RAJ RISHI GOVT. (AUTONOMOUS) COLLEGE, ALWAR (RAJ.)

(An Autonomous Institute Affiliated to RRBMU,Alwar)

THREE/FOUR YEAR UNDERGRADUATE PROGRAMME

FACULTY OF SCIENCE

Programme : Bachelor of Science (Physics)

Programme Code: UG0106 Bachelor of Science (Physics)

Subject/Course/Discipline- Physics

Medium of Instruction : Hindi / English

(Syllabus as per NEP-2020 and Choice Based Credit System)

(Academic Year 2023-24 Onwards)

27/9/23

27.9.23

Name of College	Raj Rishi Govt. (Autonomous) College Alwar (Rajasthan)
Name of Faculty	Science
Name of Programme	Three/Four Year Bachelor of Science (Physics)
Name of Discipline	Physics

SEMESTER - WISE PAPER TITLES WITH DETAILS

Three/Four Year Bachelor of Science (Physics)										
				Physics	Credits					
S. No.	Level	Semester	Type	Programme Code	Course Code	Title	L	T	P	Total
1.	5	I	MJR	UG0106	PHY-51T-101	Mechanics	4	0	0	4
2	5	I	MJR	UG0106	PHY-51T-102	Electricity and Magnetism	4	0	0	4
3	5	I	MJR	UG0106	PHY-51P-103	Physics Lab-I	0	0	4	4
4	5	II	MJR	UG0106	PHY-52T-104	Oscillations & Wave	4	0	0	4
5	5	II	MJR	UG0106	PHY-52T-105	Thermal & Statistical Physics	4	0	0	4
6	5	II	MJR	UG0106	PHY-52P-106	Physics Lab-II	0	0	4	4
7	6	III	MJR	UG0106	PHY-63T-201	Optics	4	0	0	4
8	6	III	MJR	UG0106	PHY-63T-202	Mathematical Physics	4	0	0	4
9	6	III	MJR	UG0106	PHY-63P-203	Physics Lab-III	0	0	4	4
10	6	IV	MJR	UG0106	PHY-64T-204	Elementary Quantum Mechanics	4	0	0	4
11	6	IV	MJR	UG0106	PHY-64T-205	Electronics and Solid-State Devices	4	0	0	4
12	6	IV	MJR	UG0106	PHY-64P-206	Physics Lab-VI	0	0	4	4
13	7	V	MJR	UG0106	PHY-75T-301	Introductory Nuclear and Particle Physics	4	0	0	4
14	7	V	MJR	UG0106	PHY-75T-302	Numerical Methods and Computer Programming	4	0	0	4
15	7	V	MJR	UG0106	PHY-75P-303	Physics Lab-V	0	0	4	4
16	7	VI	MJR	UG0106	PHY-76T-304	Physics of Materials	4	0	0	4
17	7	VI	MJR	UG0106	PHY-76T-305	Atomic and Molecular Physics	4	0	0	4
18	7	VI	MJR	UG0106	PHY-76P-306	Physics Lab-VI	0	0	4	4

Name of College	**R R Autonomous College Alwar**
Name of Faculty	**Science**
Name of Programme	**UG0106 B. Sc. (Physics)**
Name of Discipline	**Major Discipline - Physics** **Minor Discipline – Chemistry, Mathematics**

PROGRAMME PREREQUISITES

Physics and Mathematics courses of Central Board of Secondary Education or equivalent.

PROGRAMME OUTCOMES (POs)

Program Outcome in B.Sc.(Physics) with Minor in Chemistry or Mathematics:

1. Strong foundational knowledge: Students will develop a strong foundational knowledge in physics, including core concepts, principles, theories, and mathematical techniques. They will also gain an understanding of the fundamental principles of chemistry or mathematics, depending on their chosen minor.
2. Problem-solving skills: Students will develop excellent problem-solving skills, both qualitative and quantitative, by applying scientific principles and mathematical techniques to analyze and solve complex problems in physics, chemistry, or mathematics.
3. Experimental skills: Students will acquire practical skills in designing, conducting, and analyzing experiments in physics and chemistry. They will learn to use various laboratory instruments and techniques, collect and interpret experimental data, and draw meaningful conclusions.
4. Computational skills: Students will develop proficiency in computational methods and numerical analysis, using appropriate software tools to model and simulate physical systems, solve mathematical problems, and analyze experimental data.
5. Critical thinking and analytical reasoning: Students will develop the ability to think critically, analyze information, and apply logical reasoning to evaluate scientific phenomena and experimental results. They will also learn to assess the validity of scientific arguments and draw evidence-based conclusions.
6. Communication skills: Students will enhance their oral and written communication skills by effectively presenting scientific concepts, experimental results, and research findings. They will learn to communicate complex scientific ideas to both technical and non-technical audiences.
7. Research and inquiry skills: Students will be able to conduct independent research, formulate scientific questions, design experiments, gather and analyze data, and draw conclusions. They will also develop skills in literature review, data interpretation, and scientific writing.
8. Interdisciplinary perspective: Students with a minor in chemistry or mathematics will gain interdisciplinary knowledge and perspectives, allowing them to explore the connections between physics and other scientific disciplines. They will be able to apply their understanding of chemistry or mathematics concepts to enhance their problem-solving abilities.
9. Ethical and professional conduct: Students will develop an understanding of the ethical responsibilities and professional conduct expected in scientific research and practice. They will be aware of the importance of integrity, safety, and ethical considerations in their work.
10. Lifelong learning: Students will develop a passion for learning and an appreciation for the dynamic nature of scientific knowledge. They will be equipped with the skills and motivation to engage in lifelong learning, keeping up with advancements in physics, chemistry, or mathematics and adapting to new challenges and opportunities in their careers.

These program outcomes will prepare students for diverse career paths in research, academia, industry, government, and other sectors where strong analytical and problem-solving skills, as well as a deep understanding of physics and its interdisciplinary connections, are valued.

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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 assessment (20% weightage) and (End of Semester Examination) EoSE (80% 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 80% of the total marks of the course/subject. The EoSE will be of 3 hours duration. Each question will carry equal marks and have two parts as -
   - 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 with an internal choice of each. 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 – Seminar	(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)

Name of College	R R Autonomous College Alwar
Name of Faculty	UG0106 B. Sc. (Physics)
Name of Discipline	Physics

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG-0106B. Sc. (Physics)								
				PHYSICS	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
1.	5	I	MJR	UG- 0106 PHY-51T-101-Mechanics	4	0	0	4
2.	5	I	MJR	UG- 0106 PHY-51T-102-Electricity and Magnetism	4	0	0	4
3.	5	I	MJR	UG- 0106 PHY-51P-103-Physics Lab-I	0	0	4	4
4.	5	II	MJR	UG- 0106 PHY-52T-104-Oscillations & Wave	4	0	0	4
5.	5	II	MJR	UG- 0106 PHY-52T-105-Thermal & Statistical Physics	4	0	0	4
6.	5	II	MJR	UG- 0106 PHY-52P-106-Physics Lab-II	0	0	4	4
7.	6	III	MJR	UG-0106 PHY-63T-201-Optics	4	0	0	4
8.	6	III	MJR	UG- 0106 -PHY-63T-202-Mathematical Physics	4	0	0	4
9.	6	III	MJR	UG- 0106 PHY-63P-203-Physics Lab-III	0	0	4	4
10.	6	IV	MJR	UG- 0106 PHY-64T-204-Elementary Quantum Mechanics	4	0	0	4
11.	6	IV	MJR	UG- 0106 PHY-64T-205-Electronics and Solid-State Devices	4	0	0	4
12.	6	IV	MJR	UG-0106 PHY-64P-206-Physics Lab-IV	0	0	4	4
13.	7	V	MJR	UG- 0106 PHY-75T-301-Introductory Nuclear and Particle Physics	4	0	0	4
14.	7	V	MJR	UG - 0106 PHY-75T-302-Numerical Methods and Computer Programming	4	0	0	4
15.	7	V	MJR	UG- 0106 PHY-75P-303-Physics Lab-V	0	0	4	4
16.	7	VI	MJR	UG- 0106 PHY-76T-304-Physics of Materials	4	0	0	4
17.	7	VI	MJR	UG- 0106 PHY-76T-305-Atomic and Molecular Physics	4	0	0	4
18.	7	VI	MJR	UG- 0106 PHY-76P-306-Physics Lab-VI	0	0	4	4

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Syllabus: UG0106-B.Sc. (Physics)
I-Semester- Physics
(2023-2024)

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm + EoSE)	Minimum Marks (Midterm + EoSE)
Theory	UG0106-PHY-51T-101-Mechanics	1 Hrs-MT 3 Hrs-EoSE	20 Marks-MT 80 Marks-EoSE	8 Marks-MT 32 Marks-EoSE
Theory	UG0106 PHY-51T-102-Electricity and Magnetism	1 Hrs-MT 3 Hrs-EoSE	20 Marks-MT 80 Marks-EoSE	8 Marks-MT 32 Marks-EoSE
Practical	UG0106-PHY-51P-103-Physics Lab-I	2 Hrs-MT 4 Hrs-EoSE	20 Marks-MT 80 Marks-EoSE	8 Marks-MT 32 Marks-EoSE

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
I	UG0106 PHY-51T-101-Mechanics	Mechanics	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	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 classical mechanics and selected topics from special relativity. The course aims to develop a strong foundation in the principles and laws governing the motion of objects in both inertial and non-inertial frames of reference. It also covers conservation laws, central forces, relativistic kinematics, and topics related to rigid body dynamics.			

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Detailed Syllabus

UG0106PHY-51T-101- Mechanics

Unit – I

Inertial and Non-Inertial Frames:

(i) Inertial and non-inertial frames of reference, 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.

(ii) Postulates of special theory of relativity, Lorentz transformations of velocity and acceleration; time dilation and length contraction. 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.

(iii) 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), variation with latitude, Effect of coriolis forçe on various bodies in motion on earth, Focault's pendulum.

(15 Lectures)

Unit -II

Conservation laws: Conservative forces, Potential energy in gravitational and electrostatic field, Rectilinear motion under conservative forces, Discussion of potential energy curves and motion of a particle. Centre of mass, two particle system: Motion of the 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 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 and Motion under Central forces: Law of gravitation and gravitational field, Gravitational and inertial mass, Principal 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. Keplers Laws.

(15 Lectures)

Unit-IV

1. Rigid Body Dynamics: Equation of motion of a rotating body, Inertial coefficients, Moment of inertia of a disc, cylinder, spherical cell, sphere and and rods of rectangular and circular cross section. Case of J not parallel to ω. The kinetic energy of rotation and principal axis. Precessional motion of spinning top Gyroscope, spin precession in constant magnetic field.

Relativistic Kinematics: Four vectors, Transformation of energy. and momentum, Transformation between Lab and the CM frames, Transformation of four frequency vector, longitudinal and transverse Doppler effect. Four momentum conservation, Elastic and inelastic collision of particles of two particles, Kinematics of decay products of an unstable particle, reaction threshold energy, Pair production, Compton effect.

(15 Lectures)

Suggested Books and References –

1. Mechanics, Berkeley Physics, Vol.I, Kittel, Knight, et.al. 2007, Tata McGraw-Hill
2. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill
3. Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
4. Course of Theoretical Physics, Vol-I Mechanics, L.D. Landau, E.M. Lifshitz, Butterworth-Heinemann
5. Mechanics, D.S. Mathur, S. Chand and Company Limited,
6. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
7. Introduction to Classical Mechanics: With Problems and Solutions, David Morin
8. Classical Mechanics, Herbert Goldstein, Charles P. Poole, and John L. Safko
9. Classical Mechanics, John R. Taylor
10. Mechanics, Keith R. Symon

Suggested E-resources:

1. **Online Lecture Notes and Course Materials:**

- 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/
- HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in mechanics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Course Learning Outcomes:

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

1. Understand the concept of frames of reference and distinguish between inertial and non-inertial frames. Apply transformations of displacement, velocity, and acceleration between different frames of reference.
2. Analyze the invariance of Newton's laws and conservation of energy in collision processes in different frames of reference.
3. Explain the postulates of the special theory of relativity, Lorentz transformations of velocity and acceleration, and the concepts of time dilation and length contraction.
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. Explore the conservation laws in mechanics, including the conservation of linear momentum and angular momentum. Apply these laws to analyze collision processes and the motion of systems with varying mass.
8. Understand the concepts of conservative forces and potential energy in gravitational and electrostatic fields. Analyze rectilinear motion under conservative forces and the motion of particles based on potential energy curves.

9. Study the center of mass and motion of a two-particle system. Calculate the reduced mass and apply it to conservation of linear momentum and collision analysis in one and two dimensions.
10. Examine the law of gravitation, gravitational and inertial mass, gravitational potential energy, and gravitational field. Discuss the principle of superposition and calculate gravitational fields for different geometries.
11. Analyze general motion under central forces, including the Rutherford scattering case and the discussion of trajectories in elliptical and circular orbits. Explore Kepler's laws.
12. Study relativistic kinematics and understand four vectors, energy-momentum transformations, and the Doppler effect. Apply these concepts to elastic and inelastic collision analysis and the kinematics of decay processes.
13. Investigate the dynamics of rigid bodies, including equations of motion, moment of inertia calculations, kinetic energy of rotation, and principal axes. Analyze the precessional motion of spinning tops and gyroscopes.

By the end of this course, students will have developed a strong understanding of classical mechanics, special relativity. They will be able to apply fundamental principles and laws to analyze various physical phenomena, solve problems related to motion and forces, and make connections between different concepts within the field of mechanics.

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Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
I	UG0106-PHY-51T-102	Electricity and Magnetism	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	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 vector fields, electrostatics, magnetostatics, electric fields in matter, and electromagnetic induction. The course aims to develop a strong foundation in the principles and mathematical techniques related to these topics, and their applications in physics.			

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Detailed Syllabus

UG0106PHY-51T-102- Electricity and Magnetism

Unit – I

Vector Fields: Partial derivative, Gradient of scaler field function, Line integral of a vector field, divergence in cartesian coordinato, Gauss divergence theorem. Physic meaning of divergence of a vector, concept of solid angle. Gauss law from inverse square law, Gauss-law in differential-forms. Operator, Poisson and Laplace equations. Curl of a vector function, curl in cartesian coordinates. Stoke's theorem: The physical meaning of curl of a vector. Vector identities using Del operator.

(15 Lectures)

Unit -II

The field of Moving Charges: Concept of Electrostatic field and potential due to discrete charges and continuous charge distribution, Potential energy of a system of charges, Application: Energy required to build a uniformly charged sphere, classical radius of an electron. The potential and field due to short dipole (in polar and three-dimensional cartesian coordinates), the torque and force on a dipole in an external 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.

(15 Lectures)

Unit -III

The magnetic field in free space and matter: The definition of magnetic field, properties of the magnetic field. Ampère's circuital law with applications. Ampère's law in differential from, Vector potential. Poison's equation for vector potential. Evaluation of B for (i) a current in an infinite solenoid (n) outside a current carrying long straight wire (ii) Inside a long straight wire carrying uniform current. Field of current carrying wire and Biot-Savart-law.

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

The field of a current loop. The 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. The magnetic field caused by magnetized matter. magnatization current, fired currents and the field H. **(15 Lectures)**

Unit -IV

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

Suggested Books and References –

1. Berkeley Physics Course, Vol 2 Electricity and Magnetism.
2. Feynman in Physics Vol.2
3. An Introduction to Electrodynamics by Griffiths
4. Fundamental University Physics, Mo2 Fields-Alonso & Finn.

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Suggested E-resources:

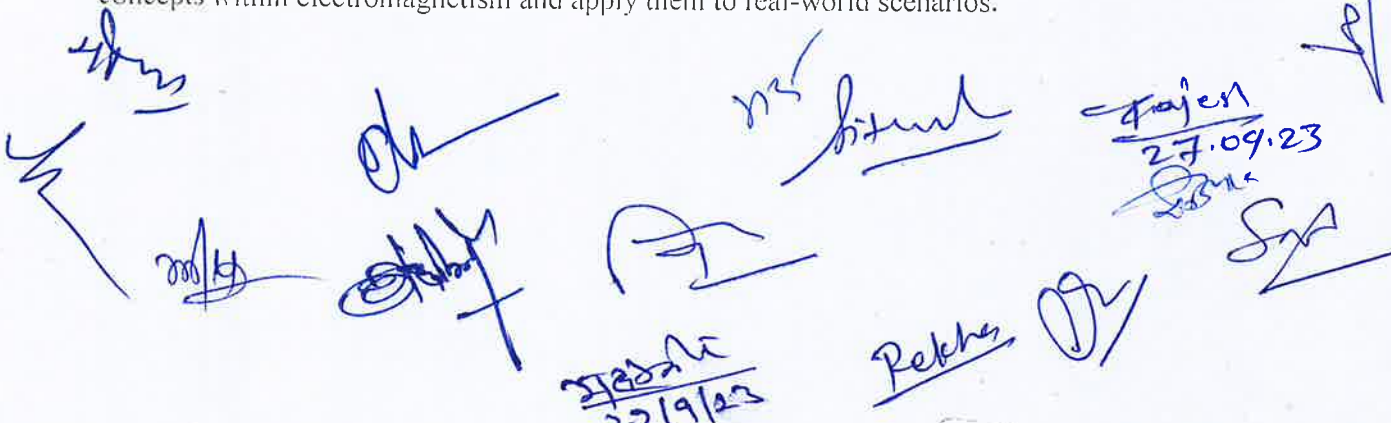
1. **Online Lecture Notes and Course Materials:**
   - MIT OpenCourseWare: Electricity and Magnetism - This resource offers lecture notes, assignments, and exams for a complete course on electricity and magnetism: https://ocw.mit.edu/courses/physics/8-02sc-physics-ii-electricity-and-magnetism-spring-2011/

Course Learning Outcomes:

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

1. Understand the concept of vector fields and their mathematical representation. Calculate partial derivatives, gradients, and line integrals of scalar and vector fields.
2. 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.
3. Apply curl to vector fields and understand its physical significance. Use Stoke's theorem to relate curl to line integrals.
4. Manipulate vector identities using the del operator and understand their applications in physics.
5. Analyze electrostatic fields and potentials due to discrete charges and continuous charge distributions. Calculate potential energy of systems of charges.
6. 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.
9. Understand the magnetic field in free space and matter. Apply Ampère's circuital law and use it in differential form with the vector potential.
10. Calculate the magnetic field for different current configurations using the Biot-Savart law and deduce the field of any current-carrying wire.
11. Apply transformation relations for electric and magnetic fields between inertial frames.
12. 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.

By the end of this course, students will have developed a strong understanding of vector fields, electrostatics, magnetostatics, electric fields in matter, and electromagnetic induction. They will be able to apply the principles and mathematical techniques learned to analyze and solve complex problems in these areas. Additionally, they will be able to make connections between different concepts within electromagnetism and apply them to real-world scenarios.



Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
I	UG0106PHY-51P-103	Physics Lab-I	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	Practical, One Hundred and Twenty hours of practical 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-I, with the mentioned experiments, is to provide students with hands-on experience in conducting experiments related to oscillations, damping, coupled oscillators, and properties of materials. The lab aims to reinforce theoretical concepts learned in the classroom, develop practical skills, and enhance the understanding of physics principles through experimentation.			

UG0106-PHY-51P-103: Physics Lab-I

The colleges are free to set new experiments of equivalent standards. This should be intimated and approved by the Convener, Board of Studies before the start of the academic session. It is binding on the college 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 centre

List of Experiments –

1. Study the variation of the time period with amplitude in large-angle oscillations using a compound pendulum.
2. To study the damping using a compound pendulum.
3. To study the excitation of normal modes and measure frequency splitting into two coupled oscillators.
4. To study the frequency of energy transfer as a function of coupling strength using coupled oscillators.
5. To study the viscous fluid damping of a compound pendulum and determine the damping coefficient and Q of the oscillator.
6. To study the electromagnetic damping of a compound pendulum and to find the variation of damping coefficients with the assistance of a conducting lamina.
7. Study of normal modes of a coupled pendulum system. Study of oscillations in mixed modes and find the period of energy exchange between the two oscillators.
8. To determine Young's modulus by bending of the beam.
9. To determine Y, σ and n by Searle's method
10. To determine the modulus of rigidity of a wire using Maxwell's needle.
11. To determine the moment of Inertia of a fly-wheel.
12. To find the motion of a spring and calculate (a) Spring constant (b) Acceleration due to gravity (g) (c) Modulus of Rigidity
13. Experiments on Linear Track:
    1. Constant velocity motion.
    2. Acceleted motion.
    3. Harmonic motion.
    4. Anharmonic motion.

5. Potential energy curves and energy conservation.
6. Elastic-collisions and conservation laws

14. Experiments with simple oscillator
    1. Inelastic collisions.
    2. Variation of time period with amplitude.
    3. Composition of two perpendicular S H Ms.
    4. Frequency response.
    5. Damping and 'O' value.
    6. Phase curves
15. Experiments with coupled oscillator.:
    1. Excitation of formal modes and frequency measurement
    2. Period of energy transfer as a function of coupling strength

16. Experiments with Torsional wave apparatus:
    1. Velocity of wave propagation.
    2. Excitation of normal modes both ends open, on end open
    3. Impedance matching.

Suggested Books and References –

Suggested E-resources.

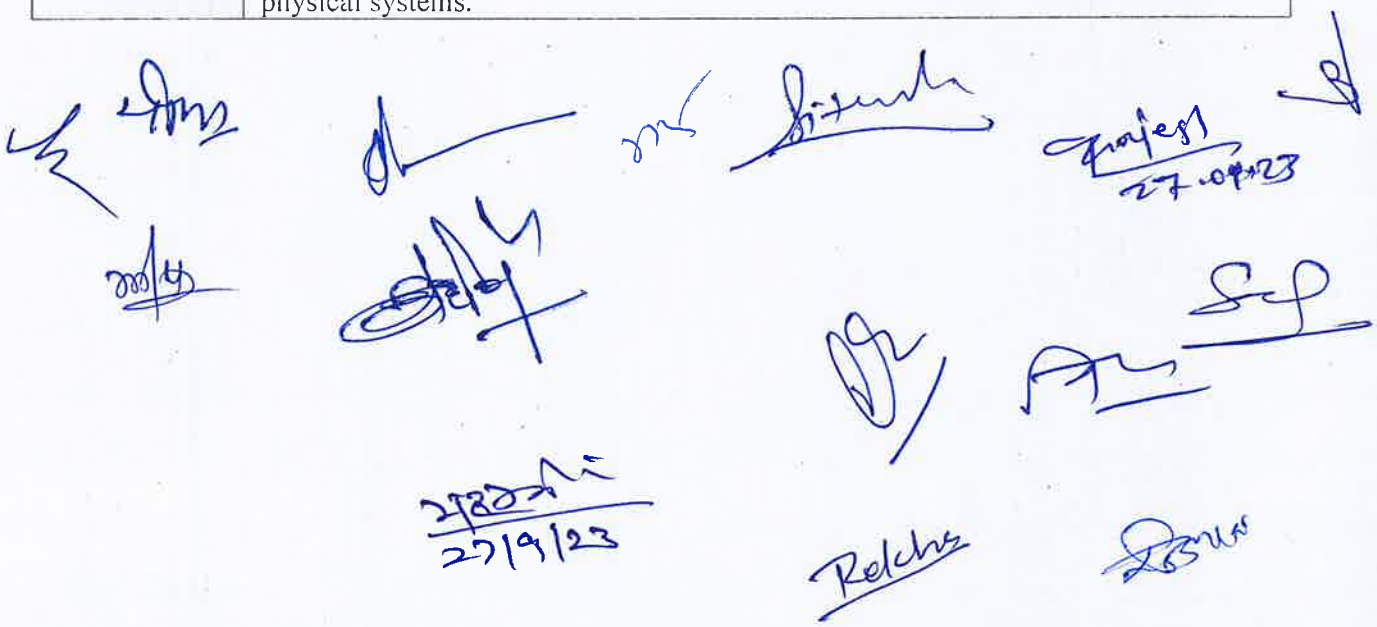
Course Learning Outcomes:

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.

Syllabus: UG0106-B.Sc. Physics
II-Semester- Physics
(2023-2024)

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm + EoSE)	Minimum Marks (Midterm + EoSE)
Theory	UG0106PHY-52T-104-Oscillations & Wave	1 Hrs-MT 3 Hrs-EoSE	20 Marks-MT 80 Marks-EoSE	8 Marks-MT 32 Marks-EoSE
Theory	UG0106PHY-52T-105-Thermal & Statistical Physics	1 Hrs-MT 3 Hrs-EoSE	20 Marks-MT 80 Marks-EoSE	8 Marks-MT 32 Marks-EoSE
Practical	UG0106PHY-52P-106-Physics Lab-II	2 Hrs-MT 4 Hrs-EoSE	20 Marks-MT 80 Marks-EoSE	8 Marks-MT 32 Marks-EoSE

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
II	UG0106PHY-52T-104	Oscillations & Wave	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	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 oscillations and wave phenomena. The course aims to develop a strong foundation in the principles and mathematical techniques related to oscillatory motion and wave propagation, and their applications in various physical systems.			



Detailed Syllabus

UG0106PHY-52T-104-Oscillations & Wave

Unit I

Free osoillations 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 system. Power Dissipation and damping of the oscillator under viscous and solid friction. Superposition of (i) Two and (ii)-N-linear undamped harmonic oscillations, beats Combination of two oscillations at right angles. Anharmonic, Oscillators-pendulum as an example.

(15 Lectures)

Unit II

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. Optical Thermal-expansion of a crystal. Non-linear effects in electrical devices. Non-linear effects in Accoustic Waves.

(15 Lectures)

Unit III

Motion of two coupled simple harmonic oscillators, Differential equations for stiffness or capacitance coupled oscillators, Normal modes, Motion in mixed mode andTransient behaviour. Effect of coupling Normal modes of vibration for CO_2 and H_2O molecules Calculation of normal mode: frequencies 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 monoatomic and diatomic lattices, acoustic and optical modes, dispersion relations, concept of group and phase velocities. Electrical transmission line, propagation velocity, loses, characteristic impedance, standing waves, effect of termination.

(15 Lectures)

Unit IV

Wave equation in one dimension and its solution for elastic waves in solid rod, gas column, transverse waves on a string.

Normal modes of a two-dimensional system. Waves in two and three dimensions, Spherical waves.

Fourier series and Analysis of triangular sawtooth and square functions. Plane Electromagnetic waves equation-and its plane wave solution, energy and momentum, Radiation pressure, Radiation resistance of free space. EM wave in dispersive media (normal case).

(15 Lectures)

Suggested Books and References –

1. Vibrations and Waves AP French
2. Physics of vibrations and waves H. Pain
3. Waves and Oscillation, Berkeley Physics Course Vol.3.

Suggested E-resources-

1. MIT OpenCourseWare: Introduction to Oscillations and Waves - This resource offers lecture notes, assignments, and exams for a complete course on electricity and magnetism: https://ocw.mit.edu/courses/res-8-009-introduction-to-oscillations-and-waves-summer-2017/

Course Learning Outcomes:

1. 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.
2. Analyze mechanical and electrical systems undergoing oscillatory motion. Calculate the energy of oscillators and examine power dissipation and damping under viscous and solid friction.
3. 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.
4. 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.
5. 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.
6. 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. Study the normal modes of vibration for molecules and electrically coupled circuits.
7. Investigate many coupled oscillators, including N-coupled oscillators and longitudinal oscillators. 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.
8. 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.
9. Explore Fourier series and analyze triangular, sawtooth, and square wave functions. Study plane electromagnetic waves, their wave equation, and plane wave solutions. Calculate energy, momentum, radiation pressure, and radiation resistance of free space. Understand electromagnetic waves in dispersive media.

By the end of this course, students will have developed a strong understanding of oscillations and wave phenomena. They will be able to analyze and solve problems related to oscillatory motion and wave propagation in various physical systems. Additionally, they will be able to apply the principles and mathematical techniques learned to explain and interpret wave phenomena in real-world scenarios.

27.09.23

Rekha

27/9/23

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
II	UG0106PHY-52T-105	Thermal & Statistical Physics	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	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 thermal and statistical physics. The course aims to develop a strong foundation in the principles and concepts of thermodynamics and statistical mechanics, and their applications in describing the behavior of macroscopic and microscopic systems.			

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Rekha

Detailed Syllabus

UG0106PHY-52T-105-Thermal & Statistical Physics

Unit I

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 and first of thermodynamics, Infinitesimal general interaction, Gibb's free energy, Phase transitions, Triple point First and second-order phase transition, Clausius Clapeyron equation Vapour pressure curve, transformation of disorder into order, 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: Derivation of Maxwell's law of distribution of velocities and its experimental verification, most probable, average and RMS velocities, Diffusion, Equip partition. Theorem, Classical theory of Specific heat capacity, specific heat of solid.

Transport Phenomenon: Mean free path, Distribution of free path, Coefficients of viscosity, thermal conductivity and diffusion. Brownian motion, Langevin's and Einstein's theories, Experimental determination of Avogadro number. **(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-Vander 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 and Nernst Heat Theorem.

(15 Lectures)

Unit IV

Quantum Statistics: Introduction to Phase space, Micro and Macro states, Thermodynamic probability Entropy and probability, Bose-Einstein and Fermi-Dirac distribution laws Calculation of the thermodynamic functions of art that weak degenerate gas. Strong degeneration, Calculation of the thermodynamic, functions of an ideal Bose gas, Derivation of Plant law, Flux of radiation energy, radiation pressure thermodynamic functions of ancideal Fermi electron: gas, Free electron model, for metals Specter of metals, Richardson's equation of thermionic a emission, Relativistic fermi gas, White dwarf stars Chandrasekhar mass limit.

(15 Lectures)

Suggested Books and References –

1. Kittle-Thermal Physics.
2. Berkeley Series, Vol. V, Statistical Physics
3. Reif-Thermodynamics and Statistical Physics.
4. Lokanathan and Khandelwal Thermodynamics and Statistical Physics.
5. Sears Thermodynamics, Kinetic Theory of Gases and Statistical Physics.

Suggested E-resources-

1. MIT OpenCourseWare: Statistical Mechanics I: Statistical Mechanics of Particles- This resource offers lecture notes, assignments, and exams for a complete course on Statistical Mechanics I, https://ocw.mit.edu/courses/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/pages/syllabus/

Course Learning Outcomes:

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

1. Understand the concepts of thermal interactions and the zeroth law of thermodynamics. Study systems in thermal contact with a heat reservoir, canonical distribution, and energy fluctuations. 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.
2. Study infinitesimal general interactions and Gibb's free energy. Explore phase transitions, including first and second-order phase transitions. Understand the Clausius-Clapeyron equation and the vapor pressure curve. Analyze the transformation of disorder into order and the efficiency of heat engines, including Carnot's cycle. Learn about the thermodynamic scale as an absolute scale and apply Maxwell relations.
3. Derive Maxwell's law of distribution of velocities and verify it experimentally. Calculate the most probable, average, and root mean square velocities. Study diffusion and the equipartition theorem. Explore the classical theory of specific heat capacity and analyze the specific heat of solids. Understand transport phenomena, including mean free path, coefficients of viscosity, thermal conductivity, and diffusion. Study Brownian motion and the theories of Langevin and Einstein. Learn about the experimental determination of Avogadro's number.
4. 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. Explore regenerative cooling and air liquefiers. Understand adiabatic demagnetization of paramagnetic substances and the properties of liquid He I and He II, including superfluidity. Learn about the quest for absolute zero and the third law of thermodynamics.
5. Study phase space, microstates, macrostates, thermodynamic probability, and entropy. Learn about quantum statistics, including Bose-Einstein and Fermi-Dirac distribution laws. Calculate the thermodynamic functions of weakly and strongly degenerate gases. Analyze the behavior of an ideal Bose gas and derive Planck's law. Study the flux of radiation energy, radiation pressure, and the thermodynamic functions of an ideal Fermi electron gas. 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.

By the end of this course, students will have developed a strong understanding of thermal and statistical physics. They will be able to apply the principles and concepts learned to analyze and solve problems related to thermodynamic systems, phase transitions, transport phenomena, low-temperature production, and quantum statistics. Additionally, they will be able to interpret and explain various phenomena and behaviors of macroscopic and microscopic systems using the principles of thermodynamics and statistical mechanics.

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
II	UG0106PHY-52P-106	Physics Lab-II	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	Practical, One Twenty hours of practical 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 analyzing 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 analyzing results. 7. To develop skills in accurately measuring and recording experimental data.			

UG0106PHY-52P-106-Physics Lab-II

The colleges are free to set new experiments of equivalent standards. This should be intimated and approved by the Convener, Board of Studies before the start of the academic session. It is binding on the college 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 centre

List of Experiments –

1. To study the Faradays Law of electromagnetic induction
2. To study the variation of power transfer by two different loads by a D.C. source and to verify the maximum power transfer theorem
3. To study the variation of charge and current in an RC circuit with a different time constant (using a DC source).
4. 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.
5. To study the rise and decay of current in an LR circuit with a source of constant emf.
6. To study the voltage and current behaviour of an LR circuit with an AC power source .Also determine power factor, impedance and phase relations.
7. To study the magnetic field along the axis of a current-carrying circular coil .Plot the necessary graph and hence find the radius of the circular coil.
8. To study the frequency response of a series LCR series circuit and to estimate the resonant frequency and find out Q-factor and band width
9. To study the frequency response and to find resonant frequencies of L-C-R parallel circuits. Also to find the quality factor and band width in L-C-R series circuit.

10. To determine the specific resistance of a material and determine the difference between two small resistance using Carey Fosters Bridge.
11. To convert a galvanometer into an ammeter of a given range.
12. To convert a galvanometer into a voltmeter of a given range.
13. Study of RC circuit with DC.
14. Study of source impedance.
15. Study of RC circuit with AC nonsinusoidal.
16. Study of RC. Circuit with AC sinusoidal.

Suggested Books and Reference –

Suggested E-resources.

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.