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

SYLLABUS

B.Sc. - Specialization
(Major – Physics)

(Semester Scheme)
Choice Based Credit System (CBCS)
[As Per The National Education Policy (NEP) – 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.) - Specialization
Major – Physics

Paper	Nomenclature of Paper	Credits	Max. Marks (EoSE)
Semester - I			
Paper	**Nomenclature of Paper**	**Credits**	**Max. Marks (EoSE)**
PAPER - I [DSC HPHY 101]	MECHANICS	04	70 Marks
PAPER - II [DSC HPHY 102]	ELECTRICITY & MAGNETISM	04	70 Marks
PHYSICS PRACTICAL LAB (I) - DSCP HPHY 111		04	60 Marks
Semester - II			
Paper	**Nomenclature of Paper**	**Credits**	**Max. Marks (EoSE)**
PAPER - III [DSC HPHY 201]	OSCILLATIONS & WAVES	04	70 Marks
PAPER - IV [DSC HPHY 202]	THERMAL & STATISTICAL PHYSICS	04	70 Marks
PHYSICS PRACTICAL LAB (II) - DSCP HPHY 211		04	60 Marks
Semester – III			
Paper	**Nomenclature of Paper**	**Credits**	**Max. Marks (EoSE)**
PAPER - V [DSC HPHY 301]	OPTICS	04	70 Marks
PAPER - VI [DSC HPHY 302]	MATHEMATICAL PHYSICS	04	70 Marks
PHYSICS PRACTICAL LAB (III) - DSCP HPHY 311		04	60 Marks
Semester – IV			
Paper	**Nomenclature of Paper**	**Credits**	**Max. Marks (EoSE)**
PAPER - VII [DSC HPHY 401]	ELEMENTARY QUANTUM MECHANICS	04	70 Marks
PAPER - VIII [DSC HPHY 402]	ELECTRONICS & SOLID STATE DEVICES	04	70 Marks
PHYSICS PRACTICAL LAB (IV) - DSCP HPHY 411		04	60 Marks
Semester – V			
Paper	**Nomenclature of Paper**	**Credits**	**Max. Marks (EoSE)**
PAPER - IX [DSC HPHY 501]	INTRODUCTORY NUCLEAR & PARTICLE PHYSICS	04	70 Marks
PAPER - X [DSC HPHY 502]	NUMERICAL METHODS & COMPUTER PROGRAMMING	04	70 Marks
PHYSICS PRACTICAL LAB (V) - DSCP HPHY 511		04	60 Marks
Semester – VI			
Paper	**Nomenclature of Paper**	**Credits**	**Max. Marks (EoSE)**
PAPER - XI [DSC HPHY 601]	PHYSICS OF MATERIALS	04	70 Marks
PAPER - XII [DSC HPHY 602]	ATOMIC & MOLECULAR PHYSICS	04	70 Marks
PHYSICS PRACTICAL LAB (VI) – DSCP HPHY 611		04	60 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); Total Marks Per Theory Paper = 100 Marks; Practical Exam Marks = 100 Marks (Internal 40 Marks + External 60 Marks); Grand Total of Marks Per Semester = 200 Marks (Theory) + 100 Marks (Practical) = 300 Marks.

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. - Specialization**
Name of Discipline	**Major 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 analyse and solve complex problems. 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. 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. 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. 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. 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. 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. 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. 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. 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. – Specialization
Major – Physics

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

As Per

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
(1 Question From Each Unit With Internal Choice) 4 X 14 MARKS EACH = 56 Marks

Maximum Marks of End-Semester Exam (Duration of Exam = 3 Hours) = 70 Marks

Continuous Internal Assessment (CIA) Exam Marks = 30 Marks

Maximum Marks (Each Theory Paper) = 100 Marks

Maximum Practical Exam Marks = 100 Marks
[Internal Practical Exam Marks = 40; External Practical Exam Marks = 60 Marks]

Total of Theory Papers = 2 x 100 Marks Each = 200 Marks

(Minimum Pass Marks 40% = 40 Marks Per Paper)

Grand Total of Marks Per Semester = 200 Marks (Theory) + 100 Marks (Practical)

= 300 Marks

Program : Bachelor of Science (B.Sc.) - Specialization, Major : Physics

Semester	Type	Paper code & Nomenclature	Credits	Duration of Examination	Max. Marks (CIA, EoSE)	Min. Marks (CIA + EoSE) (Put Together)
I	T	DSC HPHY 101 - Mechanics	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	T	DSC HPHY 102 – Electricity & Magnetism	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	P	DSCP HPHY 111 – Physics Practical Lab (I)	04	2 Hrs – Int. 3 Hrs – Ext.	40 Marks – Int. 60 Marks – Ext.	40 Marks
II	T	DSC HPHY 201 – Oscillations & Waves	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks - CIA 70 Marks – EoSE	40 Marks
	T	DSC HPHY 202 – Thermal & Statistical Physics	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	P	DSCP HPHY 211 - Physics Practical Lab (II)	04	2 Hrs – Int. 3 Hrs – Ext.	40 Marks – Int. 60 Marks – Ext.	40 Marks
III	T	DSC HPHY 301 - Optics	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	T	DSC HPHY 302 – Mathematical Physics	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	P	DSCP HPHY 311 - Physics Practical Lab (III)	04	2 Hrs – Int. 3 Hrs – Ext.	40 Marks – Int. 60 Marks – Ext.	40 Marks
IV	T	DSC HPHY 401 – Elementary Quantum Mechanics	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	T	DSC HPHY 402 - Electronics & Solid-State Devices	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	P	DSCP HPHY 411 - Physics Practical Lab (IV)	04	2 Hrs – Int. 3 Hrs – Ext.	40 Marks – Int. 60 Marks – Ext.	40 Marks
V	T	DSC HPHY 501 – Introductory Nuclear & Particle Physics	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	T	DSC HPHY 502 - Numerical Methods & Computer Programming	04	1 Hr – CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	P	DSCP HPHY 511 - Physics Practical Lab (V)	04	2 Hrs – Int. 3 Hrs – Ext.	40 Marks – Int. 60 Marks – Ext.	40 Marks
VI	T	DSC HPHY 601 – Physics of Materials	04	1 Hr - CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	T	DSC HPHY 602 – Atomic & Molecular Physics	04	1 Hr - CIA 3 Hrs – EoSE	30 Marks – CIA 70 Marks – EoSE	40 Marks
	P	DSCP HPHY 611 - Physics Practical Lab (VI)	04	2 Hrs – Int. 3 Hrs – Ext.	40 Marks – Int. 60 Marks – Ext.	40 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 two core theory courses (DSC HPHY) of 04 credits each along with core physics laboratory practicals (DSCP) of 04 credits per semester for six semesters.

Bachelor of Science (B.Sc.) - Specialization

Major - Physics

Semester - I

Paper (I) - Mechanics

(DSC HPHY 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 HPHY 101**	**Mechanics**	**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, mechanics of a system of particles motion under central forces, motion of particles, rigid body dynamics and elastic properties. 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 mechanics. 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 : Inertial & Non-Inertial Frames, Special Theory of Relativity, Coriolis Force

Inertial & Non-Inertial Frames : Inertial and non-inertial frames of reference, Explanation with examples, Transformation of displacement, velocity and acceleration between different frames of reference involving translation, Invariance of Newton's laws and energy conservation in a collision process.

Special Theory of Relativity : Postulates of the Special Theory of Relativity, Lorentz transformations of velocity and acceleration, Time dilation and length contraction.

Coriolis Force : Transformation of displacement, velocity and acceleration between different frames rotating with respect to each other, Pseudo forces, Centrifugal and Coriolis forces, Motion relative to earth (in northern and southern hemispheres) and position of latitude, Effect of Coriolis force on various bodies in motion on earth, Foucault's pendulum. **(15 Lectures)**

Unit - II : Conservation Laws, Mechanics of A System of Particles

Conservation Laws : Conservative forces, Potential energy in gravitational and electrostatic field, Rectilinear motion under conservative forces, Discussion of potential energy curve and motion of a particle, Centre of mass, Two particle system : Motion of the centre of mass (CM) and motion of one particle relative to another, Reduced mass, Conservation of linear momentum, Collision of two particles in one and two dimensions (elastic and inelastic).

Slowing down of neutrons in a moderator, Motion of a system with varying mass, Angular momentum conservation and charged particle scattering by a nucleus.

Mechanics of A System of Particles : Motion of the centre of mass of a system of particles, Motion relative to CM, Relationship for kinetic energy and angular momentum of a system of particles in the lab frame and the CM frame, Conservation of energy, Equation of rotational motion of a system of particles, Conservation of angular momentum. **(15 Lectures)**

Unit - III : Gravitation & Motion Under Central forces, Relativistic Kinetics

Gravitation & Motion Under Central forces : Law of gravitation, Gravitational and inertial mass, Gravitational potential energy and gravitational field, Principle of superposition, Gravitational field due to a large plate, Spherical shell and sphere.

General motion under central forces, General solution and discussion of trajectories, Rutherford scattering case of elliptical and circular orbits, Kepler's Laws.

Relativistic Kinetics : Lorentz transformations as rotation in space-time, World line and Minkowski space, Time-like and space like vectors, Macro-causality, Light cone and past, present and future, Four vectors, Transformation of energy and momentum, Transformation between lab and CM frames, Transformation of four frequency vectors and longitudinal and transverse Doppler effect, Four momentum conservation, Elastic and inelastic collision of a system of two particles, Kinematics of decay products of an unstable particle, Reaction threshold energy, Pair production, Compton effect. **(15 Lectures)**

Unit - IV : Rigid Body Dynamics, Elastic Properties

Rigid Body Dynamics : Equation of motion of a rotating body, Inertial coefficients, Moment of inertia of a disc, cylinder, spherical shell, sphere, and rod of rectangular and circular cross-sections, Case of J not parallel to ω, Kinetic energy of rotation and principal axes, Precessional motion of the spinning top, Gyroscope, Spin precession in the constant magnetic field.

Elastic Properties : Elasticity, Young's modulus, Bulk modulus, Modulus of rigidity, Poisson's ratio and derivation of relations between various classical constants, Bending of a beam, Torsion of a cylinder, Experimental determination of elastic constants by static and dynamical methods. **(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. Mechanics, Berkeley Physics, Vol.1, Kittel, Knight, et.al. 2007, Tata McGraw-Hill.
10. Course of Theoretical Physics, Vol-I Mechanics, L.D. Landau, E.M. Lifshitz, Butterworth-Heinemann.

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. Analyze the motion of a Foucault pendulum and understand its relation to the rotation of the Earth.
9. Define conservative and non-conservative forces and analyze rectilinear motion under conservative forces.
10. Analyze potential energy curves and understand the motion of particles under conservative forces.
11. Explain the concept of the center of mass and its relevance in the motion of systems of particles.
12. Apply the concept of conservation of angular momentum and analyze particle scattering by a nucleus.
13. Understand the equations of motion for rotating bodies and the concept of the moment of inertia.
14. Analyze the kinetic energy of rotation and the motion of spinning tops.
15. Understand the motion under central forces, including gravitational interaction, and apply Kepler's laws.

Bachelor of Science (B.Sc.) - Specialization

Major - Physics

Semester - I

Paper (II) – Electricity & Magnetism

(DSC HPHY 102, 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 HPHY 102	Electricity & Magnetism	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. 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. 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, polarization, magnetostatics, and electromagnetic waves.			

Unit - I : Scalar & Vector Fields, Field of Moving Charges

Scalar &Vector Fields : Partial derivative, Gradient of scalar field function, Line integral of a vector field, Divergence in cartesian coordinates, Gauss's divergence theorem, Physical meaning of divergence of a vector, Concept of solid angle, Gauss's law from inverse square law, Gauss's law in differential forms operator, Poisson's & Laplace's equations, Curl of a vector function, Curl in cartesian coordinates, Stoke's theorem : Physical meaning of the curl of a vector, Vector identities using del operator.

Field of Moving Charges : Concept of electrostatic-field and electric-potential due to discrete charges and continuous charge distribution, Potential energy of a system of charges, Applications : Energy required to build a uniformly charged sphere, Classical radius of an electron, Potential and field due to a short dipole (in polar and three-dimensional (3D) cartesian coordinates), Torque and force on a dipole in an external field. **(15 Lectures)**

Unit - II : Magnetic Force Field, Magnetic Field In Free Space And Matter

Magnetic Force Field : Magnetic forces, Measurement of charge in motion, Invariance of charge, Electric field measured in different frames of reference, Field of a point charge moving with constant velocity, Force on a moving charge, Interaction between moving charge and other moving charges.

Magnetic Field In Free Space And Matter : Definition of magnetic field, Properties of the magnetic field, Ampère's circuital law with applications, Ampère's law in differential form, Vector potential, Poison's equation for vector potential, Vector potential and evaluation of B for (i) a current in an infinite solenoid (ii) outside a current carrying long straight wire (iii) inside a long straight wire carrying uniform current, Field of any current carrying wire and deduction of Biot-Savart’s law.

Transformation relations for different components of electric and magnetic fields between two inertial frames.

Field of a current loop, Force on a magnetic dipole in an external field, Electric currents in atoms, Bohr magneton, Orbital gyromagnetic ratio, Electron spin and magnetic moment, Magnetic susceptibility, Magnetic field caused by magnetized matter, Magnetization current, Free currents and the field H. **(15 Lectures)**

Unit - III : Electric Field in Matter

Electric Field In Matter : Electrical moments of a system of discrete charges and continuous charge distribution, Dipole and quadrupole moments of discrete charge distribution, Simple examples, Atomic & molecular-dipoles, Atomic polarizability, Permanent dipole moments, Dielectrics, Capacitor filled with a dielectric, Potential and field due to a polarized sphere, Dielectric sphere placed in uniform field, Field of a charge in dielectric medium and Gauss’s law, Connection between electric susceptibility & atomic polarizability, Polarization in changing fields, Bound charge (polarization) current. **(15 Lectures)**

Unit - IV : Electromagnetic Induction (EMI)

EMI : Faraday's law of electromagnetic induction (EMI), Conducting rod moving through a uniform magnetic field, Differential form of Faraday's law, Inductance, Self-inductance of a solenoid of finite length, Mutual inductance, Mutual inductance between two coils, Self-inductance of a straight conductor, Energy stored in an inductor and in the magnetic field, Displacement current, Modified Ampere's law, Maxwell's equations-in-differential and integral forms. (**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, demonstrate knowledge of gradient, divergence, and curl operators and their applications in electromagnetism.
2. Apply Gauss divergence and Stoke's theorems to analyze electric and magnetic fields, explain the behavior of electric fields and potential energy in different charge distributions, analyze the interaction of electric dipoles with external electric fields and calculate the resulting potentials, solve problems related to Poisson's and Laplace's equations in electrostatics.
3. Describe the behavior of electric fields in different types of matter, including dielectrics and polarized spheres, understand the concept of electric displacement, susceptibility, and dielectric constant, understand the concept of vector fields and their mathematical representation. Calculate partial derivatives, gradients, and line integrals of scalar and vector fields.
4. 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.
5. Apply curl to vector fields and understand its physical significance. Use Stoke's theorem to relate curl to line integrals. Manipulate vector identities using the del operator and understand their applications in physics.
6. Analyze electrostatic fields and potentials due to discrete charges and continuous charge distributions. Calculate potential energy of systems of charges. Apply the concept of electrostatic potential to determine the energy required to build a uniformly charged sphere and the classical radius of an electron.
7. 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.
8. Investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Analyze the electric field measured in different frames of reference. Analyze the behavior of magnetic fields in various materials and the effects of currents on magnetic fields.
9. Apply Ampere's law and the magnetic vector potential to calculate magnetic fields in different scenarios. Explain the properties of electromagnetic waves and their behavior in isotropic and dispersive media.
10. Calculate the energy density and radiation pressure of electromagnetic waves, understand the spectrum of electromagnetic waves and its implications, investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Understand the magnetic field in free space and matter. Apply Ampère's circuital law and use it in differential form with the vector potential.
11. 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.
12. 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.
13. Analyze inductance, self-inductance, mutual inductance, and energy stored in inductors and magnetic fields. Understand displacement current and its role in Maxwell's equations.
14. 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.) - Specialization

Major - Physics

Semester - I

Physics Practical Lab (I)

(DSCP HPHY 111, Credits Practical 04, Practical Hours 120)

Maximum Practical Exam Marks = 100 Marks
(i) Internal Practical Exam Marks = 40 Marks
(ii) External Practical Exam Marks = 60 Marks (Duration : 4 hrs.)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
I	DSCP HPHY 111	Physics Practical Lab (I)	5	04
Level of Course	Type of The Course	Delivery Type of The Course		
Introductory	Core	Practical, One Hundred And Twenty 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. 2. To develop practical skills in using various electrical components and instruments. 3. To reinforce theoretical concepts learned in the corresponding lecture course through practical applications. 4. To enhance problem-solving and analytical skills by analysing experimental data and interpreting results. 5. To promote scientific inquiry, critical thinking, and the ability to design and execute experiments. 6. To foster teamwork and collaboration in conducting experiments and analysing results. 7. To develop skills in accurately measuring and recording experimental data.			

DSCP HPHY 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 Circuits 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, 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.) - Specialization

Major - Physics

Semester - II

Paper (III) - Oscillations & Waves

(DSC HPHY 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 HPHY 201**	**Oscillations & Waves**	**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 oscillations & waves in a broader framework. 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 & waves. 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 : Free Oscillations, Oscillations In An Arbitrary Potential Well, SHM, Superposition of Undamped Harmonic Oscillators

Free oscillations of systems with one degree of freedom, Oscillations in an arbitrary potential well, Simple harmonic motion-solution using complex exponentials, Examples of mechanical and electrical systems, Superposition of (i) two and (ii)-N-linear undamped harmonic oscillations, Energy of oscillator, Power Dissipation, Quality factor & damping of the oscillator under viscous and solid friction. **(15 Lectures)**

Unit - II : Forced Oscillations With Damping, Power of An Oscillator, Resonance, Series & Parallel LCR Circuits, Ballistic Galvanometer, Anharmonic Oscillators

Undamped oscillator with harmonic force, Forced oscillations with damping, Effect of varying the resistive term, Transient phenomenon, Power absorbed by a driven oscillator, Frequency response, Phase relations, Quality factor, Resonance : Electrical oscillations, Series and parallel LCR circuit.

Electromechanical system : Ballistic galvanometer, Effect of damping, Anharmonic oscillator – Pendulum as an example. **(15 Lectures)**

Unit - III : Two-Coupled & Many-Coupled Oscillators

Two-Coupled Oscillators : Motion of the two coupled simple harmonic oscillators, Coupled oscillators; Normal modes, Motion in mixed mode, Transient behaviour, Effect of coupling, Normal modes of vibration of CO_2 and H_2O molecules, Calculation of normal modes : Forced oscillations and resonance for two coupled oscillators, Electrically coupled circuits : frequency response, Reflected impedance effect of coupling (inductive case) and resistive loads.

Many Coupled Oscillators : N-coupled oscillators, Normal modes and their properties, Longitudinal oscillators, Equation of motion for one dimensional (1D) monoatomic and diatomic lattices, Acoustic and optical modes, Dispersion relations, Concept of group and phase-velocities. **(15 Lectures)**

Unit - IV : Wave Equation In Different Dimensions, Electromagnetic (EM) Waves

Wave Equation In Different Dimensions : Wave equation in one dimension (1D) and its solution for elastic waves in solid rod, Gas column, Transverse waves on a string, Normal modes of a two-dimensional (2D) system, Waves in two (2D) and three (3D) dimensions, Spherical waves, Fourier series & analysis of triangular sawtooth & square functions.

Reflection and transmission of waves on a string at a boundary, Reflection and transmission of energy, Standing waves on a string of fixed length, Standing wave ratio (SWR), Energy of a vibrating string.

Electromagnetic (EM) Waves : Plane electromagnetic (EM) waves equation and its plane wave solution, Energy & momentum, Radiation pressure, Radiation resistance of free space, EM wave in dispersive media (normal case), Spectrum of electromagnetic radiations. **(15 Lectures)**

Reference 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. The Physics of Vibrations and Waves by H. J. Pain, 6th Ed., John Wiley & Sons Ltd.
4. Waves and Oscillation, Berkeley Physics Course Vol.3.
5. Mechanics by Charles Kittel, Berkeley Physics Course.
6. Introduction to Classical Mechanics by R. G. Takwale, P S. Puranik, TMH.
7. Classical Mechanics by Herbert Goldstein, Pearson Education.
8. Classical Mechanics by Dr. J. C. Upadhyaya, Himalaya Publishing House.
9. Analytical Mechanics by Louis N. Hand, Janet D. Finch, Cambridge University Press.
10. Mechanics by L.D. Landau and E. M. Lifshitz, Elsevier.
11. An Introduction To Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
12. Mechanics, D. S. Mathur, S. Chand and Company Limited.
13. Mechanics, Berkeley Physics, Vol.1, Kittel, Knight, et.al. 2007, Tata McGraw-Hill.

14. Course of Theoretical Physics, Vol-I Mechanics, L.D. Landau, E.M. Lifshitz, Butterworth-Heinemann.

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. Analyze damped harmonic oscillations and understand the effects of damping on oscillatory motion.
2. Analyze driven harmonic oscillators with damping and understand frequency response and power dissipation.
3. Explain the behavior of coupled oscillators and analyze systems of oscillators with neighbor interactions.
4. 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.
5. Analyze mechanical and electrical systems undergoing oscillatory motion. Calculate the energy of oscillators and examine power dissipation and damping under viscous and solid friction.
6. 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.
7. 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.
8. 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.
9. 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.
10. Study the normal modes of vibration for molecules and electrically coupled circuits.
11. Investigate many coupled oscillators, including N-coupled oscillators and longitudinal oscillators.
12. 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.
13. 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.
14. 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.
15. Calculate the energy of a vibrating string and analyze the energy in each normal mode.

Bachelor of Science (B.Sc.) - Specialization

Major - Physics

Semester - II

Paper (IV) – Thermal & Statistical Physics

(DSC HPHY 202, 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 HPHY 202	Thermal & Statistical Physics	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 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 : Thermal & Adiabatic Interactions, Zeroth Law, General Thermodynamical Interaction, Carnot’s Engine, Clausius-Clapeyron Equation & Maxwell’s Relations

Thermal And Adiabatic Interactions : Thermal interaction, Zeroth law of thermodynamics, Systems in thermal contact with a heat-reservoir (canonical distribution), Energy Fluctuations, Entropy of a system in a heat bath, Helmholtz free energy, Adiabatic interaction and enthalpy, General interaction & first law of thermodynamics, Infinitesimal general interaction, Gibb’s free energy, Phase transitions, Triple point, First and second-order phase transitions, Clausius-Clapeyron equation, Vapour pressure curve, Transformation of disorder into order, Heat engine & 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 and RMS velocities, Diffusion, Equipartition theorem.

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

Unit - III : Production of Low Temperatures & Classical Statistics

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 : Nuclear paramagnetism, Liquid He I and He II, Superfluidity, Quest for absolute zero, Third law of thermodynamics & Nernst's heat theorem.

Classical Statistics : Validity of classical approximation, Phase space, Micro & Macro states, Thermodynamic probability, Entropy and probability, Monoatomic ideal gas, Barometric equation, Specific heat of diatomic gas, Ortho- & para-hydrogen, Specific heat capacity of solids. **(15 Lectures)**

Unit - IV : Quantum Statistics

Quantum Statistics : Bose-Einstein and Fermi-Dirac 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, Flux of radiation energy, Radiation pressure, Thermodynamic functions of an ideal Fermi electron gas, Free electron model for metals, Spectra of metals, Richardson's equation of thermionic emission.

(15 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
3. 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
4. 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 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.
21. Understand the concept of kinetic theory of gases, energy distribution function & Maxwell’s equations.
22. Experimental verification of Maxwell velocity distribution & principle of equipartition of energy.
23. Explain the transport phenomenon of gases, mean free path, distribution of mean paths, viscosity & diffusion.
24. Explanation of thermodynamics in the framework of statistical approach.
25. 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.
26. Formulation of quantum statistics & explanations.
27. Postulates of quantum statistics, wavefunction, exchange degeneracy, Bose-Einstein & Fermi-Dirac statistics, Planck distribution function.
28. Learn about quantum statistics, including Bose-Einstein and Fermi-Dirac distribution laws. Calculate the thermodynamic functions of weakly and strongly degenerate gases.
29. Analyze the behavior of an ideal Bose gas and derive Planck's law.
30. Study the flux of radiation energy, radiation pressure, and the thermodynamic functions of an ideal Fermi electron gas.
31. 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.
32. Understand the concepts of contact potential & thermionic emission, nuclear spin-states.

Bachelor of Science (B.Sc.) - Specialization

Major - Physics

Semester - II

Physics Practical Lab (II)

(DSCP HPHY 211, Credits Practical 04, Practical Hours 120)

Maximum Practical Exam Marks = 100 Marks
(i) Internal Practical Exam Marks = 40 Marks
(ii) External Practical Exam Marks = 60 Marks (Duration : 4 hrs.)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
II	**DSCP HPHY 211**	**Physics Practical Lab (II)**	**5**	**04**
Level of Course	**Core**	**Delivery Type of The Course**		
Introductory	**Core**	**Practical, One Hundred and Twenty 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 HPHY 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), σ (Poisson's ratio) and η (modulus of rigidity) by Searle's method.

5. To determine the 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.