 |

**Objectives : 1**. To gain knowledge on synthesis and characterization of nanomaterials.
**2.** To understand the advancements and applications of nanostructures.

| CO No | Course outcomes<br>Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO-1 | Infer the history of nanotechnology and explain the various dimensions of nanostructures | PSO-1 | U |
| CO-2 | Apply the characterization techniques of nanomaterials (XRD,SEM,TEM and Analytical Electron Microscope) | PSO-3 | Ap |
| CO-3 | Explain the synthesis of nanomaterials and categorize their properties | PSO-2 | An |
| CO-4 | Interpret quantum well, quantum wires and quantum dots | PSO-5 | E |
| CO-5 | Explain the carbon nanotubes and its applications. | PSO-6 | E |
| CO-6 | Discuss the applications of nanotechnology in various fields | PSO-4 | C |

**Modules**

**Credits: 4** **Total contact hours: 75 (Including assignments and tests)**

| Unit | Section | Topics | Lecture hours | Learning outcome | Pedagogy | Assessment/ Evaluation |
|---|---|---|---|---|---|---|
| **I** | **Introduction to nanotechnology** | | | | | |
| | 1 | History of nanotechnology – Inorganic nanomaterials - Organic nanomaterials - Techniques in nanotechnology | 3 | To understand the history of nanotechnology and its techniques | Lecture Discussion with PPT illustration | Evaluation through short test<br><br>Multiple choice |

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|---|---|---|---|---|---|---|
| | 2 | Dimensions of nanostructures – One dimensional nanoscale – Two dimensional nanoscale– Three dimensional nanoscale | 3 | To be able to distinguish the dimensions of nanoscale | Lecture discussion with illustration | questions<br><br>Formative assessment I |
| | 3 | Nanocrystals. Synthesis of nanomaterials: sol-gel method, ball milling, colloidal growth | 3 | To know the principles of nanomaterials and their synrhesis. | Lecture discussion | |
| | 4 | Characterization of nanomaterials – X-ray diffraction (XRD) – Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM) – Analytical Electron Microscope – Significance of nanoparticles | 3 | To distinguish between nanorings, nanorods, nanoshells and to acquire knowledge on the properties of nanoparticles | Lecture discussion | |
| **II** | Quantum wells, Quantum wires and Quantum Dots | | | | | |
| | 1 | Introduction – Potential well – Quantum well – Particle in a box – One-dimensional box – Two-dimensional box – Three-dimensional box | 5 | To acquire knowledge on Potential ,Quantum well and Particle in a box | Lecture with PPT Illustration | Formative assessment I |
| | 2 | Superlattices– Types of Superlattices | 3 | To understand the concept of Superlattices and its types | Question-answer session<br><br>Lecture | |
| | 3 | Applications of quantum wells –Quantum wire – Density of States (3D, 2D, 1D, 0D) –Quantum dots – Electrons in mesoscopic structures. | 4 | To know the density of States, Quantum dots and electron in mesoscopic structure | Lecture with PPT Illustration | |
| **III** | Carbon Nanotubes | | | | | |
| | 1 | Discovery of nanotubes – | 3 | To acquire | Lecture | |

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|---|---|---|---|---|---|---|
| | | Allotropes of carbon – Structure of carbon nanotubes | | knowledge on discovery, Allotropes of carbon and structure of carbon nanotubes | Discussion videos ppt | Formative assessment II |
| | 2 | Categories of carbon nanotubes : Tours – Buckminster fullerene – Carbon nanohorns – Fullerite – Nanobud | 3 | To categorize carbon nanotubes | Lecture<br>Discussion videos | |
| | 3 | Synthesis of carbon nanotubes: Laser method – Electrolysis – Chemical Vapour Deposition (CVD) | 3 | To have a knowledge on synthesis of carbon nanotubes | Lecture with PPT Illustration | |
| | 4 | Purification of carbon nanotubes and fullerene – Applications of carbon nanotubes. | 3 | To acquire knowledge on purification and applications of carbon nanotubes | Lecture<br>Discussion videos | |
| IV Bionanotechnology | | | | | | |
| | 1 | Biomachinery- DNA Nanotechnology | 3 | To understand the human body system and DNA | Lecture with PPT Illustration | Evaluation through short test |
| | 2 | Coding- Polymerisation | 3 | To acquire the Knowledge on Coding and polymerization | Lecture with PPT Illustration | Formative assessment II |
| | 3 | DNA computing – Electronic properties | 3 | To have a knowledge on DNA computing and electronic properties | Lecture with Discussion | |
| | 4 | Biocomputers –DNA sensing- Self-assembly | 3 | To know the biological devices and self assembly | Lecture with PPT Illustration | |
| **V** | Applications of Nanotechnology | | | | | |
| | 1 | Nanoelectronics- Single Electron Transistor- Principle- Coulomb Blockade | 3 | To have a knowledge on Solar power using nanotechnology | Lecture with PPT | Short test<br>Formative assessment II |

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|---|---|---|---|---|---|---|
| | 2 | NEMS- MEMS- Electronics – Batteries | 3 | To acquire knowledge on nanocomposites and nanotechnology in textiles | Brain storming session.<br><br>Lecture<br><br>Illustration | |
| | 3 | Water Purification- Ceramic membranes | 3 | To understand the nanooptics and nanotechnology in communication field | Lecture with PPT<br><br>Illustration | |
| | 4 | Nanomedicine- photodynamic therapy – Tissue welding | 3 | To acquire knowledge on MEMS, Photonic crystals and thin film optics | Lecture<br><br>Discussion videos | Open Book Test |

PO- Program outcome; LO – Learning outcome; Cognitive Level R – Remember; U – Understand; Ap- Apply, An- Analyze; E-Evaluate; C- Create

**Semester - VI** **Major Core IX**

**Name of the Course : Digital Systems and Applications**

**Subject code : PC1762**

| No. of Hours per week | No of Credits | Total no of Hours | Marks |
|---|---|---|---|
| 6 | 5 | 90 | 100 |

Objectives: 1. To understand the different concepts in digital electronics, digital devices and applications.
2. To prepare students to perform the analysis and design of various digital electronic circuits.

| CO | Upon completion of this course, students will be able to: | PSO addressed | CL |
|---|---|---|---|
| CO - 1 | understand the fundamental concepts and techniques used in Digital Electronics. | PSO - 4 | U |
| CO - 2 | perform conversions among different number systems and apply in digital designing. | PSO - 2 | Ap |
| CO - 3 | infer the basic logic gates, understand Boolean algebra and simplify simple Boolean functions by using basic Boolean properties. | PSO - 1 | U |
| CO - 4 | understand, analyse and design various combinational and sequential circuits. (Flip flop, Counters, MUX, DEMUX, Encoder, Decoder etc.) | PSO - 5 | Ap |
| CO - 5 | understand the architecture and operations of microprocessor 8085. | PSO - 7 | U |
| CO - 6 | develop the basic idea about the instruction set and data transfer schemes. | PSO - 6 | Ap |

**Total Hours: 90 (Incl. Seminar & Test)**

| Unit | Section | Description | Lecture hours | Learning outcome | Pagagogy | Assessment/Evaluation |
|---|---|---|---|---|---|---|
| **I** | **Logic gates and Boolean Algebra** | | | | | |
| | 1 | Universal logic gates – NOR, NAND | 3 | To be able to build basic logic gates OR, AND, NOT and Ex-OR using NOR | PPT, Lecture method | Quiz, Assignment, Formative assessment (I) |

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|---|---|---|---|---|---|---|
| | | | | and NAND only | | |
| | 2. | De Morgan's theorems – Positive and negative logic – Boolean laws and theorems | 4 | To simplify Boolean expressions | Lecture | |
| | 3. | Sum of products method – truth table to Karnaugh map (Three variable and Four variable maps) – Karnaugh simplifications – Don't care conditions | 4 | To interpret the result of sum of product method using Karnaugh map | Lecture | |
| | 4. | Product of sums method – Product of sums simplification. | 4 | To interpret the result product of sums method using Karnaugh map | PPT, Lecture, Group discussion | |
| **II** | **Number System** | | | | | |
| | 1 | Binary number system – Binary to decimal conversion | 3 | To understand the concept of binary number system | PPT, | Quiz, Assignment, Formative assessment (I) |
| | 2. | Decimal to binary – Octal numbers – Hexadecimal numbers | 4 | To be able to convert decimal number into its equivalent binary, hexadecimal and octal numbers | Lecture, Problem solving | |
| | 3. | Binary addition – Binary subtraction – $1^s$ and 2s complement method | 4 | To be able to add and subtract two binary numbers using 1s | Lecture, Group discussion, Problem solving | |

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|---|---|---|---|---|---|---|
| | | | | and 2s complement method | | |
| | 4. | Arithmetic building blocks – Half adder and full adder (truth table and Karnaugh map). | 4 | To know the basic Arithmetic building blocks | PPT, Lecture, Group discussion | |
| **III** | **555 timer and flipflops** | | | | | |
| | 1 | 555 timer – Monostable multivibrator Astable multivibrator | 4 | To know the working principle of 555 timer | Lecture, Group discussion | Quiz, Assignment, Formative assessment (I & II), |
| | 2 | Frequency divider – Logic gate flip flop – R-S flip flop – Clocked R-S flip flop | 4 | To distinguish between R-S flip flop and Clocked R-S flip flop | PPT, Lecture, | |
| | 3. | J-K flip flop – R-S master slave flip flop – J-K master – Slave flip flop | 5 | To understand the working principle of master slave flip flops | PPT, Lecture, Group discussion | |
| | 4. | D flip flop | 2 | To understand the working principle of D flip flop | PPT, Lecture, | |
| **IV** | **Registers and Counters** | | | | | |
| | 1 | Types of registers – Serial in - Serial Out – Serial in - Parallel Out | 2 | To analyze various types of shift registers | PPT, Lecture, | Quiz, Formative assessment (II), |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2 | Parallel in - Serial Out – Parallel in – Parallel Out | 4 | To distinguish between Parallel in Serial Out – Parallel in Parallel Out shift registers | PPT, Lecture, | |
| | 3 | Ring counter – Decade counter: A MOD - 5 counter | 4 | To know the principle of ring counter and decade counter | PPT, Lecture, | |
| | 4 | Shift counter – Shift counter Modulus. | 3 | To distinguish between various counters | PPT, Lecture, | |
| **V** | **A-D and D-A converters** | | | | | |
| | 1 | Variable Resistor Network – Binary Ladders | 2 | To understand the concept of binary ladders | Lecture, PPT | Group discussion, Formative assessment (II), |
| | 2 | D-A converter – A-D converter – Simultaneous conversion | 3 | To be able to convert D-A and A-D | Lecture. | |
| | 3 | Multiplexer – De multiplexer | 4 | To understand the concept of multiplexer and de multiplexer | Lecture, PPT | |
| | 4 | Encoder: Decimal to BCD encoder - Decoders : BCD to decimal decoder – Seven segment decoder | 6 | To be able to understand the operation of encoder and decoder | Lecture | |

**Semester** : VI **Major Core - VIII**

**Name of the Course** : **Mathematical Methods of Physics**

**Subject code** : **PC1761**

| No of hours per week | No of credits | Total no of hours | Marks |
|---|---|---|---|
| 6 | 6 | 90 | 100 |

| CO | Upon completion of this course, students will be able to: | PSO addressed | CL |
|---|---|---|---|
| CO - 1 | Illustrate linear dependence and combination of vectors as quantities in Physics. | PSO - 4 | U |
| CO - 2 | Evaluate problems in matrices. | PSO - 4 | E |
| CO - 3 | Solve ordinary and partial differential equations related to Physical Science. | PSO - 2 | C |
| CO - 4 | Adapt Fourier transform technique to obtain the Fourier series of periodic functions of Physics. | PSO - 5 | C |
| CO - 5 | Understand and manipulate random variables using the theory of probability including tools of probability transformation and characteristic functions. | PSO - 6 | U |

## Modules

**Credit:6** **Total Hours:90 (Incl. Seminar & Test)**

| Unit | Section | Topics | Lecture hours | Learning outcome | Pedagogy | Assesment/Evaluation |
|---|---|---|---|---|---|---|
| **I** | **Vector Analysis** | | | | | |
| | 1 | Point function - Scalar field – Vector field - Gradient of a Scalar field - Physical interpretation | 4 | To understand basic concepts of scalar field and vector field | Illustration and theoretical derivation | Evaluation through: quiz, |
| | 2 | Lamellar Vector field - line, surface and volume integrals - | 3 | To be able to evaluate line, surface and volume integrals | Illustration, Theoretical formulation Problem Solving | Problem solving |

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|---|---|---|---|---|---|---|
| | | | | | | Theoretical derivation |
| | 3 | Divergence of a vector function – Expression for divergence in Cartesian coordinates | 2 | To derive expression for divergence of a vector function | Analysis Theoretical formulation and Problem solving | Formative assessment |
| | 4 | Curl of vector function – Expression for curl in Cartesian coordinates – Physical significance of curl | 4 | To understand the physical significance of curl operator and solve physical problems | Theoretical formulation and Problem solving | |
| | 5 | Gauss divergence theorem – Green's theorem. | 2 | To derive Gauss divergence theorem and Green's theorem | Illustration and theoretical derivation | |
| **II** | **Matrices** | | | | | |
| | 1 | Eigen values - Eigen vectors | 2 | To understand the basic concepts of eigen values and eigen vectors | Theoretical formulation and Problem solving | Evaluation through: quiz, |
| | 2 | Characteristic equation of a matrix – Cayley – Hamilton theorem - – Theorems on eigen values and eigen vectors | 5 | To derive theorems on eigen values and eigen vectors | Illustration and theoretical derivation | Problem solving |
| | 3 | Diagonalization of matrices – Special type of matrices – Inverse of a matrix | 5 | To diagonalize and also find inverse of the given matrix | Theoretical formulation and Problem solving | Theoretical derivation |
| | 4 | Non-homogenous linear equations – Cramer's rule for solving non-homogenous linear equations | 3 | To solve non-homogenous linear equations using Cramer's rule | Illustration, Theoretical formulation and Problem solving | Formative assessment |
| **III** | **Differential Equations** | | | | | |

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|---|---|---|---|---|---|---|
| | 1 | First order equations – Variables separable method | 4 | To use variable separable method to solve first order differential equations | Illustration, Theoretical formulation and Problem solving | Evaluation through: quiz, |
| | 2 | Homogenous equations – Non – homogenous equations reducible to homogenous ones – | 4 | To reduce non homogenous equations to homogenous equations | Illustration, Theoretical formulation and Problem solving | Problem solving |
| | 3 | Linear differential equations – Equations of first order and higher degrees | 4 | To understand the solving of first order and higher order differential equations | Illustration, Theoretical formulation and Problem solving | Theoretical derivation |
| | 4 | Physical examples: Radioactive decay process. | 3 | To apply solving techniques of differential equation to solve physical problems | Illustration, Theoretical formulation and Problem solving | Formative assessment |
| **IV** | **Fourier Analysis** | | | | | |
| | 1 | Harmonic oscillations – Harmonic synthesis and analysis – Fourier contribution | 4 | To understand the basic concepts of harmonic synthesis | Illustration, Theoretical formulation | Evaluation through: quiz, |
| | 2 | Fourier series –Dirichlet's theorem – Fourier coefficients – Fourier cosine and sine series | 5 | To evaluate Fourier series | Illustration, Theoretical formulation and Problem solving | Problem solving |
| | 3 | Symmetry – Complex form of Fourier series – Change in interval of expansion | 4 | To apply Fourier theorem for change in interval of expansion | Descriptive lecture and Theoretical formulation | Theoretical derivation |
| | 4 | Applications of Fourier series: Sawtooth wave - Half wave rectifier – Full wave rectifier | 2 | To use Fourier series to evaluate physical problems | Descriptive lecture and Theoretical formulation | Formative assessment |
| **V** | **Random Variables and Probability** | | | | | |

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|---|---|---|---|---|---|---|
| | 1 | Random Variables – Simple random sample – Mean – Median – Mode – Dispersion | 5 | To understand basic concepts of random variables | Illustration, Theoretical formulation | Evaluation through: quiz, |
| | 2 | Elementary properties of probability – Conditional probability – Addition rule of probability – Multiplication law of probability | 6 | To verify addition rule of probability and multiplication law of probability | and Problem solving | Problem solving<br>Theoretical derivation |
| | 3 | Probability distribution – Mean, variance and standard deviation of Poisson distribution. | 4 | To analyze probability distribution and solve physical problems | Illustration, Theoretical formulation | Formative assessment |

PO- Program outcome; LO – Learning outcome; Cognitive Level R – Remember; U – Understand; Ap- Apply, An- Analyze; E-Evaluate; C- Create

**Semester VI**

**Major core X: Nuclear Physics**

**Subject Code: PC1763**

| No of hours per week | No of credits | Total no of hours | Marks |
|---|---|---|---|
| 5 | 5 | 75 | 100 |

**Objective: 1.** To enable the students to understand the properties, models and radioactive reaction of the nucleus.

**2.**To create awareness on nuclear reactions such as fission, fusion, radiation detectors and elementary particles so that students can shine.

| CO | Upon completion of this course the students will be able to : | PSO addressed | CL |
|---|---|---|---|
| **CO- 1** | **Define** the fundamentals of nuclear matter (properties of nuclei and Nuclear forces) | PSO-2 | R |
| **CO- 2** | **Apply** the principles of physics in the measurements of Nuclear size, Nuclear spin, Nuclear energy levels and Nuclear magnetic moment | PSO-1 | Ap |
| **CO- 3** | **Assess** radioactivity and various nuclear reactions (nuclear fission and fusion) | PSO-3 | E |
| **CO -4** | **Explain** the decay modes, Radiation Detectors and Particle Accelerators (Ionisation chamber,Proportional counter,Geiger Muller counter,Linear accelerator, Cyclotron, Synchro cyclotron, Betatron) | PSO-5 | U |
| **CO- 5** | **Discuss** the classification of elementary particles and Quark model | PSO-5 | E |
| **CO -6** | **Analyse** the characteristics and behavier of elementary particles and their fundamental interactions | PSO-7 | An |
| **CO -7** | **Develop** a deeper understanding of some important applications of nuclear physics in Nuclear Reactor and Source of stellar energy. | PSO-6 | C |

## Modules

## Total contact hours: 75 ( Including lectures, assignment and tests)

| Unit | Section | Topics | Lecture Hours | Learning outcomes | Pedagogy | Assessment/Evaluation |
|---|---|---|---|---|---|---|
| **I** | **Properties of Nuclei** | | | | | |
| | **1** | Constituents of nuclei - Isotopes, Isobars, Isotones and mirror nuclei - Nuclear mass and binding energy - Unit of atomic mass - Binding energy and stability of nucleus | **3** | Define the basis of nuclei and stability of nucleus | Lecture discussion | Evaluation Class test, oral question Assignment I |
| | **2** | Mass defect and packing fraction - Binding fraction Vs mass number curve - Nuclear size - Nuclear spin - Nuclear energy levels | **3** | Apply various Binding energy relations | Derivation and group discussion | |
| | **3** | Nuclear magnetic moment - Parity of nuclei - Nuclear quadrupole moment - Statistics of nuclei | **3** | solution of Nuclear magnetic moment | Derivation, problem solving and group discussion | |
| | **4** | Nuclear forces - Liquid drop model - Semi-empherical mass formula - Shell model | **3** | Apply Nuclear forces in different models | Derivation and group discussion | |

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| **II** | **Radioactivity** | | | | | |
| | **1** | Radioactivity - Radioactive reactions - Radioactive decay law - Statistical nature of radioactivity | **3** | Solve Radioactive reactions | Derivation discussion | Evaluation Class test, oral question Assignment<br><br>I/II |
| | **2** | Activity or strength of a radio-sample - Radioactive decay : Conservation laws | **3** | Define and derive Radioactive decay | Derivation and group discussion problem solving | |
| | **3** | Radioactive series: Displacement law - Successive transformation – Radioactive equilibrium | **3** | Statement and proof of displacement law | Derivation and group discussion problem solving | |
| | **4** | Radioactive dating: Age of minerals, rocks - Alpha decay - Beta decay - Gamma decay. | **3** | Radioactive dating and its applications | Derivation and group discussion problem solving | |
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| **III** | **Nuclear Reactions** | | | | | |
| | **1** | Nuclear Reactions: Basics - Conservation laws in nuclear Reactions - Energetics of nuclear Reactions | **3** | Analyse Conservation laws in nuclear Reactions | Derivation discussion | Evaluation Class test, oral question Assignment<br><br>II |
| | **2** | Cross section of nuclear Reactions - Reaction mechanisms - | **2** | Define and derive nuclear Reactions , Reaction mechanisms | Derivation and group discussion | |

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|---|---|---|---|---|---|---|
| | | Nuclear fission - Energy released in fission of U-235 | | &Nuclear fission | | |
| | **3** | Liquid drop theory of fission - Nuclear chain reaction - Nuclear Reactor - Types of reactor - Breeder reactor - Fission bomb | **4** | Define and Derive Nuclear chain reaction, Types of reactor, Breeder reactor & Fission bomb | Derivation and group discussion, PPT | |
| | **4** | Fusion: Thermo nuclear reaction - Source of stellar energy: Natural fusion - Uncontrolled fusion: Hydrogen bomb. | **3** | Define, derive and apply Uncontrolled fusion: Hydrogen bomb | Derivation and group discussion | |
| **IV** | **Radiation Detectors and Particle Accelerators** | | | | | |
| | **1** | Introduction - Ionisation chamber - Proportional counter - Geiger Muller counter - Neutron detection | **3** | Discuss different types of Radiation Detectors | Derivation discussion | Evaluation Class test, oral question Assignment II/III |
| | **2** | Cloud chamber - Scintillation counter - Photographic detection - Solid state track detector | **3** | Define and derive Cloud chamber & Scintillation counter | Derivation and group discussion, PPT | |
| | **3** | Semiconductor detector - Particle accelerators - Linear accelerator | **3** | Define and Derive different types of Particle accelerators | Derivation and group discussion | |
| | **4** | Cyclotron - Synchro cyclotron - | **3** | Define , derive and apply | Derivation and group discussion | |

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|---|---|---|---|---|---|---|
| | | Betatron | | Cyclotron , Synchro cyclotron and Betatron | | |
| **V** | **Elementary Particles** | | | | | |
| | **1** | Introduction - Fundamental Interactions - Pions and Muons - K mesons – Hyperons, Antiparticles | **3** | Analyse Fundamental Interactions | Discussion PPT | Evaluation Class test, oral question Assignment **III** |
| | **2** | Classification of elementary particles - Conservation laws - CPT theorem | **3** | Analyse classification of elementary particles | Derivation and group discussion, PPT | |
| | **3** | Resonance particles - Symmetry classification of elementary particles | **3** | Explain symmetry classification of elementary particles | Derivation and group discussion | |
| | **4** | Quark model Unification of interactions - The standard model. | **3** | Define , derive and apply Quark model | Derivation and group discussion, PPT | |

**Books:**


1. Gupta, A.B. (2015). *Modern Physics*. ( 2nd ed.). New Delhi: Books and Allied (P) Ltd.

Unit I: Chapter 18 : 18.1-18.3, 18.5-18.16, 18.17, 18.18, 18.18.1, 18.19, 18.19.1 - 18.19.4

Unit II: Chapter 19 : 19.1 - 19.9, 19.11

Unit III: Chapter 20: 20.1-20.16

Unit IV: Chapter 21: 21.1-21.5, 21.7, 21.7.1, 21.7.2, 21.9, 21.11-21.16, 21.17.2, 21.18

Unit V: Chapter 22: 22.1-22.9, 22.10, 22.11-22.14

2. Arthur Beiser. (2006). *Concepts of Modern Physics*. ( 6th ed.).New Delhi: Tata McGraw - Hill Edition,

Unit II: Chapter 12: 12.4-12.6, Appendix (theory of alpha decay)

## Reference Books:


1. Tayal D.C. (2002). *Nuclear Physics*. ( 1st ed.). New Delhi: Himalaya Publishing House.

2. Roy R.R. and Nigam B.P. (1983). .*Nuclear Physics*, (2nd ed.). Bangalore: New age International Ltd.

3. SatyaPrakash, (2004). *Nuclear Physics and Particle Physics*. (1st ed.). New Delhi: S. Sultan Chand & Sons Publications.