# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - I

## Paper (I) - Mechanics & Oscillations (I)

## (DSC PHY 101, Credits Theory 02, Lectures 30)

**Max. Marks: 35**

**Duration of EoSE : 3 hrs.**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer.** **(7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks.** **(4 x 7 marks each = 28 marks)**

| **Semester** | **Code of The Course** | **Title of The Course/Paper** | **NHEQF Level** | **Credits** |
|---|---|---|---|---|
| **I** | **DSC PHY 101** | **Mechanics & Oscillations (I)** | **5** | **02** |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the course is to provide students with a comprehensive understanding of mechanics, including the laws of motion, frames of reference, forces, motion of particles and rigid bodies and rigid body dynamics. The course aims to develop their knowledge and skills in analysing and solving problems related to these topics, using appropriate mathematical formalism and physical concepts. | | | |

### Unit - I : Physical Laws & Frames of Reference

(a) Introduction to reference frames, Coordinates transformation Inertial & Non-Inertial frames, Transformation of displacement, velocity, acceleration between different frames of reference involving translation, Galilean transformation & Invariance of Newton's laws.

(b) Coriolis Force : Transformation of position, velocity & acceleration in rotating frame, Pseudo forces, Coriolis force, Motion relative to earth. **(10 Lectures)**

### Unit - II : Conservation Laws & Simple Harmonic Motion (SHM)

Conservative Forces : Introduction about Conservative & Non-Conservative forces, Rectilinear motion under conservative forces, Discussion of potential energy curve & Motion of a particle, Introduction about oscillations in a potential well, Simple harmonic motion (SHM).

**(06 Lectures)**

### Unit - III : Centre of Mass Frame

Introduction about centre of mass (CM), Centre of mass frame : Collision of two particles in one & two dimensions (elastic & inelastic), Slowing down of neutrons in a moderator, Motion of a system with varying mass, Conservation of angular momentum, Charge particle scattering by a nucleus. **(07 Lectures)**

### Unit - IV : Rigid Body Dynamics

Equation of motion of a rotating body, Inertial coefficients, Case of **J** not parallel to **ω**, Kinetic energy of rotation & idea of principal axis, Calculation of moment of inertia of a disc, spherical shell, hollow & solid spheres, and cylindrical objects (cylindrical shell & solid cylinder) about their symmetric axis through center of mass. **(07 Lectures)**

**Reference Books/Text Books**


1. Mechanics by Charles Kittel, Berkeley Physics Course.
2. Introduction to Classical Mechanics by R. G. Takwale, P S. Puranik, TMH.
3. Classical Mechanics by Herbert Goldstein, Pearson Education.
4. Classical Mechanics by Dr. J. C. Upadhyaya, Himalaya Publishing House.
5. Analytical Mechanics by Louis N. Hand, Janet D. Finch, Cambridge University Press.
6. Mechanics by L.D. Landau and E. M. Lifshitz, Elsevier.
7. An Introduction To Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
8. Mechanics, D. S. Mathur, S. Chand and Company Limited.


**Suggested E-Resources :**

1. MIT OpenCourseWare: Classical Mechanics - This resource provides lecture notes, problem sets, and solutions for a complete course on classical mechanics: https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in mechanics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Understand the concept of inertial and non-inertial frames of reference and their implications on the laws of motion.
2. Apply transformations of displacement, velocity, and acceleration between different frames of reference involving translation.
3. Explain the Galilean transformation and the invariance of Newton's laws.
4. Analyze the motion in rotating frames, including the transformation of displacement, velocity, and acceleration, and the effects of pseudo forces such as the Coriolis force.
5. Analyze the motion of a Foucault pendulum and understand its relation to the rotation of the Earth.
6. Define conservative and non-conservative forces and analyze rectilinear motion under conservative forces.
7. Analyze potential energy curves and understand the motion of particles under conservative forces.
8. Explain the concept of the center of mass and its relevance in the motion of systems of particles.
9. Apply the concept of conservation of angular momentum and analyze particle scattering by a nucleus.
10. Understand the equations of motion for rotating bodies and the concept of the moment of inertia.
11. Analyze the kinetic energy of rotation and the motion of spinning tops.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - I

## Paper (II) - Electromagnetism (I)

## (DSC PHY 102, Credits Theory 02, Lectures 30)

**Max. Marks : 35**

**Duration of EoSE : 3 hrs.**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| I | DSC PHY 102 | Electromagnetism (I) | 5 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | Core | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of electrostatics. It aims to develop their knowledge and skills in analysing scalar and vector fields, electric fields, and their interactions. The course will also cover important topics such as electric potential and polarization. | | | |

### Unit - I : Scalar & Vector Fields

Concept of Field, Scalar & Vector fields, Gradient of scalar field, Physical significance & formalism of gradient, Problems based on gradient of a scalar & vector function, Divergence & Curl of a vector field in cartesian coordinates system, Concept of solid angle, Gauss divergence & Stoke's theorem, Gauss law from inverse square law, Differential form of Gauss law. **(07 Lectures)**

### Unit - II : Electric Field & Potential Energy

Potential energy of system of (i) Discrete N-charges (ii) Continuous charge distribution, Energy required to build a uniformly charged sphere, Classical radius of electron, Electric field due to a short electric dipole, Interaction of electric dipole with external uniform & non-uniform electric field, Potential due to a uniformly charged spherical shell, Poisson's & Laplace equations in cartesian coordinates & applications to solve the problems of electrostatics.

**(07 Lectures)**

### Unit - III : Electric Field In Matter

Definition of moments of charge distribution, Multipole expansion, Dielectrics, Induced dipole moments, Polar & Non-polar molecules, Free & bound charges, Polarization, Atomic polarizability, Electric displacement vector, Electric susceptibility, Dielectric constant & relations between them. **(07 Lectures)**

## Unit - IV : Electric Field & Electric Potential In Relation To A Sphere

Electric potential & electric field due to a uniformly polarized sphere (i) Outside the sphere (ii) At the surface of the sphere (iii) Inside the sphere.

Electric field due to a dielectric sphere placed in a uniform electric field (a) Outside the sphere (b) Inside the sphere.

Electric field-due to a charge placed in dielectric medium & Gauss's law, Clausius-Mossotti relation in dielectrics. **(09 Lectures)**

**Reference Books/Text Books**


1. Electricity & Magnetism by A.S. Mahajan & Abbas A. Rangwala Tata McGraw-Hill.
2. Introduction to Electrodynamics by David J. Griffith, Prentice Hall of India Pvt. Ltd. New Delhi.
3. Fundamental University Physics Vol II: Fields and Waves by Alonso/Finn, Addison – Wesley Publishers.
4. Classical Electrodynamics by J. D. Jackson, Wiley Student Edition.
5. Classical Electrodynamics : A Modern Perspective by Kurt Lechner, Springer International Publishing AG.
6. Classical Electrodynamics by P. Sengupta, New Age International Publishers.
7. Classical Electrodynamics (Revised Edition) by S. P. Puri, Narosa Publishers.


**Suggested E-Resources**

1. MIT OpenCourseWare: Electrostatics - This resource offers lecture notes, assignments, and exams for a complete course on electrostatics : https://ocw.mit.edu/courses/physics/8-02sc-physics-ii-electricity-and-magnetism-spring-2011/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in electrostatics and electric fields: http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elefie.html

**Course Learning Outcomes:**

By the end of the course, students should be able to:

1. Understand the concept of scalar and vector fields and their physical significance.
2. Demonstrate knowledge of gradient, divergence, and curl operators and their applications in electromagnetism.
3. Apply Gauss divergence and Stoke's theorems to analyze electric and magnetic fields.
4. Explain the behavior of electric fields and potential energy in different charge distributions.
5. Analyze the interaction of electric dipoles with external electric fields and calculate the resulting potentials.
6. Solve problems related to Poisson's and Laplace's equations in electrostatics.
7. Describe the behavior of electric fields in different types of matter, including dielectrics and polarized spheres.
8. Understand the concept of electric displacement, susceptibility, and dielectric constant.
9. Understand the concept of vector fields and their mathematical representation. Calculate partial derivatives, gradients, and line integrals of scalar and vector fields.
10. Apply Gauss's divergence theorem and understand the physical meaning of divergence in Cartesian coordinates. Relate divergence to the concept of solid angle and Gauss's law.
11. Apply curl to vector fields and understand its physical significance. Use Stoke's theorem to relate curl to line integrals.
12. Manipulate vector identities using the del operator and understand their applications in physics.
13. Analyze electrostatic fields and potentials due to discrete charges and continuous charge distributions. Calculate potential energy of systems of charges.
14. Apply the concept of electrostatic potential to determine the energy required to build a uniformly charged sphere and the classical radius of an electron.
15. Analyze the potential and field due to a short dipole in polar and Cartesian coordinates. Calculate the torque and force on a dipole in an external field.
16. Investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Analyze the electric field measured in different frames of reference.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - I

## Physics Practical Lab (I)

## (DSCP PHY 111, Credits Practical 02, Practical Hours 60)

**Max. Practical Marks = 50 Marks**
**Internal Marks = 20 Marks**
**External Practical Exam = 30 Marks (Duration : 3 hrs.)**

**Note: Out of the following experiments, 8 experiments must be done by the students in the semester.**
**(4 hrs. per week)**

<table>
<tr><th>Semester</th><th>Code of The Course</th><th>Title of The Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>I</td><td>DSCP PHY 111</td><td>Physics Practical Lab (I)</td><td>5</td><td>02</td></tr>
<tr><td>Level of Course</td><td>Type of The Course</td><td colspan="3">Delivery Type of The Course</td></tr>
<tr><td>Introductory</td><td>Core</td><td colspan="3">Practical, Sixty Hours of Practicals including diagnostic and formative assessment during practical hours.</td></tr>
<tr><td>Prerequisites</td><td colspan="4">Physics and Mathematics courses of Central Board of Secondary Education or equivalent.</td></tr>
<tr><td>Objectives of The Course :</td><td colspan="4">1. To provide hands-on experience in conducting experiments related to electricity and magnetism.<br>2. To develop practical skills in using various electrical components and instruments.<br>3. To reinforce theoretical concepts learned in the corresponding lecture course through practical applications.<br>4. To enhance problem-solving and analytical skills by analysing experimental data and interpreting results.<br>5. To promote scientific inquiry, critical thinking, and the ability to design and execute experiments.<br>6. To foster teamwork and collaboration in conducting experiments and analysing results.<br>7. To develop skills in accurately measuring and recording experimental data.</td></tr>
</table>

### DSCP PHY 111 : Physics Practical Lab (I)

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

**List of Experiments : Semester - I**

1. To study the variation of power transfer to different loads by a D.C. source and to verify maximum power transfer theorem.
2. To determine internal resistance of a D.C. source (source resistance) and to verify the maximum power transfer theorem by studying the dependence of power delivered to the load on load.
3. To study the transient behaviour of a RC circuit using a DC source by varying values of R and C.
4. To study the characteristics of a semiconductor junction diode and determine forward and reverse resistances.
5. To determine the specific resistance of the material of a wire using Carey Foster's bridge.
6. To determine the difference between two small resistances using Carey Foster's bridge.
7. To convert galvanometer into an ammeter of a given range.
8. To convert galvanometer into a voltmeter of a given range.
9. To study the resonance frequency of series LCR circuit and hence to determine resonance frequency, quality factor & bandwidth.
10. To study the variation of power transfer by two different loads by a D.C. source and to verify the maximum power transfer theorem.
11. To study the resonance of parallel LCR circuit and hence to determine resonance frequency, quality factor & bandwidth.
12. To determine the Poisson's ratio of the rubber.
13. To study the rise and decay of current in an L-R circuit with a source of constant EMF and to determine the time constant.
14. To determine the difference between two small resistances using Carey Foster's bridge.
15. To study the behaviour of an RC Circuits with varying resistance and capacitance using AC mains as a power source and also to determine the impedance and phase relations.
16. To study the rise the decay of current in an LR circuit with a source of constant EMF.
17. To study the voltage and current behavior of an LR circuit with an AC power source. Also, determine power factor, impedance and phase relations.
18. To study the magnetic field along the axis of a current carrying circular coil, drawing the necessary curve and hence find the radius of the circular coil.
19. Any experiment according to undergraduate level physics theory.

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Demonstrate proficiency in using various electrical components and instruments required for conducting experiments.
2. Apply theoretical concepts of electricity and magnetism to design and execute experiments.
3. Analyze experimental data using appropriate mathematical and statistical techniques.
4. Interpret experimental results and draw conclusions based on data analysis.
5. Develop skills in accurately measuring physical quantities and recording experimental observations.
6. Communicate experimental procedures, results, and conclusions effectively in written reports.

# B.Sc. (Pass Course) - Physics

## Semester - II

## Paper (III) - Mechanics & Oscillations (II)

## (DSC PHY 201, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer.** **(7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks.** **(4 x 7 marks each = 28 marks)**

| **Semester** | **Code of The Course** | **Title of The Course/Paper** | **NHEQF Level** | **Credits** |
|---|---|---|---|---|
| **II** | **DSC PHY 201** | **Mechanics & Oscillations (II)** | **5** | **02** |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the course is to provide students with knowledge related to oscillations, damping, coupled oscillators, and properties of materials. The lab aims to reinforce theoretical concepts learned in the classroom, develop conceptual skills, and enhance the understanding of physics principles both through sharpened theoretical skills & experimentation. | | | |

**Unit - I : Motion Under Central Forces**

Introduction about central forces, Motion under central forces, Gravitational interaction, Inertia and Gravitational mass, General solution under gravitational interaction, Kepler's laws, Discussion of trajectories, Cases of elliptical & circular orbits, Rutherford scattering, Relation between impact parameter & angle of scattering. **(08 Lectures)**

**Unit - II : Simple & Damped Harmonic Oscillations**

Spring-mass system, Mass on a spring, Torsional oscillator, LC circuit & Energy of the oscillator, Damped force & motion under damping, Damped simple harmonic oscillator, Power dissipation. **(07 Lectures)**

**Unit - III : Driven Harmonic Oscillations**

Driven harmonic oscillator with damping, Frequency response, Phase relations, Quality factor, Resonance, Series & parallel combinations of LCR circuit. **(07 Lectures)**

## Unit - IV : Coupled Oscillations

Equation of motion of two coupled simple harmonic oscillators, Motion in normal modes, Motion in mixed modes, Transient behaviour, Electrically coupled circuits, Frequency response, Dynamics of a number of oscillators with neighbor interactions. **(08 Lectures)**


**References Books/Text Books**

1. The Physics of Wave and Oscillation by N.K. Bajaj, McGrow Hill Education.
2. Vibration and Waves by A. P. French, CBS Publishers.
3. Mechanics by Charles Kittel, Berkeley Physics Course.
4. Introduction to Classical Mechanics by R. G. Takwale, P S. Puranik, TMH.
5. Classical Mechanics by Herbert Goldstein, Pearson Education.
6. Classical Mechanics by Dr. J. C. Upadhyaya, Himalaya Publishing House.
7. Analytical Mechanics by Louis N. Hand, Janet D. Finch, Cambridge University Press.
8. Mechanics by L.D. Landau and E. M. Lifshitz, Elsevier.
9. An Introduction To Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
10. Mechanics, D. S. Mathur, S. Chand and Company Limited.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Oscillations & Waves - This resource provides lecture notes, problem sets, and solutions for a complete course on oscillations & waves : https://ocw.mit.edu/courses/res-8-009-introduction-to-oscillations-and-waves-summer-2017/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in oscillations & waves : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

**Course Learning Outcomes :**

By the end of the course, students should be able to :

1. Understand the motion under central forces, including gravitational interaction, and apply Kepler's laws.
2. Analyze damped harmonic oscillations and understand the effects of damping on oscillatory motion.
3. Analyze driven harmonic oscillators with damping and understand frequency response and power dissipation.
4. Explain the behavior of coupled oscillators and analyze systems of oscillators with neighbor interactions.
5. Understand the concept of free oscillations and analyze systems with one degree of freedom. Study oscillations in arbitrary potential wells and solve simple harmonic motion problems using complex exponentials.
6. Analyze mechanical and electrical systems undergoing oscillatory motion. Calculate the energy of oscillators and examine power dissipation and damping under viscous and solid friction.
7. Understand the superposition of two undamped harmonic oscillations and the concept of beats. Analyze the combination of two oscillations at right angles and study anharmonic oscillators using the pendulum as an example.
8. Study forced oscillations with damping and harmonic forces. Analyze the effect of varying the resistive term and understand transient phenomena in driven oscillators. Calculate power absorbed by a driven oscillator and examine frequency response, phase relations, and quality factor.
9. Explore resonance in electrical oscillations, series and parallel LCR circuits, and electromechanical systems, such as, ballistic galvanometers. Study non-linear effects in electrical devices and acoustic waves.
10. Analyze the motion of two coupled simple harmonic oscillators and derive the differential equations for stiffness or capacitance-coupled oscillators. Understand normal modes and motion in mixed modes.
11. Study the normal modes of vibration for molecules and electrically coupled circuits.
12. Investigate many coupled oscillators, including N-coupled oscillators and longitudinal oscillators.
13. Understand the concept of normal modes, calculate normal mode frequencies, and study the motion of monoatomic and diatomic lattices. Explore dispersion relations, group and phase velocities, and the effects of coupling.
14. Study the wave equation in one dimension and its solutions for elastic waves in solid rods, gas columns, and transverse waves on a string. Analyze normal modes of a two-dimensional system and waves in two and three dimensions, including spherical waves.
15. Understand the reflection and transmission of waves on a string at a boundary, including the reflection and transmission of energy. Analyze impedance matching and standing waves on a string of fixed length.
16. Calculate the energy of a vibrating string and analyze the energy in each normal mode.

## B.Sc. (Pass Course) - Physics

## Semester - II

## Paper (IV) - Electromagnetism (II)

## (DSC PHY 202, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| II | DSC PHY 202 | Electromagnetism (II) | 5 | 02 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours. | | |
| Prerequisites | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| Objectives of The Course : | The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of electromagnetism. It aims to develop their knowledge and skills in analysing scalar and vector fields, electric and magnetic fields, and their interactions, as described by Maxwell's equations. The course will also cover important topics such as electric potential, polarization, magnetostatics, and electromagnetic waves. | | | |

### Unit - I : Magnetostatics

Properties of magnetic field, Lorentz force, Ampere's law, Magnetic field due to a current carrying solid conducting cylinder (a) Outside (b) At the surface & (ii) Inside the cylinder, Ampere's law in differential form, Introduction of magnetic vector potential, Bio-Savart's law & application to magnetic vector potentials. **(08 Lectures)**

### Unit - II : Magnetic Field In Matter

Atomic magnet, Gyromagnetic ratio, Bohr-magneton, Larmor frequency, Induced magnetic moment & diamagnetism, Spin magnetic moment, Para- & ferromagnetism, Intensity of magnetization, Magnetic permeability & susceptibility, Free & bound current densities, Magnetic field due to a uniformly magnetized material & non-uniformly magnetized material.

**(09 Lectures)**

**Unit - III : Maxwell's Equations & Electromagnetic waves (A)**

Displacement current, Maxwell's Equations, Electromagnetic wave equation, Electromagnetic waves & properties, Electromagnetic waves in free space & isotropic medium. **(06 Lectures)**

**Unit - IV : Electromagnetic waves (B)**

Electromagnetic spectrum, Energy density of electromagnetic waves, Poynting theorem, Radiation pressure & resistance in free space, Electromagnetic waves in dispersive medium. **(07 Lectures)**

**Reference Books/Text Books**


1. Electricity & Magnetism by A.S. Mahajan & Abbas A. Rangwala Tata McGraw-Hill.
2. Introduction to Electrodynamics by David J. Griffith, Prentice Hall of India Pvt. Ltd. New Delhi.
3. Fundamental University Physics Vol II: Fields and Waves by Alonso/Finn, Addison – Wesley Publishers.
4. Classical Electrodynamics by J. D. Jackson, Wiley Student Edition.
5. Classical Electrodynamics : A Modern Perspective by Kurt Lechner, Springer International Publishing AG.
6. Classical Electrodynamics by P. Sengupta, New Age International Publishers.
7. Classical Electrodynamics (Revised Edition) by S. P. Puri, Narosa Publishers.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Electricity and Magnetism - This resource offers lecture notes, assignments, and exams for a complete course on electricity and magnetism: https://ocw.mit.edu/courses/8-03sc-physics-iii-vibrations-and-waves-fall-2016/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in electromagnetism : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

**Course Learning Outcomes :**

By the end of the course, students should be able to :

1. Analyze the behavior of magnetic fields in various materials and the effects of currents on magnetic fields.
2. Apply Ampere's law and the magnetic vector potential to calculate magnetic fields in different scenarios.
3. Explain the properties of electromagnetic waves and their behavior in isotropic and dispersive media.
4. Calculate the energy density and radiation pressure of electromagnetic waves.
5. Understand the spectrum of electromagnetic waves and its implications.
6. Investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Analyze the electric field measured in different frames of reference.
7. Understand the magnetic field in free space and matter. Apply Ampère's circuital law and use it in differential form with the vector potential.
8. Calculate the magnetic field for different current configurations using the Biot-Savart law and deduce the field of any current-carrying wire.
9. Apply transformation relations for electric and magnetic fields between inertial frames.
10. Study electric fields in matter, including electrical moments, dipole and quadrupole moments, atomic and molecular dipoles, and dielectrics. Analyze the field of a charge in a dielectric medium and the connection between electric susceptibility and atomic polarizability.
11. Investigate electromagnetic induction, Faraday's law, and the effects of conducting rods and loops moving in magnetic fields. Understand the differential and integral forms of Faraday's law.
12. Analyze inductance, self-inductance, mutual inductance, and energy stored in inductors and magnetic fields. Understand displacement current and its role in Maxwell's equations.
13. Explore Maxwell's equations in differential and integral form, their application in material media, and the boundary conditions for electric and magnetic fields at vacuum-dielectric and vacuum-metal boundaries.

# B.Sc. Pass Course - Physics

## Semester - II

## Physics Practical Lab (II)

## (DSCP PHY 211, Credits Practical 02, Practical Hours 60)

**Max. Practical Marks = 50 Marks**
**Internal Marks = 20 Marks**
**External Practical Exam = 30 Marks (Duration : 3 hrs.)**

**Note: Out of the following experiments, 8 experiments must be done by the students in the semester.**
**(4 hrs. per week)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| II | DSCP PHY 211 | Physics Practical Lab (II) | 5 | 02 |
| Level of Course | Core | Delivery Type of The Course | | |
| Introductory | Core | Practical, Sixty Hours of Practicals including diagnostic and formative assessment during practical hours. | | |
| Prerequisites | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| Objectives of The Course : | The objective of the Physics Practical Lab (II), with the mentioned experiments, is to provide students with hands-on experience in conducting experiments related to electricity & magnetism. The lab aims to reinforce theoretical concepts learned in the classroom, develop practical skills, and enhance the understanding of physics principles through experimentation. | | | |

### DSCP PHY 211 : Physics Practical Lab (II)

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

### List of Experiments : Semester - II

1. To study the random decay and determine the decay constant using the statistical board.
2. Using compound pendulum study the variation of time period with amplitude in large angle oscillations.
3. To study damping using a compound pendulum/bar pendulum and determine damping coefficient & quality factor of the compound pendulum.

4. To study radius of gyration and to determine acceleration due to gravity (g) using a compound pendulum/bar pendulum.
5. To determine Young's modulus by bending of rectangular cross-sectional beam.
6. To determine Young's modulus (Y), $\sigma$ (Poisson's ratio) and $\eta$ ( modulus of rigidity) by Searle's method.
7. To determine modulus of rigidity of a wire using Maxwell's needle.
8. To study the variation of surface tension with temperature using Jaeger's method.
9. To find the motion of a spring and calculate (a) spring constant (b) acceleration due to gravity (g) (c) modulus of rigidity.
10. To study the sensitivity of a cathode ray oscilloscope (CRO).
11. To convert a given voltmeter to an ammeter of suitable range and calibrate the ammeter.
12. To convert a given ammeter (μA to mA) to a voltmeter of suitable range and calibrate the voltmeter.
13. To study the Fresnel's & Fraunhoffer's diffraction.
14. To determine the moment of Inertia of a fly-wheel.
15. To study the motion of a spring and calculate (a) spring constant (b) acceleration due to gravity (g) (c) modulus of rigidity.
16. Any experiment according to undergraduate level physics theory.

**Course Learning Outcomes :**

Through these experiments, students will develop practical skills in experimental techniques, data collection, analysis, and interpretation. They will also enhance their understanding of fundamental concepts and principles in oscillations, damping, coupled oscillators, and material properties. The lab experiences will foster critical thinking, problem-solving abilities, and the application of theoretical knowledge to real-world scenarios.

# B.Sc. (Pass Course) - Physics

## Semester - III

## Paper (V) - Thermodynamics

## (DSC PHY 301, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note : There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer.** **(7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks.** **(4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| III | DSC PHY 301 | Thermodynamics | 6 | 02 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours. | | |
| Prerequisites | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| Objectives of The Course : | The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of thermodynamics. It aims to develop their knowledge and skills in analyzing general thermodynamical interactions, theory & application of Clausius-Clapeyron equation, Carnot's theorem, Maxwell relations, production and applications of low temperatures & superconductors. | | | |

**Unit - I : General Thermodynamical Interaction**

Thermal interaction, Zeroth law of thermodynamics, Helmholtz free energy, Adiabatic interaction & Enthalpy, General interaction & First law of thermodynamics, Infinitesimal general interaction, Gibb's free energy & Phase transitions, Clausius-Clapeyron equation, Vapour-pressure curve. **(09 Lectures)**

**Unit - II : Carnot's Engine & Maxwell's Relations**

Heat engine & efficiency of engine, Carnot's cycle & efficiency of Carnot's engine, Refrigerator, Carnot's theorem, Second law of thermodynamics, Thermodynamic scale as an absolute scale, Maxwell relations & applications. **(07 Lectures)**

**Unit - III : Production of Low Temperature**

Joule-Thomson expansion & Joule-Thomson coefficients for ideal as well as Van der Waal's gas, Porous-plug experiment, Inversion temperature, Regenerative cooling, Cooling by adiabatic expansion & Cooling by demagnetization. **(07 Lectures)**

**Unit - IV : Applications of Low Temperature & Superconductors**

Liquid Helium, He I & He II, Superfluidity, Quest for absolute zero, Nernst's heat theorem, Qualitative discussion of superconductivity : Introduction to superconductors, Experimental features of superconductivity (Critical temperature, Persistent current, Critical magnetic field, Meissner effect, Type I & Type II superconductors), Isotope effect & Electron-phonon interaction, Applications of superconductors. **(07 Lectures)**

**Reference Books/Text Books**


1. Thermal Physics by Kittel, San Francisco: W.H. Freeman Publisher.
2. Statistical and Thermal Physics by S Lokanathan, R S Gambhir, PHI Learning Publisher.
3. Statistical Physics by Berkeley Series Vol. V, McGraw Hill India.
4. Fundamentals of Statistical and Thermal Physics by F. Reif, Sarat Book House.
5. An Introduction To Thermodynamics by Y. V. C. Rao, Universities Press.
6. Thermodynamics : A Complete Undergraduate Course by Andrew M. Steane, OUP Oxford.
7. Thermodynamics (Foundations & Applications) by E. P. Gyftopoulos & G. P. Beretta, Dover Publications.


**Suggested E-Resources :**

1. MIT OpenCourseWare: Thermodynamics - This resource offers lecture notes, assignments, and exams for a complete course on thermodynamics : https://ocw.mit.edu/courses/5-60-thermodynamics-kinetics-spring-2008/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in thermodynamics : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Understand the concept of general interactions in thermodynamics and first law of thermodynamics.
2. Demonstrate knowledge of general interactions in thermodynamics, first law in thermodynamics, Helmholtz free energy, Gibb's free energy & Clausius-Clapeyron equation, vapor-pressure curve.
3. Understand the concepts of thermal interactions and the zeroth law of thermodynamics.
4. Study systems in thermal contact with a heat reservoir, canonical distribution, and energy fluctuations.
5. Calculate the entropy of a system in a heat bath and analyze the Helmholtz free energy. Explore adiabatic interactions, enthalpy, and the first law of thermodynamics.
6. Study infinitesimal general interactions and Gibb's free energy.
7. Explore phase transitions, including first and second-order phase transitions. Understand the Clausius-Clapeyron equation and the vapor pressure curve.
8. Analyze the transformation of disorder into order and the efficiency of heat engines, including Carnot's cycle.
9. Learn about the thermodynamic scale as an absolute scale and apply Maxwell relations.
10. Derive Maxwell's law of distribution of velocities and verify it experimentally. Calculate the most probable, average, and root mean square velocities.
11. Study diffusion and the equipartition theorem. Explore the classical theory of specific heat capacity and analyze the specific heat of solids.
12. Understand transport phenomena, including mean free path, coefficients of viscosity, thermal conductivity, and diffusion.
13. Applications of Clausius-Clapeyron equation, first & second law of thermodynamics.
14. Explain the concept of Carnot's engine and applications, Maxwell equations and their applications.
15. Explain the principle of low temperature production, Joule-Thomson expansion and porous plug experiment.
16. Explain the concept of regenerative cooling and applications by adiabatic cooling & colling by demagnetization.
17. Applications of low temperature production, He I & He II, superfluidity.
18. Applications of superfluidity in superconductors, Meisner effect.
19. Study the production of low temperatures and cooling by adiabatic expansion. Analyze the coefficient of performance, Joule-Thomson effect, J-T coefficient, and temperature of inversion.
20. Learn about the quest for absolute zero and the third law of thermodynamics.

# B.Sc. (Pass Course) - Physics

## Semester - III

## Paper (VI) - Electronics & Solid State Devices (I)

## (DSC PHY 302, Credits Theory 02, Lectures 30)

**Duration of EoSE: 3 hrs.** **Max. Marks : 35**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| III | DSC PHY 302 | Electronics & Solid State Devices (I) | 6 | 02 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours. | | |
| Prerequisites | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| Objectives of The Course : | The objective of this course is to provide students with a comprehensive understanding of electronics & solid-state devices. The course aims to develop a strong foundation in the principles and concepts of electronics, various circuit related network theorems, transistors, rectifiers & voltage regulation. | | | |

**Unit - I : Circuit Analysis**
Network - Important definitions, Loop & nodal analysis based on DC & AC circuits (Kirchhoff's Laws), Four terminal network, Current-volt conventions, Open circuit, Short circuit & Hybrid parameters of any four terminals network, Input, output & mutual impedance for an active four terminal network. **(06 Lectures)**

**Unit - II : Network Theorems**
**Various Circuit Theorems :** Superposition theorem, Thevenin theorem, Norton theorem, Reciprocity theorem, Compensation theorem, Maximum power transfer theorem & Miller's theorem. **(09 Lectures)**

**Unit - III : Transistor**
Notations & volt-ampere relations for bipolar junction transistor (BJT), Concept of load line & Operating point, Introduction to hybrid parameters of transistors, Common-base (CB), Common-emitter (CE) & Common-collector (CC) configurations of transistors & equivalent circuits, Analysis of transistor amplifiers using hybrid parameters & frequency response.
**(09 Lectures)**

**Unit – IV : Rectifiers and Voltage Regulation**

Half-wave, Full wave and Bridge rectifiers, Calculation of ripple factor, Efficiency and regulation, Filters : Series inductors, Shunt capacitor, L-sections and π-sections filters, Voltage regulation and Voltage stabilization by Zener diode, Voltage multiplier circuits. **(06 Lectures)**

**Reference Books/Text Books**


1. Electronics Fundamental and Applications by John D Ryder, Prentice Hall of India Pvt. Ltd, New Delhi.
2. Engineering Electronics by John D. Ryder, McGraw Hill Book Company , New Delhi.
3. Integrated Electronics, Analog & Digital Circuits and Systems by Millman/Hailkias, McGraw Hill Ltd.
4. Digital Computer Electronics by Albert Paul Malvino, Tata McGraw- Hill Pub. Co. Ltd. New Delhi(1983).
5. Electronics Fundamental and Applications by John D. Ryder, Prentice Hall of India Pvt. Ltd, New Delhi.
6. Engineering Electronics by John D. Ryder, McGraw Hill Book Company , New Delhi.
7. Integrated Electronics :Analog & Digital Circuits And systems by Millman/Hailkias :McGraw Hill Ltd.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Electronics - This resource offers lecture notes, assignments, and exams for a complete course on electronics : https://ocw.mit.edu/search/?q=electronics
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in electronics : http://hyperphysics.phy-astr.gsu.edu/hbase/Electronic/etroncon.html#c1

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Understand the concept of Kirchhoff's first and second laws and their applications in circuits.
2. Basic understanding of open and short circuits and their relevance in circuits and applications.
3. Understanding of the use and importance of hybrid parameters and their applications in circuits and transistors.
4. Understand the concept of network theorems to make circuit analysis easier and lucid.
5. Development of understanding of Superposition, Thevenin, Norton, Reciprocity, Compensation and maximum power transfer and miller theorems and their applications.
6. Introduction to the concept of bipolar junction transistor.
7. Introduction to the concept of loadline, operating point and hybrid parameters for transistors.
8. Introduction to the concept of transistor as amplifiers.
9. Common base, common emitter & common collector configuration of transistors and their characteristic curves.
10. Hybrid parameter concept as applied to transistor amplifiers.
11. Frequency response of transistor amplifiers.

## B.Sc. (Pass Course) - Physics

## Semester - III

## Physics Practical Lab (III)

## (DSCP PHY 311, Credits Practical 02, Practical Hours 60)

**Max. Practical Marks = 50 Marks**
**Internal Marks = 20 Marks**
**External Practical Exam = 30 Marks (Duration : 3 hrs.)**

**Note: Out of the following experiments, 8 experiments must be done by the students in the semester.**
**(4 hrs. per week)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| **III** | **DSCP PHY 311** | **Physics Practical Lab (III)** | **6** | **02** |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Practical, Sixty Hours of Practicals including diagnostic and formative assessment during practical hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the physics lab with the mentioned experiments, is to provide students with hands-on experience in conducting experiments related to optics, thermodynamics and mechanics. Optics experiments include formation of Newton's rings, use of Michelson's Interferometer, experiments related to prism, grating, biprism, specific rotation of sugar solution. Thermodynamics experiments include Desorme's method & Lee's apparatus. Electrical experiments include determination of bandgap of a semiconductor & ballistic galvanometer. The lab aims to reinforce theoretical concepts learned in the classroom, develop practical skills, and enhance the understanding of physics principles through experimentation. | | | |

**DSCP PHY 311 : Physics Practical Lab (III)**

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

**List of Experiments : Semester - III**

1. To determine the thermodynamic constant $\gamma = C_P/C_V$ using Clements & Desorme's method.
2. To determine the thermal conductivity of a poor thermal conductor by Lee's method.

3. To study the specific rotation of sugar solution by polarimeter.
4. To determine the bandgap of a given semiconductor using a junction diode.
5. Using platinum resistance thermometers find the melting point of a given substance.
6. Using Newton's rings method find out the wavelength of a monochromatic source.
7. To determine the ballistic constant of a ballistic galvanometer (BG).
8. To determine the high resistance by leakage method using ballistic galvanometer (BG) and condenser.
9. To determine wavelength of light by grating element using a spectrometer.
10. To determine the dispersive power of a grating element using spectrometer.
11. Using Newton's rings method find out the refractive index of a given liquid.
12. Using Michelson's interferometer find out the wavelength of given monochromatic source of light (Sodium light).
13. To determine dispersive power of prism using spectrometer.
14. To study variation of gain with frequency using a single-stage transistor audio amplifier.
15. To verify Lenz's law and study conductor interaction with a bar magnet falling vertically into the hollow metallic cylinder.
16. To study modulus of rigidity of a material as a function of temperature.
17. To determine the bandgap of a given semiconductor using a junction diode.
18. To study variation of gain with frequency using a single-stage transistor audio amplifier.
19. Any experiment according to undergraduate level physics theory.

**Course Learning Outcomes:**

Through these experiments, students will develop practical skills in experimental techniques, data collection, analysis, and interpretation. They will also enhance their understanding of fundamental concepts and principles in optics, electronics & thermodynamics. The lab experiences will foster critical thinking, problem-solving abilities, and the application of theoretical knowledge to real-world scenarios.

## B.Sc.

## Semester - IV

## Paper (VII) - Statistical Physics

## (DSC PHY 401, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note : There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| IV | DSC PHY 401 | Statistical Physics | 6 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the course is to provide students with a comprehensive understanding of statistical physics inclusive of kinetic theory of gases, transport phenomenon of gases, classical statistics & quantum statistics. The course aims to develop their knowledge and skills in analysing and solving problems related to these topics, using appropriate mathematical formalism and physical concepts. | | | |

**Unit - I : Kinetic Theory of Gases**

Distribution law of molecular velocities, Most probable, Average & RMS velocities, Energy distribution function, Experimental verification of the Maxwell velocity distribution, Principle of equipartition of energy. **(07 Lectures)**

**Unit - II : Transport Phenomenon of Gases**

Transport Phenomenon : Mean free path, Distribution of free paths, Coefficients of viscosity, Thermal conductivity, diffusion & their interrelation. **(06 Lectures)**

**Unit - III : Classical Statistics**

Validity of classical approximation, Phase space, micro- & macro-states, Entropy & thermodynamic probability, Monoatomic ideal gas, Barometric equation, Specific heat capacity of diatomic gas, Heat capacity of solids. **(08 Lectures)**

**Unit - IV : Quantum Statistics**

Black body radiation & failure of classical statistics, Postulates of quantum statistics, Indistinguishability, Wavefunction & exchange degeneracy, A priori-probability, Bose-Einstein statistics & distribution function, Plank distribution function & radiation formula, Fermi-Dirac statistics & distribution function, Contact potential, Thermionic emission, Specific heat anomaly of metals, Nuclear spin statistics (Para- & Ortho-hydrogen).

**(09 Lectures)**


**Reference Books/Text Books**

1. Thermal Physics by Kittel, Publisher: San Francisco: W.H. Freeman.
2. Statistical and Thermal Physics by S. Lokanathan& R. S. Gambhir, Publisher: PHI Learning.
3. Thermodynamics & Statistical Physics (Hindi) by Dr. Arvind Jain, Devi Ahilya Prakashan.
4. Statistical Physics by Berkeley Series Vol. V, Publisher: McGraw Hill India.
5. Fundamentals of Statistical and Thermal Physics by F. Reif, Sarat Book House.


**Suggested E-Resources :**

1. MIT OpenCourseWare: Statistical Physics - This resource provides lecture notes, problem sets, and solutions for a complete course on statistical physics : https://ocw.mit.edu/search/?q=statistical%20physics
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in statistical physics : http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/disfcn.html

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Understand the concept of kinetic theory of gases, energy distribution function & Maxwell's equations.
2. Experimental verification of Maxwell velocity distribution & principle of equipartition of energy.
3. Explain the transport phenomenon of gases, mean free path, distribution of mean paths, viscosity & diffusion.
4. Explanation of thermodynamics in the framework of statistical approach.
5. Formulation of classical statistics to form phase space, micro- and macro-spaces, thermodynamic probability, monoatomic ideal gas & heat capacity of solids. Understand classical statistics and its validity. Study phase space, microstates, macrostates, thermodynamic probability, and entropy.
6. Formulation of quantum statistics & explanations.
7. Postulates of quantum statistics, wavefunction, exchange degeneracy, Bose-Einstein & Fermi-Dirac statistics, Planck distribution function.
8. Learn about quantum statistics, including Bose-Einstein and Fermi-Dirac distribution laws. Calculate the thermodynamic functions of weakly and strongly degenerate gases.
9. Analyze the behavior of an ideal Bose gas and derive Planck's law.
10. Study the flux of radiation energy, radiation pressure, and the thermodynamic functions of an ideal Fermi electron gas.
11. Understand the free electron model for metals, the spectrum of metals, Richardson's equation of thermionic emission, relativistic Fermi gas, and the Chandrasekhar mass limit for white dwarf stars.
12. Understand the concepts of contact potential & thermionic emission, nuclear spin-states.

## B.Sc.

## Semester - IV

## Paper (VIII) – Electronics & Solid State Devices (II)

## (DSC PHY 402, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note : There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer.** **(7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks.** **(4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| IV | DSC PHY 402 | Electronics & Solid State Devices (II) | 6 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| Introductory | Core | Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours. | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the course is to provide students with a comprehensive understanding of biasing in transistor, oscillators, operational amplifiers, feedback amplifiers, field effect transistors & digital electronics. | | | |

### Unit -I

Fixed and emitter biasing, Bias stability in transistor circuits, Feedback requirements for oscillations, Circuit requirement for oscillation, Basis idea of direct coupled and RC coupled amplifiers, Basic oscillator analysis, Colpitt and Hartley oscillators, RC oscillators.

**(07 Lectures)**

### Unit -II

**Amplifiers with Feedback :** Concept of feedback, Positive and negative feedback, Voltage and current feedback circuits, Advantages of negative feedback- stabilization of gain by negative feedback, Effect of feedback on output and input resistance, Reduction of nonlinear distortion by negative feedback, Effect on gain- frequency response. **(07 Lectures)**

### Unit -III

**Operational Amplifier :** Differential amplifier, DC levels shifter, Operational amplifier, Input and output impedances, Input offset current, Applications : Unity gain buffer, Adder, Subtractor, Integrator and Differentiator. **(07 Lectures)**

### Unit -IV

**Field Effect Transistor and Digital Circuits :** Field Effect Transistor (FET) and its characteristic biasing JFET, AC-operation of JFET and MOSFET, Binary arithmetic, Logic fundamentals AND, OR, NOT, NOR,NAND, XOR gates, Boolean theorems, Transistor as a switch, Logic gates : circuit realization of logic functions, Analog to digital and digital to analog analysis, DTL, RTL, TTL circuits. **(09 Lectures)**

**Reference Books**

1. Electronics Fundamental and Applications by John D. Ryder, Prentice Hall of India Pvt. Ltd, New Delhi.
2. Engineering Electronics by John D. Ryder, McGraw Hill Book Company , New Delhi.
3. Integrated Electronics :Analog & Digital Circuits And systems by Millman/Hailkias :McGraw Hill Ltd.
4. Digital Computer Electronics by Albert Paul Malvino, Tata McGraw- Hill Pub. Co. Ltd. New Delhi(1983).

**Suggested E-Resources :**

1. MIT OpenCourseWare: Statistical Physics - This resource provides lecture notes, problem sets, and solutions for a complete course on statistical physics : https://ocw.mit.edu/search/?q=statistical%20physics
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in statistical physics : http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/disfcn.html

**Course Learning Outcomes :**

By the end of the course, students should be able to :

1. Basic understanding of concept of oscillators.
2. Concept and electronics of different types of oscillators of Colpitts and Hartley oscillators, RC oscillators.
3. Basic understanding of operational amplifiers, characteristics in form of inverting, non-inverting, adder, buffer and difference amplifiers.
4. Basic understanding of applications of operational amplifiers in form of integrator, differentiator, multiplier and divider, voltage to current and current to voltage convertor.
5. Concept of feedback and feedback amplifiers, effect on frequency gain response.
6. Introduction to field effect transistors (FETs), metal-oxide-semiconductor field effect transistors (MOSFET) and voltage-current responses.
7. Learning of digital circuits and related theories.

# B.Sc. - Physics

## Semester - IV

## Physics Practical Lab (IV)

## (DSCP PHY 411, Credits Practical 02, Practical Hours 60)

**Max. Practical Marks = 50 Marks**
**Internal Exam = 20 Marks**
**External Practical Exam (Duration : 3 hrs.) = 30 Marks**

**Note: Out of the following experiments, 8 experiments must be done by the students in the semester.**
**(4 hrs. per week)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| IV | DSCP PHY 411 | Physics Practical Lab (IV) | 6 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Practical, Sixty Hours of Practicals including diagnostic and formative assessment during practical hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of the physics lab-IV, with the mentioned experiments, is to provide students with hands-on experience in conducting experiments related to electronics. The lab aims to reinforce theoretical concepts learned in the classroom, develop practical skills, and enhance the understanding of physics principles through experimentation. | | | |

**DSCP PHY 411 : Physics Practical Lab (IV)**

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

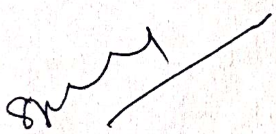
**List of Experiments : Semester - IV**

1. To construct a half-wave rectifier using single diode and analysis of ripple factor and efficiency.
2. To construct a half-wave rectifier using L & $\pi$ section filters and analysis of ripple factor and efficiency.
3. To construct full wave/bridge rectifiers and analysis of ripple factor and efficiency.

4. To construct full wave/bridge rectifiers using various filter circuits and analysis of ripple factor and efficiency.
5. To study characteristics of a given transistor PNP (common emitter, common base and common collector configurations).
6. To study characteristics of a given transistor NPN (common emitter, common base and common collector configurations).
7. To study analog to digital (A to D) conversion in digital electronics
8. To study digital to analog (D to A) conversion in digital electronics.
9. To measure the inductance of a coil by Anderson's bridge experiment.
10. To study the working of a De-Sauty bridge & to compare the capacitances of two capacitors.
11. Plot of thermoemf versus temperature of hot junction constant and determination of neutral temperature using Cu-Fe thermocouple.
12. To determine the speed of sound in air by standing wave method using speaker, signal generator, microphone & CRO (2-beam oscilloscope).
13. To determine the power factor (cosφ) of a given coil using CRO.
14. To determine charge-to-mass ratio (e/m) by Thomson's method.
15. To determine the speed of sound in air by standing wave method using speaker, signal generator, microphone & CRO (2-beam oscilloscope).
16. Any experiment according to undergraduate level physics theory.

**Course Learning Outcomes:**

Through these experiments, students will develop practical skills in experimental techniques, data collection, analysis, and interpretation. They will also enhance their understanding of fundamental concepts and principles in electronics. The lab experiences will foster critical thinking, problem-solving abilities, and the application of theoretical knowledge to real-world scenarios.



# Bachelor of Science (B.Sc.)
# Subject - Physics
# Semester - V
# Paper (IX) - Quantum Mechanics (I)
# (DSC PHY 501, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**
**Note: There will be two parts in end-semester theory paper.**
**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**
**Part B of the paper will consist of four questions one question from each unit with internal choice.**
**Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| **V** | **DSC PHY 501** | **Quantum Mechanics (I)** | **7** | **02** |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of this course is to provide students with a comprehensive understanding of quantum mechanics, history, origin, Schrodinger's equations & postulates of quantum mechanics. The course aims to develop a strong foundation in the principles and concepts of quantum mechanics, and its applications for futuristics advancements. | | | |

## Unit - I : Origin and Experimental Evidence of Quantum Theory

Development of quantum theory - Historical development & experimental evidence for quantum theory, Electromagnetic (EM) radiation, Black body radiation, Qualitative discussion of spectral distribution of energy, Limitations of classical theory, Planck's radiation law, Photoelectric effect, Compton effect, Matter Waves : de Broglie hypothesis, Davison Germer experiment. **(07 Lectures)**

## Unit - II : Uncertainty Principle & Schrodinger's Wave Mechanics

Uncertainty principle and its consequences, Gamma ray microscope, Diffraction from a single slit, Its application, such as, (i) non-existence of electron in nucleus, (ii) ground state energy of H-atom, (iii) ground state energy of harmonic oscillator (iv) natural width of spectral lines, Schrodinger's equation : Need and justification, Time-dependent and time-independent forms, Physical significance of the wave function & its interpretation, Probability current density.

**(07 Lectures)**

## Unit - III : Postulates & Operators of Quantum Mechanics

Operators in quantum mechanics, Definition of a linear operator, Linear & Hermitian operators, State function, Expectation value of dynamical variable-position, momentum & energy, Fundamental postulates of quantum mechanics, Eigen function & eigen values, Degeneracy, Orthogonality of eigen function, Commutation relations, Ehrenfest's theorem & complementarily wave packet, Group & phase velocities, Principle of superposition, Gaussian wave packet. **(08 Lectures)**

## Unit - IV : Simple Solutions of Schrodinger's Equations

Time independent Schrodinger equation & stationary state solution, Boundary & continuity conditions on the wave function, Particle in one dimensional (1D) box, Eigen function & eigen values, Discrete energy levels, Extension of results to the three-dimensional (3D) case & degeneracy of levels. **(08 Lectures)**

**Reference Books/Text Books :**

1. P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill.
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005.
5. Introduction to Modern Physics by H.S Mani, G.K. Mahta, East West Press Pvt., New Delhi (1988).
6. Introduction To Modern Physics by Richtmeyer, Kennard and Cooper, McGraw Hill,1969, Sixth Edition.
7. Quantum Mechanics : Theory and Applications by A. K. Ghatak and S. Lokanathan, Macmillan India Ltd.
8. Perspectives of Modern Physics by A. Beiser, McGraw Hill Inc., US.

**Suggested E-Resources :**

1. MIT OpenCourseWare : Introductory Quantum Mechanics - This resource offers lecture notes, assignments, and exams for a complete course on introductory quantum mechanics : https://ocw.mit.edu/search/?q=introductory%20quantum%20mechanics%20
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in introductory quantum mechanics : http://hyperphysics.phy-astr.gsu.edu/hbase/quacon.html#quacon

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Development of the basic concept of quantum theory, historical evidences and experimental evidences of quantum theory, electromagnetic and blackbody radiations & spectral distribution of energy.
2. Limitations of classical theory explaining what it could not explain which quantum mechanics can explain qualitatively.
3. Planck's radiation law & Compton effect, Matter waves in reference to de Broglie hypothesis.
4. Davison-Germer experiment to confirm wave nature of electrons which further proved de Broglie hypothesis.
5. Schrödinger's wave mechanics and the uncertainty principle along with its effect, Gamma ray microscope.
6. Diffraction at a single slit to show non-existence of electron in nucleus, ground state energy of H-atom & harmonic oscillator, and natural width of spectral lines.
7. Concept of wavefunction, interpretation, properties of wavefunction, probability & probability density & physical acceptance conditions for wavefunction, Time-independent Schrödinger wave equation for stationary states, Concept of postulates & operators in quantum mechanics.
8. Understanding of the concept of linear & Hermitian operators, state function and expectation value, Understanding of eigen function & eigen value, degeneracy, orthogonality, commutation relations.
9. Explanation of Ehrenfest's theorem, group & phase velocities, principle of superposition & Gaussian wave packet, Application of Schrödinger's wave equation, Understanding of the concept of particle in one-dimensional box, discrete energy levels, Explanation of 1D simple harmonic oscillator, zero-point energy.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - V

## Paper (X) - Nuclear Physics (I)

## (DSE PHY 502, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| V | DSE PHY 502 | Nuclear Physics (I) | 7 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Elective** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of this course is to provide students with a comprehensive understanding of nuclear physics in form of nuclear properties, radioactive decays, detectors & interaction of nuclear radiation with matter. The course aims to develop a strong foundation in the principles and concepts of nuclear physics, and their applications in describing the nucleus and nuclear interactions. | | | |

### Unit - I : Nuclear Properties (I)

Rutherford's theory of a particle scattering, Properties of nuclei : Nuclear angular momentum, Nuclear magnetic dipole moment, Electric quadrupole moment & Nuclear ellipticity, Hofstadter experiment, Nuclear spin, Isospin, Parity & Orbital angular momentum, Parity conservation. **(07 Lectures)**

### Unit - II : Nuclear Properties (II)

Nuclear Mass & Mass Spectroscopy, Packing fraction, Nuclear Energy, Discovery of neutron & proton-neutron hypothesis, Neutron to proton Ratio ($n/z$), The nuclear potential, Nuclear mass, Mass defect & Binding energy, Theory of nuclear forces, Properties of nuclear forces. **(08 Lectures)**

### Unit - III : Radioactive Decays

Basics of $\alpha$-decay, Theory of $\beta$-emission spectrum, Gammow factor, Geiger-Nuttal law, Range of $\alpha$-particles.

β-decay : Kinematics of β-decay, β-decay spectrum, Positron emission, Electron capture, Pauli's Neutrino hypothesis.

Gamma decay : Basics of Gamma decay, Kinematics of Gamma decay, Internal conversion, Applications of radioactivity. **(07 Lectures)**

## Unit - IV : Detectors & Interaction of Nuclear Radiation With Matter

Particle & Radiation Detectors : Ionization chamber, Gas-filled detectors, Current-mode & Pulse-mode operation of detector, Proportional counter, Geiger-Muller counter.

Interaction of Nuclear Radiation with Matter : Energy loss by heavy charge particles in matter, Interaction of electrons with matter, Range of charged particles, Bremsstrahlung radiation, Cherenkov radiation, Gamma ray interaction with matter. **(08 Lectures)**

**Reference Books/Text Books**


1. Nuclear and Particle Physics by W. E. Burcham and M Jobes, Addison-Wesley Longman Inc.
2. Nuclear and Particle Physics by Brian R Martin, John Wiley & Sons.
3. Introduction to Nuclear and Particle Physics by Das and Ferbal, World Scientific.
4. Elements of Nuclear Physics by Walter E. Meyerhof, McGraw-Hill Book Company.
5. Introductory Nuclear Physics by Kenneth S. Krane, John Wiley & Sons.
6. Introduction to Elementary Particles by David J. Griffiths, John Wiley & Sons.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Nuclear Physics - This resource offers lecture notes, assignments, and exams for a complete course on nuclear physics : https://ocw.mit.edu/courses/8-701-introduction-to-nuclear-and-particle-physics-fall-2020/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in nuclear physics : http://hyperphysics.phy-astr.gsu.edu/hbase/Nuclear/nucstructcon.html

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Understanding of the various nuclear properties of nuclei; nuclear magnetic dipole moment & electric quadrupole moment.
2. Rutherford's theory of particle scattering, applications and inferences.
3. Explanation of nuclear ellipticity, nuclear spin, isospin, parity, parity conservation, and orbital angular momentum.
4. Explanation of Hofstadter experiment.
5. Concepts of nuclear mass, nuclear energy, packing fraction.
6. Discovery of neutron, n-p hypothesis, n/p ratio, nuclear potential, mass defect, binding energy.
7. Basic understanding of theory of nuclear forces & their properties.
8. Yukawa-Meson theory.
9. Concepts of radioactive decays, α-decay, β-decay, γ-decay in detail.
10. Basic understanding and explanation of nuclear fission, nuclear fusion & nuclear reactions.
11. Basic understanding of interaction of nuclear radiation with matter, Bremsstrahlung radiation, Cherenkov radiation, Gamma ray interaction with matter.
12. Nuclear models to explain and understand the nucleus.
13. Liquid-drop model, Fermi gas model.
14. Conditions of a stable nucleus.
15. Nuclear-shell structure & assumption of Shell model.

# Bachelor of Science (B.Sc.)
# Subject - Physics
# Semester - V
# Physics Practical Lab (V)
# (DSCP PHY 511, Credits Practical 02, Practical Hours 60)

**Max. Practical Exam Marks = 50 Marks**
**Internal Exam Marks = 20 Marks**
**External Practical Exam Marks = 30 Marks (Duration : 3 hrs.)**

**Note: Out of the following experiments, 8 experiments must be done by the students in the semester.**
**(4 hrs. per week)**

<table>
<tr><th>Semester</th><th>Code of The Course</th><th>Title of The Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>V</td><td>DSCP PHY 511</td><td>Physics Practical Lab (V)</td><td>7</td><td>02</td></tr>
<tr><th>Level of Course</th><th>Type of The Course</th><th colspan="3">Delivery Type of The Course</th></tr>
<tr><td>Introductory</td><td>Core</td><td colspan="3">Practical, Sixty Hours of Practicals including diagnostic and formative assessment during practical hours.</td></tr>
<tr><td>Prerequisites</td><td colspan="4">Physics and Mathematics courses of Central Board of Secondary Education or equivalent.</td></tr>
<tr><td>Objectives of The Course :</td><td colspan="4">The objective of this course is to provide students with a comprehensive understanding of practical physics. The course aims to develop a strong foundation in the principles and concepts of practical physics in special reference to electronics & electrical domains.</td></tr>
</table>

**DSCP PHY 511 : Physics Practical Lab (V)**

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

**List of Experiments : Semester – V**

1. To plot & study the characteristic curves of a junction diode & a Zener diode.
2. To design a Zener regulated power supply and study the regulation with various loads.
3. To study the LC transmission line at (i) at a fixed frequency and (ii) at variable frequencies.
4. To determine the bandgap of a semiconductor using a junction diode.
5. To study the characteristics of a field effect transistor (FET) and design/study amplifier of

finite gain.

6. To study the characteristics of operational amplifier (OP-AMP) as unity buffer.
7. To study the characteristics of operational amplifier (OP-AMP) in non-inverting & inverting configurations.
8. Using discrete components, study OR, AND, NOT logic gates and to compare with DTL & TTL integrated circuits (ICs).
9. To study the frequency response of a transistor amplifier and obtain the input & output impedance of the transistor amplifier.
10. To determine the Hall coefficient of a semiconductor sample using the Hall effect.
11. To study the resonance in an LCR circuit at (i) a fixed frequency by varying capacitance (C), and (ii) by varying frequency.
12. To study the RC transmission line at 50 Hz of operational frequency.
13. To study and verify Thevenin's and Norton's theorems.
14. To study a voltage multiplier circuit to generate high voltage DC from AC.
15. Any other practical that relates to theory.

**Course Learning Outcomes:**

Through these experiments, students will develop practical skills in experimental techniques, data collection, analysis, and interpretation. They will also enhance their understanding of fundamental concepts and principles in electronics. The lab experiences will foster critical thinking, problem-solving abilities, and the application of theoretical knowledge to real-world scenarios.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - VI

## Paper (XI) - Quantum Mechanics (II)

## (DSC PHY 601, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice.**

**Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| VI | DSC PHY 601 | Quantum Mechanics (II) | 7 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of this course is to provide students with a comprehensive understanding of quantum mechanics, history, origin, Schrodinger's equations & postulates of quantum mechanics. The course aims to develop a strong foundation in the principles and concepts of quantum mechanics, and its applications for futuristics advancements. | | | |

### Unit - I : Bound State Problems (I)

Potential step & rectangular potential barrier, Calculation of reflection & transmission coefficients, Tunnel Effect and application to alpha decay, Square well potential problem, Calculation of transmission coefficient. **(07 Lectures)**

### Unit – II : Bound State Problems (II)

Particle in one dimensional (1D) infinite potential well & finite depth potential well, Eigen value & Eigen functions, Simple harmonic oscillator (1D), Energy eigen function & energy Eigen values, Zero point energy. **(07 Lectures)**

### Unit - III : Applications of Quantum Theory To Atomic Spectroscopy

Quantum features of spectra of one electron atoms, Frank–Hertz experiment & discrete energy states, Schrodinger equation for a spherically symmetric potential, Schrodinger equation for a one electron atom in spherically coordinates, Separation of variables, Orbital angular momentum & quantization, Spherical harmonics, Energy levels of H–atom, Shapes of n = 1 &

n = 2 wave functions, Average value of radius of H-atom, Comparison with Bohr Model & Bohr's correspondence principle, Stern & Gerlach experiment, Spin & magnetic moment, Spin-orbit coupling & qualitative explanation of fine structure, Atoms in magnetic field, Zeeman splitting. **(09 Lectures)**

## Unit - IV : Molecular Spectroscopy

Qualitative features of molecular spectra : Rigid rotator, Discussion of energy, Eigen values & eigen function, Rotational energy levels of diatomic molecules, Rotational spectra, Vibrational energy levels of diatomic molecules, Vibrational spectra, Vibrational rotational spectra (CO & HCl molecules). **(07 Lectures)**

**Reference Books/Text Books :**


1. P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill.
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005.
5. Introduction to Modern Physics by H.S Mani, G.K. Mahta, East West Press Pvt., New Delhi (1988).
6. Introduction To Modern Physics by Richtmeyer, Kennard and Cooper, McGraw Hill,1969, Sixth Edition.
7. Quantum Mechanics : Theory and Applications by A. K. Ghatak and S. Lokanathan, Macmillan India Ltd.
8. Perspectives of Modern Physics by A. Beiser, McGraw Hill Inc., US.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Introductory Quantum Mechanics - This resource offers lecture notes, assignments, and exams for a complete course on introductory quantum mechanics : https://ocw.mit.edu/search/?q=introductory%20quantum%20mechanics%20
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in introductory quantum mechanics : http://hyperphysics.phy-astr.gsu.edu/hbase/quacon.html#quacon

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Development of the basic concept of quantum theory, historical evidences and experimental evidences of quantum theory, electromagnetic and blackbody radiations & spectral distribution of energy.
2. Limitations of classical theory explaining what it could not explain which quantum mechanics can explain qualitatively.
3. Planck's radiation law & Compton effect, Matter waves in reference to de Broglie hypothesis.
4. Davison-Germer experiment to confirm wave nature of electrons which further proved de Broglie hypothesis.
5. Schrödinger's wave mechanics and the uncertainty principle along with its effect, Gamma ray microscope.
6. Diffraction at a single slit to show non-existence of electron in nucleus, ground state energy of H-atom & harmonic oscillator, and natural width of spectral lines.
7. Concept of wavefunction, interpretation, properties of wavefunction, probability & probability density & physical acceptance conditions for wavefunction.
8. Time-independent Schrödinger wave equation for stationary states.
9. Concept of postulates & operators in quantum mechanics.
10. Understanding of the concept of linear & Hermitian operators, state function and expectation value.
11. Understanding of eigen function & eigen value, degeneracy, orthogonality, commutation relations.
12. Explanation of Ehrenfest's theorem, group & phase velocities, principle of superposition & Gaussian wave packet, Application of Schrödinger's wave equation.
13. Understanding of the concept of particle in one-dimensional box, discrete energy levels.
14. Explanation of 1D simple harmonic oscillator, zero-point energy.

# Bachelor of Science (B.Sc.)
## Subject - Physics
## Semester - VI
## Paper (XII) - Nuclear Physics (II)
## (DSE PHY 602, Credits Theory 02, Lectures 30)

**Duration of EoSE : 3 hrs.** **Max. Marks : 35**

**Note: There will be two parts in end-semester theory paper.**

**Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 1 mark for correct answer. (7 x 1 mark each = 7 marks)**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 7 marks. (4 x 7 marks each = 28 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| VI | DSE PHY 602 | Nuclear Physics (II) | 7 | 02 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Elective** | **Lecture, Thirty Lectures including diagnostic and formative assessments during lecture hours.** | | |
| **Prerequisites** | Physics and Mathematics courses of Central Board of Secondary Education or equivalent. | | | |
| **Objectives of The Course :** | The objective of this course is to provide students with a comprehensive understanding of nuclear physics in form of nuclear models, nuclear fission, nuclear reactions, accelerators, fundamental interactions & quark model. The course aims to develop a strong foundation in the principles and concepts of nuclear physics, and their applications in describing the nucleus and nuclear interactions. | | | |

### Unit - I : Nuclear Models & Nuclear Reactions

Segre-chart, Liquid-drop model, Semi-empirical mass formula, Condition of stability, Fermi-gas model, Evidence for nuclear-shell structure, Nuclear magic numbers, Basic assumptions of shell model.

Nuclear Reactions : Classification of nuclear reactions, Conservation law, Kinematics of nuclear reactions, Q-value, Threshold energy, Reaction-rate & reaction cross-section.

**(08 Lectures)**

### Unit - II : Nuclear Fission & Nuclear Fusion

Discovery of nuclear fission, Energy Release in fission, Fission products, Mass distribution of fission products, Charge distribution of fission products, Ionic charge of fission products, Fission cross-section & threshold, Neutron emission in fission, Prompt neutrons & delayed neutrons, Mechanism for the emission of delayed neutrons. Energy of fission, Neutrons, Theory of nuclear fission & liquid drop model, Four factor formula, Barrier penetration theory of spontaneous fission, Nuclear energy sources, Nuclear fission as a source of energy, Nuclear chain reaction, Condition of controlled chain reaction, Classification of nuclear reactors & uncontrolled chain reaction.

Nuclear Fusion : Energy released in nuclear fusion, Fusion reaction in stars. **(07 Lectures)**

## Unit - III : Accelerators

Ion sources, Cock-Craft-Walten High voltage generators, Van de-Graff generator, Drift tube Linear accelerators, Waveguide Accelerator, Magnetic focusing in cyclotron, Synchrocyclotron, Betatron, Electromagnetic induction (EMI) accelerator, Electron synchrotron, Proton synchrotron. **(07 Lectures)**

## Unit - IV : Fundamental Interactions & Quark Model

Fundamental Interactions : Four fundamental forces, Symmetries & conservation laws, C, P & T conservation, Applications of symmetry arguments to particle reactions, Parity non-conservation in weak interaction, CP violation.

Quark Model : Flavour symmetries, Gellmann-Nishijima formula, Eight-fold way, Octet diagram for meson & baryon, Concept of quark model, November revolution, Baryon decuplet, Color quantum numbers & Gluons. **(08 Lectures)**

**Reference Books/Text Books**


1. Nuclear and Particle Physics by W. E. Burcham and M Jobes, Addison-Wesley Longman Inc.
2. Nuclear and Particle Physics by Brian R Martin, John Wiley & Sons.
3. Introduction to Nuclear and Particle Physics by Das and Ferbal, World Scientific.
4. Elements of Nuclear Physics by Walter E. Meyerhof, McGraw-Hill Book Company.
5. Introductory Nuclear Physics by Kenneth S. Krane, John Wiley & Sons.
6. Introduction to Elementary Particles by David J. Griffiths, John Wiley & Sons.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Nuclear Physics - This resource offers lecture notes, assignments, and exams for a complete course on nuclear physics : https://ocw.mit.edu/courses/8-701-introduction-to-nuclear-and-particle-physics-fall-2020/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in nuclear physics : http://hyperphysics.phy-astr.gsu.edu/hbase/Nuclear/nucstructcon.html

**Course Learning Outcomes :**

By the end of the course, students should be able to:

1. Understanding of the various nuclear properties of nuclei; nuclear magnetic dipole moment & electric quadrupole moment.
2. Rutherford's theory of particle scattering, applications and inferences.
3. Explanation of nuclear ellipticity, nuclear spin, isospin, parity, parity conservation, and orbital angular momentum, Explanation of Hofstadter experiment.
4. Concepts of nuclear mass, nuclear energy, packing fraction, Discovery of neutron, n-p hypothesis, n/p ratio, nuclear potential, mass defect, binding energy.
5. Basic understanding of theory of nuclear forces & their properties, Yukawa-Meson theory.
6. Concepts of radioactive decays, α-decay, β-decay, γ-decay in detail, Basic understanding and explanation of nuclear fission, nuclear fusion & nuclear reactions.
7. Basic understanding of interaction of nuclear radiation with matter, Bremsstrahlung radiation, Cherenkov radiation, Gamma ray interaction with matter.
8. Nuclear models to explain and understand the nucleus, Liquid-drop model, Fermi gas model.
9. Conditions of a stable nucleus, Nuclear-shell structure & assumption of Shell model.

# Bachelor of Science (B.Sc.)
# Subject - Physics
# Semester - VI
# Physics Practical Lab (VI)
# (DSCP PHY 611, Credits Practical 02, Practical Hours 60)

**Max. Practical Exam Marks = 50 Marks**
**Internal Practical Exam Marks = 20 Marks**
**External Practical Exam Marks = 30 Marks (Duration : 3 hrs.)**

**Note: Out of the following experiments, 8 experiments must be done by the students in the semester.**
**(4 hrs. per week)**

<table>
<tr><th>Semester</th><th>Code of The Course</th><th>Title of The Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>VI</td><td>DSCP PHY 611</td><td>Physics Practical Lab (VI)</td><td>7</td><td>02</td></tr>
<tr><th>Level of Course</th><th>Type of The Course</th><th colspan="3">Delivery Type of The Course</th></tr>
<tr><td>Introductory</td><td>Core</td><td colspan="3">Practical, Sixty Hours of Practicals including diagnostic and formative assessment during practical hours.</td></tr>
<tr><td>Prerequisites</td><td colspan="4">Physics and Mathematics courses of Central Board of Secondary Education or equivalent.</td></tr>
<tr><td>Objectives of The Course :</td><td colspan="4">The objective of this course is to provide students with a comprehensive understanding of practical physics. The course aims to develop a strong foundation in the principles and concepts of practical physics in special reference to photoelectric, electronics, thermodynamics & electrical domains.</td></tr>
</table>

**DSCP PHY 611 : Physics Practical Lab (VI)**

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

**List of Experiments : Semester – VI**

1. To determine the Stefan's constant by black body method.
2. To determine the Stefan's constant by solar cell method.
3. To study the temperature dependence of resistivity of a semiconductor sample by four probe method.
4. To study the characteristics of a GM counter and verification of inverse square law for a

given radioactive source.

5. To study the absorption coefficient in aluminium (Al) foil of varying thicknesses using GM counter.
6. To measure the magnetic field using ballistic galvanometer and search coil.
7. To measure the value of electric charge by Millikan's oil drop method.
8. To study the (1x8)/(1x4) demultiplexer using digital circuit platform.
9. To study the variation of magnetic field of an electromagnet with current.
10. To determine the Planck's constant by photocell (retarding potential method using optical filters, preferably five different coloured optical filters).
11. To determine the Planck's constant using solar cell.
12. To study the polarization by reflection from a glass plate with the help of Nicol's prism and verify Brewster's law.
13. To study and verify law of Malus using Nicol's prism experimental set-up.
14. To study the polarization by reflection from a glass plate with the help of Nicol's prism and verify Brewster's law.
15. Any other experiment related to theory.

**Course Learning Outcomes:**

Through these experiments, students will develop practical skills in experimental techniques, data collection, analysis, and interpretation. They will also enhance their understanding of fundamental concepts and principles in electronics. The lab experiences will foster critical thinking, problem-solving abilities, and the application of theoretical knowledge to real-world scenarios.