# S. S. Jain Subodh P.G. College (Autonomous)
# Jaipur

## SYLLABUS

**B.Sc.**
**(Subject - Physics)**

**(Semester Scheme)**
**Choice Based Credit System (CBCS)**
**(As Per The National Education Policy - 2020)**

| | |
|---|---|
| I & II Semester Examinations | 2025-2026 |
| III & IV Semester Examinations | 2026-2027 |
| V &VI Semester Examinations | 2027-2028 |

**[Onwards]**

## S. S. Jain Subodh P.G. College (Autonomous), Jaipur
## Bachelor of Science (B.Sc.)
## Subject – Physics

**Syllabus & Exam Outline of Physics**

| Paper | Nomenclature of Paper | Credits | Max. Marks (EoSE) |
|---|---|---|---|
| **Semester - I** | | | |
| **Paper** | **Nomenclature of Paper** | **Credits** | **Max. Marks (EoSE)** |
| PAPER - I [DSC PHY 101] | MECHANICS & OSCILLATIONS | 04 | 70 Marks |
| PHYSICS PRACTICAL LAB (I) - DSCP PHY 111 | | 02 | 30 Marks |
| **Semester - II** | | | |
| **Paper** | **Nomenclature of Paper** | **Credits** | **Max. Marks (EoSE)** |
| PAPER - II [DSC PHY 201] | ELECTROMAGNETISM | 04 | 70 Marks |
| PHYSICS PRACTICAL LAB (II) - DSCP PHY 211 | | 02 | 30 Marks |
| **Semester - III** | | | |
| **Paper** | **Nomenclature of Paper** | **Credits** | **Max. Marks (EoSE)** |
| PAPER - III [DSC PHY 301] | OPTICS | 04 | 70 Marks |
| PHYSICS PRACTICAL LAB (III) - DSCP PHY 311 | | 02 | 30 Marks |
| **Semester – IV** | | | |
| **Paper** | **Nomenclature of Paper** | **Credits** | **Max. Marks (EoSE)** |
| PAPER - IV [DSC PHY 401] | THERMODYNAMICS & STATISTICAL PHYSICS | 04 | 70 Marks |
| PHYSICS PRACTICAL LAB (IV) - DSCP PHY 411 | | 02 | 30 Marks |
| **Semester - V** | | | |
| **Paper** | **Nomenclature of Paper** | **Credits** | **Max. Marks (EoSE)** |
| PAPER - V [DSC PHY 501] | ELECTRONICS & SOLID STATE DEVICES | 04 | 70 Marks |
| PHYSICS PRACTICAL LAB (V) - DSCP PHY 511 | | 02 | 30 Marks |
| **Semester - VI** | | | |
| **Paper** | **Nomenclature of Paper** | **Credits** | **Max. Marks (EoSE)** |
| PAPER - VI [DSC PHY 601] | QUANTUM MECHANICS & SPECTROSCOPY | 04 | 70 Marks |
| PHYSICS PRACTICAL LAB (VI) – DSCP PHY 611 | | 02 | 30 Marks |

**DSC = Discipline Specific Core; DSE = Discipline Specific Elective; DSCP = Discipline Specific Core Practical; SEM = Seminar; PRJ = Project Work; EoSE = End-of-Semester Examination; CIA = Continuous Internal Assessment.**

**Marks Break-Up : End-of-Semester Exam (EoSE) (70 Marks) + Continuous Internal Assessment (CIA) (30 Marks); Practical Examination Marks = 50 Marks (20 Internal Exam + 30 External Exam); Grand Total = 150 Marks Per Semester.**

**Theory Classes : Four hours per week for each of the papers; EoSE duration of three hours for each of the papers.**
**Practical Classes : Four hours practical classes per week and EoSE practical examination of three hours duration.**

| | |
|---|---|
| **Name of College** | **S.S. Jain Subodh P.G. College (Autonomous), Jaipur** |
| **Name of Faculty** | **Science** |
| **Name of Programme** | **Under Graduate (U.G.) - B.Sc. (Maths Group)** |
| **Name of Discipline** | **Discipline - Physics** |

| **PROGRAMME PREREQUISITES** |
|---|
| Physics and Mathematics courses of Central Board of Secondary Education or equivalent. |
| **PROGRAMME OUTCOMES (POs)** |
| 1. Proficiency in Scientific Principles : Students will demonstrate a strong understanding of fundamental scientific principles in physics and mathematics. They will be able to apply these principles to analyze and solve complex problems.<br>2. Analytical and Critical Thinking : Students will develop analytical and critical thinking skills through the study of physics and mathematics. They will be able to evaluate and interpret data, formulate hypotheses, and draw logical conclusions based on evidence.<br>3. Quantitative and Computational Skills : Students will acquire proficiency in quantitative and computational methods. They will be able to perform calculations, manipulate mathematical expressions, and use computational tools to solve scientific problems.<br>4. Experimental and Laboratory Skills : Students will gain hands-on experience in conducting experiments, using laboratory equipment, and analysing experimental data. They will understand the importance of accurate measurement, data interpretation, and documentation.<br>5. Problem Solving and Modelling : Students will develop problem-solving skills and the ability to create mathematical models to represent real-world phenomena. They will apply mathematical and scientific concepts to formulate and solve problems in physics, chemistry, and related fields.<br>6. Interdisciplinary Understanding : Students will develop an interdisciplinary perspective by integrating concepts from physics, chemistry, and mathematics. They will understand the connections and interdependencies among these disciplines and their applications in other scientific and technological areas.<br>7. Effective Communication : Students will develop effective oral and written communication skills. They will be able to communicate scientific ideas, theories, and experimental results clearly and concisely to both technical and non-technical audiences.<br>8. Ethical and Professional Responsibility : Students will understand and adhere to ethical and professional standards in scientific research and practice. They will demonstrate integrity, responsible conduct, and respect for intellectual property.<br>9. Lifelong Learning : Students will recognize the importance of lifelong learning and professional development. They will be motivated to pursue further studies, engage in research, and keep up with advancements in physics, chemistry, and mathematics.<br>10. Teamwork and Collaboration : Students will develop teamwork and collaboration skills through group projects, laboratory work, and research activities. They will be able to work effectively in diverse teams and contribute to collective goals. |

**Scheme of Examination-**

**1 Credit = 25 Marks For Examination/Evaluation**

Continuous assessment in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous Internal Assessment (CIA) (30% weightage) and End of Semester Examination (EoSE) (70% weightage).

1. Sessional work will consist of class tests, mid-semester examination(s), homework assignments, etc., as determined by the faculty in charge of the courses of study.
2. Each Paper of EoSE shall carry 70% of the total marks of the course/subject. The EoSE will be of 3 hours duration. Each question will carry equal marks and the paper will consist of two parts given as follows :
   - Part A of the paper shall have multiple questions of equal marks. This first question shall be based on knowledge, understanding and applications of the topics/texts covered in the syllabus.
   - Part B of the paper shall consist of 4 questions from with an internal choice in each of the units. The four questions will be set with one from each of the units with internal choice. Third to fourth questions shall be based on applications of the topics/texts covered in the syllabus (60% weightage) and shall involve solving Problems (40% weightage), if applicable.
3. 75% Attendance is mandatory for appearing in EoSE.
4. To appear in the EoSE examination of a course/subject student must appear in the mid-semester examination and obtain at least a "C" grade in the course/subject.
5. Credit points in a Course/Subject will be assigned only if, the student obtains at least a C grade in midterm and EoSE examination of a Course/Subject.

**Contact Hours –**

**15 Weeks per Semester**

| | |
|---|---|
| L – Lecture | (1 Credit = 1 Hour/Week) |
| T – Tutorial | (1 Credit = 1 Hour/Week) |
| S – Self-Study | (1 Credit = 2 Hours/Week) |
| P – Practical/Practicum | (1 Credit = 2 Hours/Week) |
| F – Field Practice/Projects | (1 Credit = 2 Hours/Week) |
| SA – Studio Activities | (1 Credit = 2 Hours/Week) |
| I – Internship | (1 Credit = 2 Hours/Week) |
| C – Community Engagement and Service | (1 Credit = 2 Hours/Week) |

**Exit and Entrance Policy**

1. Students who opt to exit after completion of the first year and have secured 12 credits will be awarded a **UG Certificate** if, in addition, they complete one internship of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within two years and complete the degree programme within the stipulated maximum period of six years.
2. Students who opt to exit after completion of the second year and have secured 24 credits will be awarded the **UG diploma** if, in addition, they complete one internship of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of two years and complete the degree programme within the maximum period of six years.

3. Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 36 credits and satisfying the minimum credit requirement.
4. A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 84 credits and have satisfied the minimum credit requirements.
5. Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 84 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

**Letter Grades and Grade Points**

| Letter Grade | Grade Point | Marks Range (%) |
|---|---|---|
| O (outstanding) | 10 | 91 - 100 |
| A+ (Excellent) | 9 | 81 - 90 |
| A (Very good) | 8 | 71 - 80 |
| B+ (Good) | 7 | 61 - 70 |
| B (Above average) | 6 | 51 - 60 |
| C (Average) | 5 | 40 - 50 |
| P (Pass) | 4 | |
| F (Fail) | 0 | |
| Ab (Absent) | 0 | |

When students take audit courses, they may be given a pass (P) or fail (F) grade without any credits.

**S. S. Jain Subodh P.G. College (Autonomous), Jaipur**

**B.Sc.**

**(Subject – Physics)**

## Examination Scheme For Each Paper – Choice Based Credit System (CBCS)

**Under**

## The National Education Policy (NEP) 2020

| | |
|---|---|
| **Part A 7 QUESTIONS (Very Short Answer Questions Out of 10)** | **7 x 2 MARKS EACH = 14 Marks** |
| **Part B 4 QUESTIONS**<br>**(1 Question From Each Unit With Internal Choice)** | **4 x 14 MARKS EACH = 56 Marks** |

| | | |
|---|---|---|
| **Max. Marks of End-Semester Exam** | **=** | **70 Marks** |
| **Continuous Internal Assessment (CIA)** | **=** | **30 Marks** |
| **Maximum Marks (Each Theory Paper)** | **=** | **100 Marks** |

**Maximum Practical Exam Marks = 50 Marks**
**[Internal Practical Exam = 20 Marks; External Practical Exam = 30 Marks]**

**Total of Theory Papers Per Semester = 1 x 100 Marks = 100 Marks**

**(Minimum Pass Marks 40% = 40 Marks)**

| | |
|---|---|
| **Total of Practical Marks** | **= 50 Marks** |
| **Grand Total of Marks Per Semester** | **= 100 Marks (Theory) + 50 Marks (Practical)** |
| | **= 150 Marks** |

## Program : Bachelor of Science (B.Sc.)
## Subject - Physics

| Semester | Type | Paper code & Nomenclature | Credits | Duration of Examination | Max. Marks (CIA, EoSE) | Min. Marks (CIA + EoSE) (Put Together) |
|---|---|---|---|---|---|---|
| I | T | DSC PHY 101 - Mechanics & Oscillations | 04 | 1 Hr – CIA<br>3 Hrs – EoSE | 30 Marks – CIA<br>70 Marks – EoSE | 40 Marks |
| | P | DSCP PHY 111 - Physics Practical Lab (I) | 02 | 2 Hrs – Int.<br>3 Hrs – Ext. | 20 Marks – Int.<br>30 Marks – Ext. | 20 Marks |
| II | T | DSC PHY 201 - Electromagnetism | 04 | 1 Hr – CIA<br>3 Hrs – EoSE | 30 Marks – CIA<br>70 Marks – EoSE | 40 Marks |
| | P | DSCP PHY 211 - Physics Practical Lab (II) | 02 | 2 Hrs – Int.<br>3 Hrs – Ext. | 20 Marks – Int.<br>30 Marks – Ext. | 20 Marks |
| III | T | DSC PHY 301 - Optics | 04 | 1 Hr – CIA<br>3 Hrs – EoSE | 30 Marks – CIA<br>70 Marks – EoSE | 40 Marks |
| | P | DSCP PHY 311 - Physics Practical Lab (III) | 02 | 2 Hrs – Int.<br>3 Hrs – Ext. | 20 Marks – Int.<br>30 Marks – Ext. | 20 Marks |
| IV | T | DSC PHY 401 - Thermodynamics & Statistical Physics | 04 | 1 Hr – CIA<br>3 Hrs – EoSE | 30 Marks – CIA<br>70 Marks – EoSE | 40 Marks |
| | P | DSCP PHY 411 - Physics Practical Lab (IV) | 02 | 2 Hrs – Int.<br>3 Hrs – Ext. | 20 Marks – Int.<br>30 Marks – Ext. | 20 Marks |
| V | T | DSC PHY 501 – Electronics & Solid State Devices | 04 | 1 Hr – CIA<br>3 Hrs – EoSE | 30 Marks – CIA<br>70 Marks – EoSE | 40 Marks |
| | P | DSCP PHY 511 - Physics Practical Lab (V) | 02 | 2 Hrs – Int.<br>3 Hrs – Ext. | 20 Marks – Int.<br>30 Marks – Ext. | 20 Marks |
| VI | T | DSC PHY 601 - Quantum Mechanics & Spectroscopy | 04 | 1 Hr – CIA<br>3 Hrs – EoSE | 30 Marks – CIA<br>70 Marks – EoSE | 40 Marks |
| | P | DSCP PHY 611 - Physics Practical Lab (VI) | 02 | 2 Hrs – Int.<br>3 Hrs – Ext. | 20 Marks – Int.<br>30 Marks – Ext. | 20 Marks |

**DSC = Discipline Specific Core; DSCP = Discipline Specific Core Practical; DSE = Discipline Specific Elective; T = Theory; P = Practical; EoSE = End-of-Semester Examination; CIA = Continuous Internal Assessment (Mid-Term Test); PHY = Physics; Int. = Internal; Ext. = External.**

**Student needs to complete one core theory course (DSC) of 04 credits along with core physics laboratory practicals (DSCP) of 02 credits per semester.**

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - I

## Paper (I) - Mechanics & Oscillations

## (DSC PHY 101, Credits Theory 04, Lectures 60)

**Duration of EoSE : 3 hrs.** **Max. Marks: 70**

**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 2 marks for correct answer. (7 x 2 marks each = 14 marks)**

**Part B of the paper will consist of four questions with one question from each unit with internal choice. Each question will carry 14 marks. (4 x 14 marks each = 56 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| I | DSC PHY 101 | Mechanics & Oscillations | 5 | 04 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Sixty 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, simple harmonic motion (S.H.M.), damped & driven harmonic oscillations & coupled oscillations. 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. The objective of the course is to provide students with knowledge related to oscillations, damping and coupled oscillators. 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 : Physical Laws, Frames of Reference, Special Theory of Relativity, Coriolis Force, Conservation Laws

Frames of Reference : 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.

Special Theory of Relativity : Postulates of Special Theory of Relativity, Lorentz transformation, Transformation of velocity, acceleration, Length contraction, Time dilation and its experimental evidence.

Coriolis Force : Transformation of position, velocity & acceleration in rotating frame, Pseudo forces, Coriolis force, Motion relative to earth.

Conservative Forces : Introduction about conservative & non-conservative forces, Rectilinear motion under conservative forces. **(15 Lectures)**

**Unit - II : Centre of Mass & Rigid body**

Centre of Mass : Introduction about centre of mass (CM), Centre of mass frame, Collision of two particles in one (1D) & two (2D) dimensions (both 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.

Rigid Body Dynamics : Equation of motion of a rotating rigid body, Inertial coefficients, Case of J not parallel to $\omega$, 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, Precessional motion of the spinning top. **(15 Lectures)**

**Unit - III : Motion Under Central Forces, Simple Harmonic Oscillations (SHM) & Damped Harmonic Oscillations**

Motion under Central Forces : Introduction about central forces, Motion under the effect of central forces, Gravitational interaction, Inertia and gravitational mass, General solution under gravitational interaction, Kepler's laws, Discussion of trajectories : Cases of elliptical and circular orbits, Rutherford scattering.

Simple Harmonic Motion : Simple harmonic motion (SHM), Discussion of potential energy curve & Motion of a particle, Introduction about oscillations in a potential well.

Damped Harmonic Oscillations : Damped force and motion under damping, Damped harmonic oscillator, Power dissipation. **(15 Lectures)**

**Unit - IV : Driven Harmonic Oscillations & Coupled Oscillations**

(a) Driven Harmonic Oscillations : Driven harmonic oscillator with damping, Frequency response, Phase relation, Quality factor, Resonance, Series and parallel combinations of LCR circuit.

(b) Coupled Oscillations : Equation of motion of two coupled harmonic oscillators, Normal modes of motion, Motion in mixed modes & transient behaviour, Electrically coupled circuits, Frequency response. **(15 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.
9. The Physics of Wave and Oscillation by N.K. Bajaj, McGrow Hill Education.
10. Vibration and Waves by A. P. French, CBS Publishers.

**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
3. 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/
4. 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 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. Interpret Lorentz transformations as rotations in space-time, understand the concepts of world line and Minkowski space, and analyze time-like and space-like vectors.
5. Discuss the concept of causality, light cones, and the division of past, present, and future events.
6. Apply transformations of displacement, velocity, and acceleration between frames rotating with respect to each other, analyze pseudo forces, centrifugal and Coriolis forces, and their effects on various bodies in motion.
7. 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.
8. Define conservative and non-conservative forces and analyze rectilinear motion under conservative forces.
9. Analyze potential energy curves and understand the motion of particles under conservative forces.
10. Explain the concept of the center of mass and its relevance in the motion of systems of particles.
11. Apply the concept of conservation of angular momentum and analyze particle scattering by a nucleus.
12. Understand the equations of motion for rotating bodies and the concept of the moment of inertia.
13. Analyze the kinetic energy of rotation and the motion of spinning tops.
14. Understand the motion under central forces, including gravitational interaction, and apply Kepler's laws.
15. Analyze damped harmonic oscillations and understand the effects of damping on oscillatory motion.
16. Analyze driven harmonic oscillators with damping and understand frequency response and power dissipation.
17. Explain the behavior of coupled oscillators and analyze systems of oscillators with neighbor interactions.
18. Oscillations in arbitrary potential wells and solve simple harmonic motion problems using complex exponentials.
19. Analyze mechanical and electrical systems undergoing oscillatory motion. Calculate the energy of oscillators and examine power dissipation and damping under viscous and solid friction.
20. 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.
21. 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.
22. 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.
23. Study the normal modes of vibration for molecules and electrically coupled circuits.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - I

## Physics Practical Lab (I)

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

**Maximum Practical Exam Marks = 50 Marks**
**(i) Internal Practical Exam Marks = 20 Marks**
**(ii) 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)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| I | DSCP PHY 111 | Physics Practical Lab (I) | 5 | 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 : | 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. | | | |

**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 convert galvanometer into an ammeter of a given range.
2. To convert galvanometer into a voltmeter of a given range.
3. To study the variation of power transfer to different loads by a D.C. source and to verify maximum power transfer theorem.
4. To study the transient behaviour of a RC circuit using a DC source by varying values of R and C.
5. To study the characteristics of a semiconductor junction diode and determine forward and reverse resistances.
6. To determine the specific resistance of the material of a wire using Carey Foster's bridge.
7. To determine the difference between two small resistances using Carey Foster's bridge.
8. To study the resonance frequency of series LCR circuit and hence to determine resonance frequency, quality factor & bandwidth.
9. To study the resonance of parallel LCR circuit and hence to determine resonance frequency, quality factor & bandwidth.
10. 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.
11. To study the behaviour of an RC circuit with varying resistance and capacitance using AC mains as a power source and also to determine the impedance and phase relations.
12. To study the voltage and current behavior of an LR circuit with an AC power source. Also, to determine power factor, impedance and phase relations.
13. 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.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - II

## Paper (II) - Electromagnetism

## (DSC PHY 201, Credits Theory 04, Lectures 60)

**Duration of EoSE : 3 hrs.** **Max. Marks : 70**

**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 2 marks for correct answer. (7 x 2 marks each = 14 marks)**

**Part B of the paper will consist of four questions with one question from each unit with internal choice. Each question will carry 14 marks. (4 x 14 marks each = 56 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| II | DSC PHY 201 | Electromagnetism | 5 | 04 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Sixty 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 & magnetostatics. It aims to develop their knowledge and skills in analysing scalar and vector fields, electric fields & electric potential energy, electric field in matter, magnetostatics & magnetic field in matter, Maxwell's equations & electromagnetic (EM) waves. 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 electric and magnetic fields, and their interactions, as described by Maxwell's equations. The course will also cover important topics such as electric potential, magnetostatics, and electromagnetic waves. | | | |

### Unit - I : Scalar & Vector Fields, Electric Field & Electric Potential Energy

Scalar & Vector Fields : Concept of field, scalar & vector fields, Gradient of scalar field, Physical significance & formalism of gradient, Divergence & curl of a vector field in cartesian coordinates system, Problems based on gradient, divergence & curl operators.

Concept of solid angle, Gauss's divergence & Stoke's theorem, Gauss's law from inverse square law, Differential form of Gauss's law.

Electric Field & Electric Potential Energy : Invariance of charge, Potential energy of a 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 and Laplace equations in cartesian coordinates and their applications to solve the problems of electrostatics, Electric field measured in moving frames, Electric field of a point charge moving with constant velocity. **(15 Lectures)**

**Unit - II : Electric Field in Matter, Electric Field & Electric Potential In Relation To A Sphere**

Electric Field In Matter : Multipole expansion, Definition of moments of charge distribution, Dielectrics, Induced dipole moments, Polar & non-polar molecules, Free & bound charges, Polarization, Atomic polarizability, Electric displacement vector, Electric susceptibility, Dielectric constant & relation between them.

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. **(15 Lectures)**

**Unit - III : Magnetostatics & Magnetic Field in Matter**

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 and (c) inside the cylinder, Ampere's law in differential form, Introduction of magnetic vector potential, Poisson's equation for vector potential, Bio-Savart's law & application to magnetic vector potentials.

Magnetic Field In Matter : Atomic magnet, Gyromagnetic ratio, Bohr-magneton, Larmor frequency, Induced magnetic moment & diamagnetism, Spin magnetic moment, Para- & ferro-magnetism, Intensity of magnetization, Magnetic permeability & susceptibility, Free & bound current densities, Magnetic field due to a uniformly magnetized material & non-uniformly magnetized material. **(15 Lectures)**

**Unit - IV : Maxwell's Equations & Electromagnetic (EM) Waves**

Maxwell Equations : Displacement current, Maxwell's equations in differential & integral forms.

Electromagnetic (EM) Waves : Electromagnetic waves, Electromagnetic waves in an isotropic medium, Properties of electromagnetic waves, Electromagnetic waves in free space.

Spectrum of electromagnetic waves, Energy density of electromagnetic waves, Poynting vector, Radiation pressure & resistance in free space, Electromagnetic waves in dispersive medium. **(15 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
3. 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/
4. 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. 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.
17. Analyze the behavior of magnetic fields in various materials and the effects of currents on magnetic fields
18. Apply Ampere's law and the magnetic vector potential to calculate magnetic fields in different scenarios.
19. Explain the properties of electromagnetic waves and their behavior in isotropic and dispersive media.
20. Understand the energy density, radiation pressure & spectrum of electromagnetic waves and its implications.
21. Investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Analyze the electric field measured in different frames of reference.
22. Understand the magnetic field in free space and matter. Apply Ampère's circuital law and use it in differential form with the vector potential.
23. Calculate the magnetic field for different current configurations using the Biot-Savart law and deduce the field of any current-carrying wire.
24. Apply transformation relations for electric and magnetic fields between inertial frames.
25. 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.
26. Investigate electromagnetic induction, Faraday's law, Analyze inductance, self-inductance, mutual inductance and the effects of conducting rods and loops moving in magnetic fields.
27. 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.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - II

## Physics Practical Lab (II)

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

**Maximum Practical Exam Marks = 50 Marks**
**(i) Internal Practical Exam Marks = 20 Marks**
**(ii) 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)**

| 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 determine Young's modulus by bending of rectangular cross-sectional beam.

4. To determine Young's modulus (Y), $\sigma$ (Poisson's ratio) and $\eta$ ( modulus of rigidity) by Searle's method.
5. To determine modulus of rigidity of a wire using Maxwell's needle.
6. To determine the Poisson's ratio of a rubber tube.
7. 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.
8. To study damping using a compound pendulum/bar pendulum and determine damping coefficient & quality factor of the compound pendulum.
9. To study radius of gyration and to determine acceleration due to gravity ($g$) using a compound pendulum/bar pendulum.
10. To study the variation of surface tension with temperature using Jaeger's method.
11. To study the sensitivity of a cathode ray oscilloscope (CRO).
12. To convert a given voltmeter to an ammeter of suitable range and calibrate the ammeter.
13. To convert a given ammeter (μA to mA) to a voltmeter of suitable range and calibrate the voltmeter.
14. To determine the moment of Inertia of a fly-wheel.
15. 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.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - III

## Paper (III) - Optics

## (DSC PHY 301, Credits Theory 04, Lectures 60)

**Duration of EoSE : 3 hrs.** **Max. Marks : 70**

**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 2 marks for correct answer.** **(7 x 2 marks each = 14 marks)**

**Part B of the paper will consist of four questions with one question from each unit with internal choice. Each question will carry 14 marks.** **(4 x 14 marks each = 56 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| III | DSC PHY 301 | Optics | 6 | 4 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Sixty 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 optics. It aims to develop their knowledge and skills in analysing basic phenomenon of interference, far- and near-field diffraction phenomena, polarization phenomenon, quantum optics and applications, as well as basics of lasers and holographic applications. | | | |

**Unit - I : Coherence, Interference & Interferometers**

Concept of spatial and temporal coherence, Coherence length, Coherence time, Definition and propagation of wavefront, Huygen's principle of secondary wavelets, Young's double slit experiment, Types of fringes, Interference by division of wavefront : Fresnel's bi-prism, Measurement of wavelength and thickness of a thin transparent sheet, Interference by division of amplitude – Thin films (parallel and wedge-shaped films), Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes), Newton's rings : Measurement of wavelength and refractive index, Michelson's Interferometer, Shape of fringes, Measurement of wavelength, Difference between two spectral lines and the thickness of a thin transparent sheet. Theory of Fabry-Perot interferometer, visibility & shape of fringes. **(15 Lectures)**

**Unit - II : Zone Plate, Diffraction, Grating**

**Zone Plate :** The basic theory of Zone plate, Half-period zones, Zone plate, Multiple Foci of zone plate, Comparison between zone plate and convex lens.

**Fraunhofer Diffraction :** Single slit, Double slit, Multiple slits, Missing orders, Fraunhofer diffraction by a circular aperture, Fraunhofer diffraction by two parallel slits.

**Fresnel's Diffraction :** Fresnel's diffraction by a circular aperture, straight edge, and a rectangular slit, Cornu's spiral geometrical method to study Fresnel's diffraction pattern.

**Grating :** Plane diffraction grating, Transmission and reflection gratings, Concave grating, Rowland's mounting, Dispersion by a grating, Rayleigh's criterion of resolution, Resolving power of a grating, resolving power of a telescope. **(15 Lectures)**

**Unit - III : Polarization & Double Refraction**

**Polarization :** Polarization (i) Plane polarized light (ii) Circularly polarized light (iii) Elliptically polarized light, Production of plane-polarized light (i) by reflection (ii) by refraction (iii) by double refraction, and (iv) by dichroism (Polaroid), Brewster's law, Law of Malus.

**Double Refraction :** Huygens' wave theory of double refraction, Analysis of polarized light : Nicol prism, Quarter wave plate and half-wave plate, Optical activity, Laws of optical activity, Fresnel's explanation of optical activity, Specific rotation, Polarimeters : Laurent's half shade polarimeter and Biquartz polarimeter. **(15 Lectures)**

**Unit - IV : LASER, Holography & Fiber Optics**

**LASER :** Spontaneous and stimulated emission, Einstein's A and B coefficients, Relations among Einstein's coefficients, Condition for stimulated emission and absorption, Population inversion, Methods of optical pumping, Energy level scheme of He-Ne & Ruby lasers, Semiconductor laser, Working principle of Ruby, He-Ne, $CO_2$ and semiconductor laser, Tunnel lasers (qualitative discussion only).

**Holography :** Basic concept of holography, Difference between a hologram and a photograph, Construction of a hologram and reconstruction of the image, Applications of holography.

**Fiber Optics :** Introduction to optical fiber, Types of optical fiber, Total internal reflection, Explanation of propagation of light through an optical fiber. **(15 Lectures)**

**Reference Books/Text Books**


1. Optics by Brijlal and Subramanium, S. Chand Publishing.
2. Principles of Optics by B.K. Mathur, Gopala Printing.
3. Optics by D. P. Khandelwal, Himalaya Publishing House.
4. Introduction to Modern Optics by A. K. Ghatak, McGraw Hill.
5. An Introduction To Modern Optics by G. R. Fowels, Dover Publications.
6. Fundamentals of Optics by Ashok Kumar, D. R. Gulati& H. R. Gulati, R. Chand & Co.

7. Optical Physics South Asian Edition by A. Lipson, S. G. Lipson & H. Lipson, Cambridge University Press.

**Suggested E-Resources :**

1. MIT OpenCourseWare : Optics - This resource offers lecture notes, assignments, and exams for a complete course on optics : https://ocw.mit.edu/search/?q=optics
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in optics : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
3. NPTEL : https://nptel.ac.in/courses/115107131

**Course Learning Outcomes :**

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

1. Understand the concept of interference and diffraction fields and their physical significance.
2. Demonstrate knowledge of interference, diffraction, and polarization.
3. Applications of interference, and diffraction in framework of Fraunhoffer & Fresnel diffraction phenomenon.
4. Explain the formation of Newton's rings and determination of wavelength & refractive index.
5. Explain the principle of Michelson's interferometer and determination of wavelength & refractive index.
6. Explain the concept of polarization in optics.
7. Production and analysis of different type of polarizations and their applications.
8. Explain the concept of quantum optics.
9. Explain the concept of laser, holography & fiber optics.
10. Solve problems related to above mentioned topics.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - III

## Physics Practical Lab (III)

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

**Maximum Practical Exam Marks = 50 Marks**
**(i) Internal Practical Exam Marks = 20 Marks**
**(ii) 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)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| III | DSCP PHY 311 | Physics Practical Lab (III) | 6 | 2 |
| **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. To determine dispersive power of prism using spectrometer.
13. To study variation of gain with frequency using a single-stage transistor audio amplifier.
14. To verify Lenz's law and study conductor interaction with a bar magnet falling vertically into the hollow metallic cylinder.
15. To study modulus of rigidity of a material as a function of temperature.
16. To study the resolving power of a prism.
17. To study the resolving power of a grating.
18. 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.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - IV

## Paper (IV) – Thermodynamics & Statistical Physics

## (DSC PHY 401, Credits Theory 04, Lectures 60)

**Duration of EoSE : 3 hrs.** **Max. Marks : 70**

**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 2 marks for correct answer. (7 x 2 marks each = 14 marks)**

**Part B of the paper will consist of four questions with one question from each unit with internal choice. Each question will carry 14 marks. (4 x 14 marks each = 56 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| IV | DSC PHY 401 | Thermodynamics & Statistical Physics | 6 | 4 |
| **Level of Course** | **Type of The Course** | **Delivery Type of The Course** | | |
| **Introductory** | **Core** | **Lecture, Sixty 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 analysing general thermodynamical interactions, theory & application of Clausius-Clapeyron equation, Carnot's theorem and Maxwell relations, and production and applications of low temperatures. 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 : Thermal & Adiabatic Interactions

Thermal interaction, Zeroth law of thermodynamics, Systems in thermal contact with a heat reservoir (canonical distribution), Energy fluctuations, Entropy of a system, Helmholtz free energy, Adiabatic interaction and enthalpy, General interaction and first law of thermodynamics, Infinitesimal general interaction, Gibb's free energy, Phase transitions, Triple point, Clausius-

Clapeyron equation, Vapour-pressure curve, Heat engine and efficiency of engine, Carnot's Cycle, Thermodynamic scale as an absolute scale, Maxwell relations and their applications. **(15 Lectures)**

**Unit - II : Kinetic Theory & Transport Phenomenon**

**Kinetic Theory :** Derivation of Maxwell's law of distribution of velocities and its experimental verification, Most probable, Average & RMS velocities, Diffusion, Equipartition theorem, Classical theory of specific heat capacity, Specific heat of solid (Explanation on the basis of Einstein and Debye Theory).

**Transport Phenomenon :** Mean free path, Distribution of free path, Coefficients of viscosity, Thermal conductivity and diffusion. **(15 Lectures)**

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

Cooling by Adiabatic expansion, Coefficient of performance, Joule Thomson effect, J-T coefficient for ideal as well as-Van der Waal's gases, Porous plug experiment, Temperature of inversion, Regenerative cooling, Air liquefiers, Adiabatic demagnetization of paramagnetic substances, Liquid He I and He II, Superfluidity, Quest for absolute zero, Third law of thermodynamics and Nernst's heat theorem. **(15 Lectures)**

**Unit - IV : Quantum Statistics**

Introduction to phase space, Micro and macro states, Thermodynamic probability, Entropy and probability, Bose-Einstein's and Fermi-Dirac's distribution laws, Calculation of the thermodynamic functions of weak degenerate gas, Strong degeneration, Calculation of the thermodynamic functions of an ideal Bose gas, Derivation of Planck's law, Radiation pressure, Thermodynamic functions of an ideal Fermi electron gas, Free electron model for metals, Spectra of metals, Richardson's equation of thermionic emission, Relativistic Fermi gas. **(15 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.
6. An Introduction To Thermodynamics by Y. V. C. Rao, Universities Press.
7. Thermodynamics : A Complete Undergraduate Course by Andrew M. Steane, OUP Oxford.
8. Thermodynamics (Foundations & Applications) by E. P. Gyftopoulos & G. P. Beretta, Dover Publications.
9. An Introduction To Thermodynamics, The Kinetic Theory of Gases And Statistical Mechanics by F. W. Sears, Addison-Wesley Publishing Company, Inc.


**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
3. NPTEL : https://nptel.ac.in/courses/115103538

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4. NPTEL : https://onlinecourses.nptel.ac.in/noc23_me76/preview

**Course Learning Outcomes :**

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

1. Understanding of the concept of thermal & adiabatic interactions.
2. Understanding of the concept of transport phenomena of gases.
3. Understand the concept of kinetic theory of gases, energy distribution function & Maxwell's equations.
4. Experimental verification of Maxwell velocity distribution & principle of equipartition of energy.
5. Explain the transport phenomenon of gases, mean free path, distribution of mean paths, viscosity & diffusion.
6. Explanation of thermodynamics in the framework of statistical approach.
7. 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.
8. Formulation of quantum statistics & explanations.
9. Postulates of quantum statistics, wavefunction, exchange degeneracy, Bose-Einstein & Fermi-Dirac statistics, Planck distribution function.
10. Learn about quantum statistics, including Bose-Einstein and Fermi-Dirac distribution laws. Calculate the thermodynamic functions of weakly and strongly degenerate gases.
11. Analyze the behavior of an ideal Bose gas and derive Planck's law.
12. Study the flux of radiation energy, radiation pressure, and the thermodynamic functions of an ideal Fermi electron gas.
13. 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.
14. Understand the concepts of contact potential & thermionic emission, nuclear spin-states.

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# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - IV

## Physics Practical Lab (IV)

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

**Maximum Practical Exam Marks = 50 Marks**
**(i) Internal Practical Exam Marks = 20 Marks**
**(ii) 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)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| IV | DSCP PHY 411 | Physics Practical Lab (IV) | 6 | 2 |
| 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. Different experiments related to digital electronics, rectifiers, Anderson's bridge & De Sauty's bridge, transistors and optics will be performed to provide the glimpse of real-time semiconductor applications to the students. | | | |

### 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 full wave/bridge rectifiers and analysis of ripple factor and efficiency.
3. To study characteristics of a given transistor PNP (common emitter, common base and common collector configurations).
4. To study characteristics of a given transistor NPN (common emitter, common base and common collector configurations).
5. To study analog to digital (A to D) conversion in digital electronics
6. To study digital to analog (D to A) conversion in digital electronics.
7. To measure the inductance of a coil by Anderson's bridge.
8. To study the working of a De Sauty's bridge & to compare the capacitances of two capacitors.
9. To determine the speed of sound in air by standing wave method using speaker, signal generator, microphone & CRO (2-beam oscilloscope).
10. To determine the wavelength of a hollow prism.
11. To determine the refractive index of a hollow prism.
12. Using Michelson's interferometer find out the wavelength of given monochromatic source of light (Sodium light).
13. 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 (V) – Electronics & Solid State Devices

## (DSC PHY 501, Credits Theory 04, Lectures 60)

**Duration of EoSE : 3 hrs.** **Max. Marks: 70**

**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 2 marks for correct answer.** **(7 x 2 marks each = 14 marks)**

**Part B of the paper will consist of four questions with one question from each unit with internal choice. Each question will carry 14 marks.** **(4 x 14 marks each = 56 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| I | DSC PHY 501 | Electronics & Solid State Devices | 7 | 04 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Sixty 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 electronics & semiconductor device physics. It aims to develop their knowledge and skills in analysing PN junctions, bipolar junction transistors (BJTs), field effect transistors (FETs), digital circuits, diode-transistor logic (DTL), transistor-transistor logic (TTL), amplifiers, operational amplifiers, oscillators & feedback circuit mechanisms. 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 - 1 : Electric Networks, Circuit Theorems, P-N Junction, Rectifiers, Voltage Regulation**

**Electric Networks :** Definitions, Loop & nodal equations for D.C. and A.C. circuits (Kirchhoff's Laws).

**Four-Terminal Electric Network :** Ampere-volt conventions, Open, closed & hybrid parameters of four-terminal networks; Input, output & mutual impedance for active four-terminal networks.

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**Circuit Theorems :** Superposition theorem, Thevenin theorem, Norton theorem, Reciprocity theorem, Compensation theorem, Maximum power transfer theorem & Miller theorem.

**P-N Junction :** Charge densities in *n*-type & *p*-type semiconductors, Conduction by drift & diffusion of charge carriers, P-N diode equation, Capacitance effects.

**Rectifiers :** Half-wave, Full-wave & Bridge rectifiers, Ripple factor, Efficiency, Peak Inverse Voltage (PIV) & regulation, Series inductor, Shunt capacitor, L-section & $\pi$-section filters.

**Voltage Regulation :** Zener diode, Voltage regulation using Zener diodes, Voltage multipliers.

**(15 Lectures)**

**Unit - II : Transistor Fundamentals, Transistor Biasing, Field Effect Transistors (FETs)**

**Transistor Fundamentals :** Notations, Configurations : Common Base (CB), Common Emitter (CE), Common Collector (CC), Operation & characteristic curves for bipolar junction transistors (BJTs), Concept of load line & operating point, Hybrid parameters.

**Transistor Biasing :** Need for biasing & stability of Q-point, Stability factors, Types of bias circuits for thermal bias stability : Fixed bias, Collector-to-base feedback bias & Four-resistor bias.

**Field Effect Transistors (FETs) :** Introduction & merits-demerits over BJT, Biasing & Volt-Ampere characteristics.

**(15 Lectures)**

**Unit - III : Amplifiers, Amplifiers With Feedback, Operational Amplifier**

**Amplifiers :** Analysis of transistor amplifiers using hybrid parameters, Gain-frequency response, Cascade amplifiers, Basic ideas of direct-coupled & R-C coupled amplifiers and analysis, Differential amplifiers.

**Amplifiers With Feedback :** Concept of feedback, Positive & negative feedback, Voltage & current feedback circuits, Advantages of negative feedback.

**Operational Amplifier :** Definition and history of operational amplifiers, Ideal Op-Amps, Input offset voltage and current, Common-mode rejection ratio (CMRR), Input & output impedance, Open-loop gain & frequency response, Slew rate, Inverting amplifier, Non-Inverting amplifier, Voltage follower (Buffer).

**(15 Lectures)**

**Unit - IV : Oscillators & Logic Operations**

**Oscillators :** Criteria for self-excited & self-sustained oscillations, Circuit conditions for self-excited oscillations, Basic transistor oscillator circuit and its analysis, Colpitts's and Hartley oscillators & RC oscillators.

**Logic Operations :** Fundamentals of Boolean Algebra, Boolean variables and functions, De Morgan's Theorems, Basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR), Symbols, Truth tables, Boolean expressions, Diode-Transistor Logic (DTL) concept & configuration, Transistor-Transistor Logic (TTL) concept and evolution from DTL. **(15 Lectures)**

**Reference/Textbooks:**


1. Basic Electronics and Linear Circuits by N.N. Bhargava, D.C. Kulshreshtha; S.C. Gupta, McGraw Hill.
2. Electronic Devices and Circuits by J.B. Gupta, Katson Educational Series.
3. Solid State Electronic Devices by Ben G. Streetman & Sanjay Kumar Banerjee, Pearson Education India.
4. Integrated Electronics : Analogue and Digital Circuits by Milman & Halkias, McGraw Hill Education.
5. Semiconductor Physics and Devices" by Donald A. Neamen, McGraw Hill.
6. Electronic Principles by Albert Malvino and David J. Bates, SIE, McGraw Hill Education.
7. Digital Principles and Applications by Donald P. Leach, Albert Paul Malvino, and Goutam Saha, McGraw Hill.


**Suggested E-Resources :**

1. MIT OpenCourseWare : Electronics & Solid State Devices - This resource provides lecture notes, problem sets, and solutions for a complete course on electronics & solid state devices : https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007
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
3. NPTEL UG Course : https://nptel.ac.in/courses/108106181

**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.
4. Concept of feedback and feedback amplifiers, effect on frequency gain response.
5. Introduction to field effect transistors (FETs), JFETs, metal-oxide-semiconductor field effect transistors (MOSFET) and voltage-current responses.
6. Learning of digital circuits and related theories.

## Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - V

## Physics Practical Lab (V)

## (DSCP PHY 511, 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 |
|---|---|---|---|---|
| V | DSCP PHY 511 | Physics Practical Lab (V) | 7 | 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 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. | | | |

### 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 study the RC transmission line at 50 Hz of operational frequency.
2. To study the LC transmission line at (i) at a fixed frequency and (ii) at variable frequencies.
3. To study the resonance in an LCR circuit (using air core inductance and damping by a metal plate) at (i) a fixed frequency by varying capacitance (C), and (ii) by varying frequency.
4. To plot & study the characteristic curves of a junction diode & a Zener diode using breadboard elements.

5. To design a Zener regulated power supply and study the regulation with various loads.
6. To study and verify Thevenin's and Norton's theorems.
7. To study the characteristics of a field effect transistor (FET) and design/study amplifier of finite gain.
8. Using discrete components, study OR, AND, NOT logic gates and to compare with TTL integrated circuits (ICs).
9. To study the frequency response of a transistor amplifier (BJT) and obtain the input & output impedance of the transistor amplifier.
10. To study the characteristics of operational amplifier (OP-AMP) as unity buffer.
11. To study the characteristics of operational amplifier (OP-AMP) as : (i) adder & (ii) subtractor.
12. To understand and apply Kirchoff's laws for analyzing DC and AC circuits.
13. To analyze four-terminal networks and calculate open-, short-circuited and hybrid parameters.
14. 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.

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# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - VI

## Paper (VI) – Quantum Mechanics & Spectroscopy

## (DSC PHY 501, Credits Theory 04, Lectures 60)

**Max. Marks: 70**

**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 2 marks for correct answer. (7 x 2 marks each = 14 marks)**

**Part B of the paper will consist of four questions with one question from each unit with internal choice. Each question will carry 14 marks. (4 x 14 marks each = 56 marks)**

| Semester | Code of The Course | Title of The Course/Paper | NHEQF Level | Credits |
|---|---|---|---|---|
| I | DSC PHY 601 | Electronics & Solid State Devices | 7 | 04 |
| Level of Course | Type of The Course | Delivery Type of The Course | | |
| Introductory | Core | Lecture, Sixty 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 & spectroscopy. The course aims to develop a strong foundation in the principles and concepts of quantum mechanics, and its applications for futuristic advancements. The course aims to develop a strong foundation in the principles and concepts of spectroscopy physics along with molecular spectra. | | | |

### Unit - I : Evolution of Quantum physics, Uncertainty Principle & Operators

**Evolution of Quantum Physics :** Difficulties of classical mechanics to explain : Black-body emission spectrum, Specific heat of solids, Planck's quanta concept & radiation law, Photoelectric effect & Einstein's explanations, Compton's Effect, de-Broglie hypothesis, Diffraction experiments for wave particles (Davisson-Germer experiment).

**Uncertainty Principle :** Position & momentum, Angle & angular moment, Energy & time, Application of uncertainty principle : (i) Ground state energy of hydrogen atom, (ii) Ground state energy of simple harmonic oscillator, (iii) Natural width of spectral lines, (iv) Non-existence of electron in nucleus.

**Operators** : Linear operators, Product of two operators, Commuting & Non-commuting operators, Simultaneous eigenfunction & eigenvalues, Orthogonal wave functions, Hermitian operators and their eigenvalues, Hermitian adjoint operators, Eigenvalues & eigenfunction, Expectation values of operators : position, momentum, energy; Ehrenfest's theorem & complementarity, Concept of group & phase velocities, Wave packet, Gaussian wave packet, Bra-ket notation.

**(15 Lectures)**

**Unit - II: Schrödinger's Wave Equation & Solutions**

Schrödinger's Wave Equation : General equation of wave propagation, Propagation of matter waves, Time-dependent & time-independent Schrödinger's equations, Wavefunction representation ($\psi$), Physical meaning of $\psi$, Properties & conditions on $\psi$, Postulates of wave mechanics, operators, observable and measurements; Probability current density.

Time independent Schrödinger's Equation, Stationary state solution, One-dimensional (1D) problem : Particle in one dimensional (1D) box, Eigenfunctions & eigenvalues, Discrete levels, Generalization into three dimension (3D) & degeneracy of energy levels, Concept of a potential well & barrier, Step potential, Penetration through rectangular barrier, Reflection & transmission coefficients, Barriers with special shapes (graphical representation), Quantum mechanical tunneling effect (alpha decay). **(15 Lectures)**

**Unit - III : Solution of Schrödinger's Equations In Special Cases**

**Special Case - 1 :** Symmetric square well potential, Reflection & transmission coefficients, Resonant scattering, Bound state problems : Particle in one dimensional (1D) infinite potential well & finite depth potential well, Energy eigenvalues & eigenfunctions, Transcendental equation & its solution; Simple harmonic oscillator, Schrödinger's equation for simple harmonic oscillator and its solution, Eigenfunction, Eigenvalues, Zero-point energy, Quantum & classical probability density, Parity, Symmetric & antisymmetric wave functions with graphical representation.

**Special Case - 2 :** Schrödinger's equation in spherical coordinates, Schrödinger equation for one electron atom in spherical coordinates, Separation into radial & angular variables, Solution of radial equation & angular equation, Qualitative discussion of spherical harmonics, Series solution & energy eigenvalues, stationary state wave function, Wave-functions of H-atom for ground and first excited states, Average radius of H- atom, Bohr correspondence principle,

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Orbital angular momentum & its quantization, Commutation relation, Eigenvalues & eigenfunctions.

**(15 Lectures)**

**Unit - IV: H-atom, Atomic & Molecular Spectroscopy**

**H-Atom & Atomic Spectroscopy :** Energy level derivation for H-atom, Quantum features of hydrogen spectra & hydrogen-like spectra, Alkali-like spectra, Stern-Gerlach experiment, Electron spin, Spin magnetic moment, Spin-orbit coupling, Qualitative explanation of fine structure, Franck-Hertz experiment, Zeeman effect : Normal Zeeman splitting, Anomalous Zeeman effect, Qualitative explanation of Stark effect.

**Molecular Spectroscopy :** Concept of rigid rotator, Rotational energy levels, Rotational spectra, Selection rules, Intensity of spectral lines, Isotopic effect, Vibrational energy levels, vibrational spectra, Selection rules, Isotopic effect, Effect of anharmonicity in vibrational spectra, Vibrational-rotational spectra of CO & HCl molecules. **(15 Lectures)**

**Reference Books/Text Books :**


1. A Text Book of Quantum Mechanics by P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill.
2. Quantum Mechanics by Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics by Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Introduction to Quantum Mechanics by 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
3. Swayam-NPTEL Courses : QM-1 Course : https://onlinecourses.nptel.ac.in/noc23_ph04/preview
4. NPTEL Courses : QM-An Introduction : https://nptel.ac.in/courses/115106066

**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.
2. Electromagnetic and blackbody radiations & spectral distribution of energy.
3. Limitations of classical theory explaining what it could not explain which quantum mechanics can explain qualitatively.
4. Understanding of Planck's radiation law, Compton effect & de Broglie hypothesis.
5. Davison-Germer experiment to confirm wave nature of electrons which further proved de Broglie hypothesis.
6. Schrödinger's wave mechanics and the uncertainty principle along with its effect.
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, Concept of operators in QM.
9. Understanding of the concept of linear & Hermitian operators, state function and expectation value.

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11. Explanation of Ehrenfest's theorem, group & phase velocities, principle of superposition & Gaussian wave packet, Application of Schrödinger's wave equation.
12. Understanding of the concept of particle in one-dimensional box, discrete energy levels.
13. Explanation of 1D simple harmonic oscillator, zero-point energy.
14. Understanding of the solution of Schrodinger's equations in special cases;3D equation.
15. Explanation of quantum mechanics of H-atom.
16. Understanding of atomic spectroscopy & molecular spectroscopy.

# Bachelor of Science (B.Sc.)

## Subject - Physics

## Semester - VI

## Physics Practical Lab (VI)

## (DSCP PHY 611, 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 |
|---|---|---|---|---|
| V | DSCP PHY 611 | Physics Practical Lab (VI) | 7 | 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 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 determination of Planck's constant by solar & photocells, determination of Stefan's constants by solar cell & blackbody methods, determination of absorption coefficient & verification of inverse square law by GM method, Millikan's oil drop experiment and others. | | | |

### 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 resistance of a semiconductor 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 study the (1x8)/(1x4) demultiplexer using digital circuit platform.
7. To determine charge-to-mass ratio (e/m) by the Helical method.
8. To measure the magnetic field using ballistic galvanometer and search coil.
9. To study the variation of magnetic field of an electromagnet with current.
10. To measure the value of electric charge by Millikan's oil drop method.
11. To determine the Planck's constant by photocell (retarding potential method using optical filters, preferably five different coloured optical filters).
12. To determine the Planck's constant using solar cell.
13. 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.