Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**Science**
Name of Programme	**UG0810-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 analyse 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

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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.

Examination Scheme

1. 1 credit = 25 marks for examination/evaluation
2. For Regular Students there will be 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 end-semester examination) EoSE (80% weightage).
3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.
4. To appear in the EoSE examination of a course/subject a regular 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 regular student obtains at least a C grade in the CA and EoSE examination of a Course/Subject.
6. In the case of Non-Collegiate Students there will be no Continuous assessment and credit points in a course/subject will be assigned only if, the non-collegiate student obtains at least a C grade in the 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)

DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

S. No.	CATEGORY	Weightage (out of total internal marks)		THEORY					PRACTICAL		
				CORE (Only Theory)	CORE (Theory + Practical)	AEC	SEC	VAC	CORE (Theory +Practical)	SEC	VAC
	Max Internal Marks			**30**	**20**	**20**	**10**	**10**	**10**	**10**	**10**
1	**Mid-term Exam**	***50%***		**15**	**10**	**10**	**5**	**5**	**5**	**5**	**5**
2	**Assignment**	***25%***		**7.5**	**5**	**5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
3	**Attendance**	***25%***		**7.5**	**5**	**5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
		Regular Class Attendance	= 75%	3	2	2	1	1	1	1	1
			75-80%	4	3	3	1.5	1.5	1.5	1.5	1.5
			80-85%	5	4	4	2	2	2	2	2
			> 85%	7.5	5	5	2.5	2.5	2.5	2.5	2.5

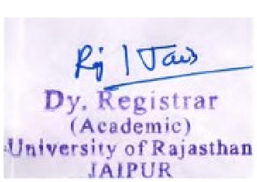
Note:

1. Continuous assessment will be the sole responsibility of the teacher concerned.
2. For continuous assessment no remuneration will be paid for paper setting, Evaluation, Invigilation etc.
3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance etc.

[courses which have Practical Examination]

The question paper will consist of **two** parts **A** & **B**.

PART-A: 20 Marks



Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 80 Marks
Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 20 marks.

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm + EoSE)	Minimum Marks (Midterm + EoSE)
Theory	**UG0810**	**1 Hrs-MT** **3 Hrs-EoSE**	**20 Marks-MT** **80 Marks-EoSE**	**8 Marks-MT** **32 Marks-EoSE**
Practical	**UG0810**	**2 Hrs-MT** **4 Hrs-EoSE**	**20 Marks-MT** **80 Marks-EoSE**	**8 Marks-MT** **32 Marks-EoSE**

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.

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Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**UG0810-B. Sc. (Physics)**
Name of Discipline	**Physics**

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0810-B. Sc. (Maths Group)								
				PHYSICS	**Credits**			
#	**Level**	**Semester**	**Type**	**Title**	**L**	**T**	**P**	**Total**
1.	5	I	MJR	**UG0810-PHY-51T-101-Mechanics**	4	0	0	4
2.	5	I	MJR	**UG0810-PHY-51T-102-Electricity and Magnetism**	4	0	0	
3.	5	I	MJR	**UG0810-PHY-51P-103-Physics Lab-I**	0	0	4	4
4.	5	II	MJR	**UG0810-PHY-52T-104-Oscillations & Wave**	4	0	0	4
5.	5	II	MJR	**UG0810-PHY-52T-105-Thermal & Statistical Physics**	4	0	0	4
6.	5	II	MJR	**UG0810-PHY-52P-106-Physics Lab-II**	0	0	4	4
7.	6	III	MJR	**UG0810-PHY-63T-201-Optics**	4	0	0	4
8.	6	III	MJR	**UG0810-PHY-63T-202-Mathematical Physics**	4	0	0	4
9.	6	III	MJR	**UG0810-PHY-63P-203-Physics Lab-III**	0	0	4	4
10.	6	IV	MJR	**UG0810-PHY-64T-204-Elementary Quantum Mechanics**	4	0	0	4
11.	6	IV	MJR	**UG0810-PHY-64T-205-Electronics and Solid-State Devices**	4	0	0	4
12.	6	IV	MJR	**UG0810-PHY-64P-206-Physics Lab-IV**	0	0	4	4
13.	7	V	MJR	**UG0810-PHY-75T-301-Introductory Nuclear and Particle Physics**	4	0	0	4
14.	7	V	MJR	**UG0810-PHY-75T-302-Numerical Methods and Computer Programming**	4	0	0	4
15.	7	V	MJR	**UG0810-PHY-75P-303-Physics Lab-V**	0	0	4	4
16.	7	VI	MJR	**UG0810-PHY-76T-304-Physics of Materials**	4	0	0	4
17.	7	VI	MJR	**UG0810-PHY-76T-305-Atomic and Molecular Physics**	4	0	0	4

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18.	7	VI	MJR	**UG0810-PHY-76P-306-Physics Lab-VI**	0	0	4	4

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Syllabus:
I-Semester
UG0810-PHY-51T-101- Mechanics

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
I	**UG0810-PHY-51T-101**	**Mechanics**	**5**	**4**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major**	**Lecture, Sixty Lectures(4 Hours in a week) 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 and elasticity.			

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 the 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.

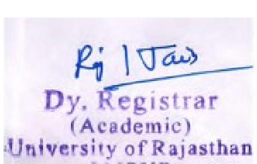
(iii) Transformation of displacement, velocity and acceleration between different frames rotating with respect to each other pseudo forces, centrifugal and Coriolis forces, Motion relative to earth (in northern and southern hemispheres), position of latitude, Effect of Coriolis forçe on various bodies 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, 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: Four vectors, Transformation of energy. and momentum, Transformation between the Lab and the CM frames, Transformation of four frequency vectors, and 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)**

Unit-IV

i. 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-section. Case of J not parallel of Kinetic energy of rotation and principal axes. The processional motion of the spinning top, Gyroscope, spin precession in the constant magnetic field.

ii. Elastic Properties offer Elasticity, Young's modulus, Bulk modulus, Modulus of Rigidity Poisson's ratio and derivation of relations between various classic constants, Bending of a beam," Torsion of a cylinder, Experimental determination of elastic constants by static and dynamical methods. **(15 Lectures)**

Suggested Books and References –

1. Mechanics, Berkeley Physics, Vol.1, 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.

14. Explore elastic properties, including Young's modulus, bulk modulus, modulus of rigidity, and Poisson's ratio. Understand the bending of beams and torsion of cylinders. Learn about experimental methods to determine elastic constants.

By the end of this course, students will have developed a strong understanding of classical mechanics, special relativity, and selected topics in elasticity. 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.

Syllabus

Semester-I

UG0810-PHY-51T-102- Electricity and Magnetism

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
I	**UG0810-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(4 Hours in a week) 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.			

Unit – I

Vector Fields: Partial derivative, Gradient of scalar field function, Line integral- of a vector field divergence in Cartesian coordinates, Gauss divergence theorem, Physical 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.
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 a short dipole (in polar and three-dimensional Cartesian coordinates), torque and force on a dipole in an external field. **(15 Lectures)**

Unit -II

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.

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 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 law.

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

The 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: 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, Bound charge (polarization) current. **(15 Lectures)**

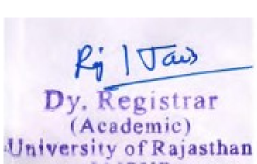
Unit-IV

Electromagnetic Induction and Maxwell's Equation: Faraday's law of electromagnetic induction, a conducting rod moving through a uniform magnetic field, a loop moving through a nonuniform magnetic field, a loop with the field source moving. 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 form. Maxwell's equations in material-media, Boundary conditions for electric and magnetic fields at vacuum-dielectric and vacuum-metal-boundaries.

(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, vol-2, Fields and waves by-Alonso & Finn.



Suggested E-resources:

1. **Online Lecture Notes and Course Materials:**
    - MIT Open Courseware: 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:

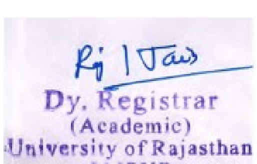
By the end of the course, students should be able to:

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 can apply the principles and mathematical techniques learned to analyze and solve complex problems in these areas. Additionally, they can connect different concepts within electromagnetism and apply them to real-world scenarios.

Syllabus
Semester-I
UG0810-PHY-51P-103: Physics Lab-I

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
I	**UG0810-PHY-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.			

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 center

Exam Scheme-

Students will have to perform two practicals in the exam. The duration of the practical exam will be conduct 2 days each day duration 4 hours.

Marks distribution

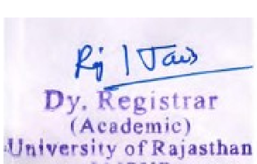
Experiment-I	Experiments-II	Viva-voice	Record	Maximum marks
30	30	10	10	80

Marking distribution in each practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	4	4	10	6	4	2

List of Experiments –

1. Using a compound pendulum study the variation of the time period with amplitude in large-angle oscillations.
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 distance of magnet using 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. Accelerated motion.
    3. Harmonic motion.
    4. Anharmonic motion.



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

14. Experiments with a 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 'Q' 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.
17. 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.

Suggested Books and References –

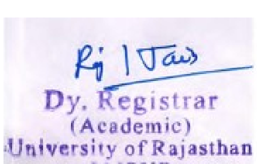
Suggested E-resources.

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
Semester-II
UG0810-PHY-52T-104-Oscillations & Wave

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
II	**UG0810-PHY-52T-104**	**Oscillations & Wave**	**5**	**4**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major**	**Lecture, Sixty Lectures(4 Hours in a week) 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.

Unit I

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, Energy of the oscillator, 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 Acoustic 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 Transient behaviour. Effect of coupling Normal modes of vibration for CO_2 and H_2O molecules Calculation of normal mode: frequencies comes 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, looses, 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 two and three dimensions, Spherical waves.

Reflection and transmission of waves on a string at a boundary. Reflection and transmission of energy. Matching of impedances. Standing waves on a string of fixed length Energy of a vibrating string, energy in each normal mode of a vibrating string, Standing Wave Ratio. Fourier series and Analysis of triangular sawtooth and square functions. Plane

Electromagnetic waves way equation and its plane wave solution, energy, and momentum, Radiation pressure, Radiation resistance of free space. EM wave in dispersive media (normal case), Spectrum of electromagnetic radiations.

(15 Lectures)

Suggested Books and References –

1. 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-

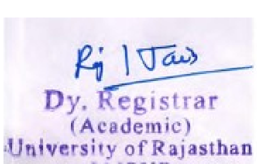
1. MIT OpenCourseWare: Introduction to Oscillations and Waves - This resource offers lecture notes, assignments, and exams for a complete course on electricity and magnetism: https://ocw.mit.edu/courses/res-8-009-introduction-to-oscillations-and-waves-summer-2017/

Course Learning Outcomes:

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.

Syllabus
Semester-II
UG0810-PHY-52T-105-Thermal & Statistical Physics

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
II	UG0810-PHY-52T-105	Thermal & Statistical Physics	5	4
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major	Lecture, Sixty Lectures(4 Hours in a week) 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.

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

Unit IV

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 Plant 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, 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:

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.

Syllabus

Semester-II

UG0810-PHY-52P-106-Physics Lab-II

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
II	UG0810-PHY-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.			

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 center

Exam Scheme-

Students will have to perform two practicals in the exam. The duration of the practical exam will be conduct 2 days each day duration 4 hours.

Marks distribution

Experiment-I	Experiments-II	Viva-voice	Record	Maximum marks
30	30	10	10	80

Marking distribution in each practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	**4**	**4**	**10**	**6**	**4**	**2**

List of Experiments –

1. To study the Faradays Law by induction coil.
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 ACmains 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 resonance in LCR-Series
9. To study resonance in LCR-Parallel
10. To determine the specific resistance of a material and determine the difference between two small resistances using the Carey Fosters Bridge.
11. To convert a galvanometer into an ammeter for the given range.
12. To convert a galvanometer into a voltmeter for the given range.
13. Determine the thermodynamic constant y (gamma) = Cp/Cv using elements and Desormes method.
14. Determine the thermal conductivity of a bad conductor by Lee's method.

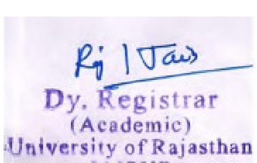
Suggested Books and Reference –

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.



Syllabus
Semester-III
UG0810-PHY-63T-201-Optics

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
III	**UG0810-PHY-63T-201**	**Optics**	**6**	**4**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major**	**Lecture, Sixty Lectures(4 Hours in a week) 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 Optics B.Sc. Honours program is designed to provide students with a comprehensive understanding of the principles, theories, and applications of optics. The program will equip students with both theoretical knowledge and practical skills, preparing them for advanced studies and careers in scientific research, industry, and academia.			

Unit-I Interference

Superposition of waves from two-point sources, Conservation of energy in interference, and visibility of fringes. Brown and Twiss experiment. Coherence time and wave packet. Interference of waves from two coherent point sources. The shape of interference fringes in 3-dimensional space and their appearance on a screen. Intensity distribution in space. Fresnel's biprism experiment. Directional transmission and reception of radio signals. Interference by division of amplitude– Thin films (parallel and wedge shaped films), Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer, the shape of fringes, Measurement of wavelength and refractive index. Theory of Fabry-Perot interferometer, visibility, and shape of fringes. Lummer Gerhke Plate: basic theory and working. Concept of Refractometer: Jamin's Refractometer.

(15 Lectures)

Unit-II Diffraction

The basic theory of Zone plate, Fresnel's diffraction by a circular aperture, straight edge, and a rectangular slit. Cornu's spiral geometrical method to study Fresnel's diffraction pattern.
Fraunhofer diffraction by a single slit and circular aperture. Fraunhofer diffraction by two parallel slits. Missing orders. Diffraction by many parallel slits. Plane diffraction grating. Transmission and reflection gratings. Concave grating. Rowland's mounting. Dispersion by a grating. Rayleigh's criterion of resolution. Resolving power of a grating, resolving power of a telescope. X-Ray diffraction: Bragg's law. **(15 Lectures)**

Unit-III Laser and Holography

Laser: Spontaneous and stimulated emission, Einstein's A and B coefficients. Relations among Einstein's coefficients, Condition for stimulated emission and absorption, Population inversion, methods of optical pumping, and Energy level scheme of He-Ne and Ruby lasers. Working principle of Ruby, He-Ne, and Co_2 laser. Tunnel lasers (qualitative discussion only). The basic concept of holography, the difference between a hologram and a photograph. Construction of a hologram and reconstruction of the image. **(15 Lectures)**

Unit-IV Polarization

Plane Electromagnetic waves and characteristics of EM waves, Polarized light and its mathematical representation, Boundary conditions for electric and magnetic fields at the vacuum dielectric interference. Reflection and refraction of EM waves at a plane dielectric surface at normal and oblique incidence. Derivation of Fresnel's relations. Polaroids, Application of Polaroids in 3-D movies,
Double refraction. Geometry of calcite crystal, ordinary and extraordinary rays. Production of polarized light by reflection and refraction. Polarization by double refraction and Huygen's theory, Nicol prism, Production and analysis of circularly and elliptically polarized light, quarter and half wave plates. Optical activity, specific rotation, biquartz and half shade polarimeters.(15 Lectures)

REFERENCES:

1. F.A. Jenkins and H.E. White, Fundamentals of Optics, Tata McGraw Hill.
2. Brij Lal and N. Subrahmaniyam, Optics, S. Chand.
3. E.Hecht, Optics, Pearson.
4. A.K.Ghatak, Optics, Tata Mc Graw Hill.
5. Devraj Singh, Fundamental of Optics, PHI

Course Objective and outcomes:

By the end of the course, students will have a thorough understanding of optical principles, practical skills in handling optical instruments, and the ability to apply their knowledge to solve complex problems in optics. This will prepare them for further studies or careers in optics-related fields.

Syllabus

Semester III

UG 0810-PHY-63T-202-Mathematical Physics

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
III	UG 0810-PHY-63T-202	Mathematical Physics	6	4
Level of Course	**Type of Course**	**Delivery of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures (2 hrs in a week) including diagnostic and formative assessment during lecture hours.**		
Prerequisites	**Introductory Physics and Mathematics courses of Central Board of Secondary Education or equivalent.**			
Objectives of the Course	This course is an introduction to concepts of advanced Mathematical methods. It can be opted for by students who wish to pursue mathematics in PG and are willing to deal with the problems of theoretical physics. It is meant to introduce the basic concepts of mathematics, i.e., Vectors, Vector spaces, the Fourier and Laplace transforms, and the properties of Dirac delta functions, Hermite, Legendre, polynomials, Partial differential equations, etc.			

Unit-I

Orthogonal Curvilinear co-ordinate system, Scale factors, expression for gradient, divergence and curl and their applications to Cartesian, circular, cylindrical and spherical polar co-ordinate systems.

Co-ordinate transformation and Jacobian, Transformation of Covariant, Contravariant and Mixed Tensors, Addition, Multiplication and Contraction of Tensors, Metric tensor and its use in transformation of tensors, Dirac Delta Function and its properties.

Unit--II

Fourier series: Fourier theorem and computation of Fourier co- efficient. Even and odd functions, half range expansion, sums and scale changes, forced oscillations, Expansion Techniques: integration and differentiation. Introduction to Fourier transform and its simple applications.

Matrices: Inverse of a matrix, adjoint, Hermition adjoint, Solution of linear equations using matrix.Norms and inner products, orthogonal sets and matrices, the Gram Schmidt process and the Q-R factorization theorem, Projection matrices,Least square fit of data. Eigen values and Eigen vectors, diagonalization of matrices. Examples involving up to 3×3 matrices and for the case of real symmetric and simple matrices, Solution of linear differential equations for the homogeneous and non-homogeneous cases.

Unit-III

Solution of differential equations-Series method: Properties of power series, solution of ordinary differential equation: Legendre's Equation, Legendre Polynomials and Functions, Hermite Polynomials. The method of Frobenius: Solution about regular singular points, The Gamma function, the Bessel-Clifford equation.Roots differing by an integer: Series method, Solution of Bessel equation for: (i) Roots not differing by an integer(ii) Equal roots(iii) Roots differing by an integer.

Basic identities involving Bessel Functions, Basic properties like orthogonality recurrence relation and generating functions of Bessel, Hermite, Legendre, and associated Legendre's function (simple applications).

Unit-IV

Solution of partial differential by separation of variable technique and its application to following Boundary Value Problems: (i) Laplace equation in three-dimensional Cartesian co-ordinate system-line charge between two earthed parallel plates. (ii) Laplace equation in Spherical coordinate system-Electricpotential about a spherical surface. (iii) Wave equation in two-dimensional Cartesian co-ordinate system Heat conduction in a thin rectangular plate. (iv) Diffusion equation in cylindrical co-ordinate system.

Reference Books:

1. Mathematical Methods by Potter and Goldberg (Prentice Hall of India Pvt. Ltd.)
2. Applied Mathematics for Engineers and Physicists by Pipes and Harvili (McGraw Hill Book Co.)
3. Mathematical Methods for Physicists: G.B. Arfken and H.J. Weber
4. Mathematical Physics: A.K. Ghatak, L.C. Goyal and S.J. Chua
5. Mathematical Physics: P. K. Chattopadhyay

Course Learning Outcomes:

After completing this course, students would be able to understand and use the following mathematical techniques:

Understand the basic properties of the tensor and Dirac Delta Function and its properties.

- Understand the basic properties of the tensor and Dirac Delta Function and its properties.
- The concept and properties of the Fourier and Laplace transform.

- Represent linear transformations as matrices and understand the fundamental properties of matrices.
- Determine the eigenvalues and eigenvectors of matrices and diagonalise the matrices.
- Determine the orthogonal basis for a vector space using the Gram-Schmidt procedure.
- The solution of partial differential equation and The properties of the essential special functions useful in physics.

Syllabus
Semester-III
UG0810-PHY-63P-203-Physics Lab-III

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
III	**UG0810-PHY-63P-203**	**Physics Lab-III**	**6**	**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:	1. To provide hands-on experience to learn and execution of programming. 2. To develop practical skills in using various programmes and algorithms for the execution of different programmes. 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 various type of programmes of numerical methods. 6. To foster teamwork and collaboration in conducting experiments and analyzing results. 7. To develop skills for the execution of the programming to accurately measures and data recording.			

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 center

Exam Scheme-

Students will have to perform two practicals in the exam. The duration of the practical exam will be conduct 2 days each day duration 4 hours.

Marks distribution

Experiment-I	Experiments-II	Viva-voice	Record	Maximum marks
30	30	10	10	80

Marking distribution in each practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	4	4	10	6	4	2

Practical lists-

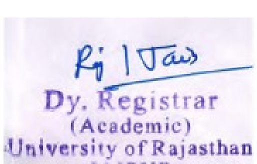
1. Using Newtons ring method find out the wavelength of a monochromatic source and find the refractive index of the liquid.
2. To determine the dispersive power of the prism.
3. To determine the wavelength of sodium light using grating.
4. To study light properties using fiber optics trainer Kit.
5. To study the numerical aperature using diode laser.
6. Measurement of inductance of a coil by Anderson's bridge.
7. Determine the wave length of sodium light using Biprism.
8. Determination of a ballistic constant of a ballistic galvanometer.
9. Determination of high resistance by Leekage method.
10. To study about the coherent source and coherent time using diode laser.
11. To study the thickness of Air film using Air wedge Method.
12. To study the resolving power of the prism.
13. To study the resolving power of the grating.
14. To study the Rydberg constant using Diffraction grating.

Suggested Books and Reference –

1. Practical optics, BY S Naftaly Menn. Ist Addition (ISBN 13:978-0124909519)

Suggested E-resources:

.http://msbahae.um.edu, the University of New Mexico.



Outcome Course Learning

1. Ability to understand formation of Newtons Ring and calculate the wave length of monochromatic source.
2. Develop understanding of light dispersion through prism
3. Proficiency in analyzing and calculating wave lenth of light by grating .
4. Learn how to determine thermal conductivity of band conductors.
5. Develop the skill in designing and analyzing the value of inductance by Anderson bridge
6. Understand theory of wavefront division and also learn how to determine wavelength of sodium light by biprism.
7. Student learn about the sensitivity of ballistic galvanometer and determined value of ballistic constant.

Syllabus

Semester IV

UG 0810-PHY-64T-204- Elementary Quantum Mechanics

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQFE Level**	**Credits**
IV	**UG0810-PHY-64T-204**	**Elementary Quantum Mechanics**	**6**	**4**
Level of Course	**Type of Course**	**Delivery of the Course**		
Introductory	**Major**	**Lecture, Sixty Lectures including diagnostic and formative assessment during lecture hours.**		
Introductory	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course	This course aims to introduce the basic features of quantum mechanics and its applications in various physical phenomena. It will help students explore the core concepts, experiments, and the mathematical framework of quantum mechanics.			

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Unit - I: Evolution of quantum physics

Failures of classical mechanics to explain: the black-body emission spectrum, the specific heat of solids. Plank quanta concept and radiation law, Photoelectric effect and Einstein's explanations. Compton Effect, de-Broglie hypothesis, diffraction and interference experiments of particle (Davisson-Germer experiment).

Uncertainty principle: position and momentum, angle and angular moment, energy and time. Application of uncertainty principle: (i) Ground state energy of hydrogen atom, (ii) ground state energy of simple harmonic oscillator. (iii) Natural width of spectral lines, (iv) Non-existence of electron in nucleus.

Operators linear operators, the product of two operators, commuting and non-commuting operators. Simultaneous eigenfunction and eigenvalues, orthogonal wave functions Hermitian operators, and their eigenvalues. Hermitian adjoint operators. eigenvalues and eigenfunction; expectation values of operators: position, momentum, energy; Ehrenfest theorem and complementarity, Concept of group and phase velocity, wave packet, Gaussian wave packet.

(15 Lectures)

Unit - II: Schrödinger wave equation and its solutions

Schrödinger wave equation: general equation of wave propagation, propagation of matter waves, time-dependent and time-independent Schrödinger equation, wavefunction representation (ψ), physical meaning of ψ. properties and conditions on ψ, postulates of wave mechanics, operators, observable and measurements; probability current density.

Time independent Schrödinger equation, stationary state solution, one dimensional problem: particle in one dimensional box, eigenfunctions and eigenvalues, discrete levels, generalization into three dimension and degeneracy of energy levels, concept of a potential well and barrier, step potential, penetration through rectangular barrier, reflection and transmission coefficients, barriers with special shapes (graphical representation), quantum mechanical tunneling effect (alpha decay). **(15 Lectures)**

Unit - III: Schrödinger equation solutions in special cases

Symmetric square well potential, reflection and transmission coefficients, resonant scattering, bound state problems: particle in one dimensional infinite potential well and finite depth potential well, energy eigenvalues and eigenfunctions, transcendental equation and its solution; Simple harmonic oscillator. Schrödinger equation for simple harmonic oscillator and its solution, eigenfunction, eigenvalues, zero point energy, quantum and classical probability density, parity, symmetric and antisymmetric wave functions with graphical representation.

The schrödinger equation in spherical coordinates, Schrödinger equation for one electron atom in spherical coordinates, separation into radial and angular variables, solution of the radial equation and angular equation, qualitative discussion of spherical harmonics, series solution, and energy eigenvalues, stationary state wave function. Wave-functions of H-atom for ground and first excited states, the average radius of H-atom, Bohr correspondence principle, orbital angular momentum and its quantization, commutation relation, eigenvalues and eigenfunctions

(15 Lectures)

UNIT IV: H-atom, Atomic and Molecular spectroscopy

Energy level derivation for H-atom, quantum features of hydrogen spectra and hydrogen like spectra, Stern-Gerlach experiment, electron spin, spin magnetic moment. Spin-orbit coupling. Qualitative explanation of fine structure, Franck-Hertz experiment. Zeeman effect, normal Zeeman splitting.

Representations, Transformations and Symmetries: Quantum States; State vectors and Wave Functions, The Hilbert Space of state Vectors; Dirac Notation-(a) State Vectors and their conjugates (b) Norm and Scalar Product (c) Basis in Hilbert Space, Dynamical Variables and Linear Operators-(a) Abstract Operators; the Quantum Conditions (b) The Adjoint; Self-Adjointness (c) Eigen values and Eigen Vectors (d) Expansion of the Identity; Projection Operators (e) Unitary Operators, Representations-(a) Representation of State Vectors: The Wave function (b) Dynarnical Variables as Matrix Operators (c) Products of Operators: The Quantum Condition (d) Self-Adjointness and Hermiticity (e) Diagonalization, Continuous Basis The Schrodinger Representation, Degeneracy; Labelling by commuting observables, Change of Basis; Unitary Transformations, Unitary Transformations Induced by change of Coordinate System: Translations, Unitary Transformation induced by Rotation of Coordinate System, The Algebra of Rotation Generators, Transformation of Dynamical Variables, Symmetries and Conservation Laws, Space, Inversion (a) Intrinsic Parity (b) The Unitary Operators of Space Inversion (c) Parity Non-Conservation, (d)Time Reversal. **(15 Lectures)**

Suggested Books and References-

1. Griffiths, Introduction to Quantum Mechanics, 2nd Edition.

2. R. Shankar, Principles of Quantum Mechanics, 2nd Edition.

3. Arthur Beiser, Perspectives of Modern Physics, 6th Edition.

4. A.K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications.

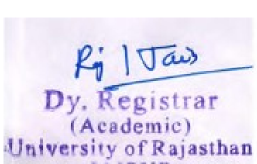
5. H.S. Mani, G.K. Mehta, Introduction to Modern Physics.

6. P.M. Mathews and K. Venkatesan-A Textbook of Quantum Mechanics.

Suggested e-Sources:

Video Lectures:

[1] MIT OpenCourseWare - 8.04 Quantum Physics I https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/



[2] Lecture Series on Quantum Physics by Prof. V. Balakrishnan, Department of Physics, IIT Madras.

Syllabus

Semester-IV

UG 0810-PHY-64T-205- Electronics and Solid-State Devices

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQFE Level**	**Credits**
IV	**UG0810-PHY-64T-205**	**Electronics and Solid-State Devices**	**6**	**4**
Level of Course	**Type of Course**	**Delivery of the Course**		

Introductory	**Major**	**Lecture, Sixty Lectures including diagnostic and formative assessment during lecture hours.**
Introductory	**Physics and Mathematics courses of Central Board of Secondary Education or equivalent.**	
Objectives of the Course	The objectives of this syllabus are to provide students with a foundational understanding of semiconductor devices and their applications in electronic circuits. Students will explore the characteristics and behavior of PN junctions, learn about diode-based clipping and clamping circuits, and understand the fundamentals and biasing of bipolar junction transistors (BJTs). The course introduces Field Effect Transistors (FETs), including their characteristics and applications, and covers Boolean Algebra, logic operations, and the concepts of Diode-Transistor Logic (DTL) and Transistor-Transistor Logic (TTL). It focuses on the analysis and design of various amplifier configurations and oscillators, highlighting feedback mechanisms and their impact on amplifier performance. Finally, the course delves into operational amplifiers, discussing their ideal and real characteristics, key parameters, and basic and advanced configurations for different applications in electronic circuits.	

Unit 1: Diode and Transistors

PN Junction: Charge densities in N and P materials; conduction by drift and diffusion of charge carriers; PN diode equation; capacitance effects.
Clipping and Clamping: Series and parallel diode clippers, positive, negative, and biased clippers; Positive and negative clamping, applications of clamping circuits.

Transistor Fundamentals: Notations and volt-ampere characteristics for bipolar junction transistors (BJTs); Concept of load line and operating point, hybrid parameters; Configurations: CB, CE, CC.
Transistor Biasing: Need for biasing and stability of Q point, stability factors; Types of bias circuits for thermal bias stability: fixed bias, collector-to-base feedback bias, and four-resistor bias.

Unit 2: FET and Logic Operations

Field Effect Transistors (FETs): Introduction of FET and its merits/demerits**,** Junction Field Effect Transistor (JFET), Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET); Circuit symbols, biasing, and volt-ampere characteristics; Source follower, operation of FET as a variable voltage resistor.

Boolean Algebra and Logic operations: Fundamentals of Boolean Algebra, Boolean variables and functions, De Morgan's Theorems, basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR), symbols, truth tables, Boolean expressions, Diode-Transistor Logic (DTL) concept and configuration, Transistor-Transistor Logic (TTL) concept and evolution from DTL.

Unit 3: Amplifiers and Oscillators

Amplifiers: Analysis of transistor amplifiers using hybrid parameters, gain-frequency response; Cascade amplifiers, basic ideas of direct-coupled and R.C. coupled amplifiers, differential amplifiers;

Amplifiers with feedback: Concept of feedback, positive and negative feedback, voltage and current feedback circuits; Advantages of negative feedback: Stabilization of gain, effect on output and input resistance, reduction of nonlinear distortion, effect on gain-frequency response.

Oscillators: Criteria for self-excited and self-sustained oscillation, circuit requirements for the build-up of oscillations; Basic transistor oscillator circuit and its analysis; Colpitt's and Hartley oscillators, R.C. oscillators, crystal oscillators and their advantages.

Unit 4: Introduction to Operational Amplifier

Operational amplifiers: Definition and history, Importance and applications in electronic circuits, Basic building blocks and components, Ideal vs. Real Op-Amps: infinite gain, infinite input impedance, zero output impedance, etc

Practical Op-Amp limitations: bandwidth, slew rate, offset voltage, bias currents, and noise; Key Parameters: Input offset voltage and current, Common-mode rejection ratio (CMRR), Power supply rejection ratio (PSRR), Input and output impedance, Open-loop gain and frequency response.

Basic Op-Amp Configurations: Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower (Buffer) circuit

Advanced Op-Amp Circuits: Summing Amplifier, Differential Amplifier, Integrator and Differentiator, Frequency Response and Stability.

Textbooks:

1. "**Basic Electronics and Linear Circuits**" by N.N. Bhargava, D.C. Kulshreshtha; S.C. Gupta.
2. **"Electronic Devices and Circuits" by J.B. Gupta** - Covers fundamental concepts of electronic devices, including diodes, transistors, and FETs, with practical examples and applications.
3. **"Solid State Electronic Devices" by Ben G. Streetman and Sanjay Kumar Banerjee** - Provides a detailed understanding of semiconductor physics and the operation of electronic devices.
4. **"Integrated Electronics: Analog and Digital Circuits" by Milman and Halkias** - Focuses on integrated electronics, covering analog and digital circuits, including operational amplifiers and their applications.

Reference books:

1. **"Semiconductor Physics and Devices" by Donald A. Neamen** - A comprehensive reference for understanding the physics of semiconductor devices.
2. **"Electronic Principles" by Albert Malvino and David J. Bates** - Detailed explanations of electronic devices and circuits, including practical application tips.
3. **"Digital Principles and Applications" by Donald P. Leach, Albert Paul Malvino, and Goutam Saha** - Provides a thorough understanding of digital logic design and its practical applications.

4. **"Design with Operational Amplifiers and Analog Integrated Circuits" by Sergio Franco** - A deeper dive into the design and application of operational amplifiers in various circuits.

E-Resources:

1. **NPTEL (National Programme on Technology Enhanced Learning)**:
   Website: https://nptel.ac.in/courses
2. **MIT Open Course Ware**:
   Website:https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/; https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/video_galleries/video-lectures/
3. **Coursera**:
   Website: Coursera - Electronics Courses
4. **edX**: Electronics Courses
   Website: https://www.edx.org/learn/electronics
5. **IEEE Xplore Digital Library**:
   Website: IEEE Xplore Digital Library

Learning Outcomes:

Upon completion of the syllabus, students will be able to understand the characteristics and behavior of PN junctions, analyze clipping and clamping circuits, and comprehend bipolar junction transistors (BJTs) and their biasing techniques. They will gain knowledge of Field Effect Transistors (FETs) including JFETs and MOSFETs, and explore Boolean Algebra and logic gates. Students will be able to analyze transistor amplifiers, understand feedback mechanisms, and study various oscillator circuits. Additionally, they will learn about operational amplifiers, their key parameters, and design basic and advanced amplifier configurations, enhancing their skills in designing and analyzing electronic circuits.

Syllabus

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Semester- IV

UG 0810-PHY-64P -206-Physics Lab-IV

Semester	Code of the Course	Title of the Course/Paper	NHEQFE Level	Credits
IV	UG0810-PHY-64P-206	Physics Lab-IV	6	4
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major	Lab experiments		
Introductory	B.Sc. Semester Practical Lab			
Objectives of the Course	The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments. • Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology			

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 center

Exam Scheme-

Students will have to perform two practicals in the exam. The duration of the practical exam will be conduct 2 days each day duration 4 hours.

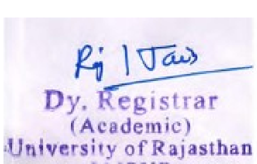
Marks distribution

Experiment-I	Experiments-II	Viva-voice	Record	Maximum marks
30	30	10	10	80

Marking distribution in each practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	4	4	10	6	4	2

List of experiments



[1] Using platinum resistance thermometer to find the melting point of a given substance.
[2] Determination of a ballistic constant of a ballistic galvanometer by leakage method.
[3] Study of variation of total thermal radiation with temperature with power supply.
[4] To study conductor interaction through fall of magnet in a hollow metal cylinder.
[5] To study temperature variation of modulus of rigidity.
[6] Plot thermo emf versus temperature graph and determine the Seeback coefficient.
[7] Study of power supply using half wave, full wave and bridge rectifier with various filter circuits.
[8] Study of half wave rectifier using single diode and application of L and C section filter.
[9] To determine emf by Thomson’s method.
[10] Study the characteristics of a given transistor (PNP/NPN) in common emitter, common base, and common collector configurations.
[11] Determine the band gap of a semiconductor using a junction diode.
[12] Study the temperature dependence of resistance in a semiconductor using the four-probe method.
[13] Study the characteristics of a junction diode and a Zener diode.
[14] Study the characteristics of a field effect transistor (FET) and design an amplifier with finite gain.
[15] Study the frequency response of a transistor amplifier and obtain the input and output impedance.
[16] Design and study an R-C phase shift oscillator and measure the output impedance (frequency response with change of R and C components).
[17] Study a voltage multiplier circuit to generate high voltage D.C. from A.C.
[18] Study OR, AND, and NOT logic gates using discrete components and compare them with TTL integrated circuits (ICs).
[19] Analyze the behavior of different types of clipping and clamping circuits using diodes.
[20] Investigate the effect of negative feedback on amplifier performance.
[21] Construct and analyze integrator and differentiator circuits, evaluating their response to input signals and frequency response.
[22] To determine Planck’s constant ‘h’ using a photoelectric cell and a direct reading potentiometer.

Reference books:

1. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky
2. "Microelectronic Circuits" by Adel S. Sedra and Kenneth C. Smith
3. "Solid State Electronic Devices" by Ben G. Streetman and Sanjay Kumar Banerjee
4. "The Art of Electronics" by Paul Horowitz and Winfield Hill
5. "Electronic Principles" by Albert Malvino and David Bates
6. "Electronic Devices and Circuits" by David A. Bell
7. "Basic Electronics for Scientists and Engineers" by Dennis L. Eggleston
8. "Foundations of Analog and Digital Electronic Circuits" by Anant Agarwal and Jeffrey H. Lang
9. "Electronic Instrumentation and Measurements" by David A. Bell

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10. "Operational Amplifiers and Linear Integrated Circuits" by Robert F. Coughlin and Frederick F. Driscoll

Learning Outcomes:

- Transistor Characteristics: Ability to analyze and interpret transistor behavior in common emitter, base, and collector configurations.
- Semiconductor Analysis: Skill in determining semiconductor band gaps using junction diodes and understanding temperature dependence of resistance.
- Amplifier Design and Analysis: Competence in designing and evaluating transistor and FET amplifiers, including gain-frequency response and input/output impedance.
- Diode Characteristics: Understanding of diode behavior, including junction and Zener diodes, and their applications in circuits.
- Power Supply and Rectifier Circuits: Proficiency in designing and analyzing power supply circuits, including rectifiers and filter circuits.
- Oscillator Design: Ability to design and evaluate R-C phase shift, Hartley, and Colpitts oscillators for frequency stability and waveform analysis.
- Feedback and Operational Amplifiers: Competence in analyzing the impact of negative feedback on amplifier performance and measuring key parameters of operational amplifiers.
- Logic Gates and Clipping/Clamping Circuits: Understanding of logic gates using discrete components and TTL ICs, and analysis of clipping and clamping circuits using diodes.
- Summing and Differential Amplifiers: Skill in designing and analyzing summing and differential amplifier circuits, measuring CMRR and output characteristics.
- Integrator and Differentiator Circuits: Proficiency in constructing and evaluating integrator and differentiator circuits, assessing their response to input signals and frequency characteristics.
- Op-Amp Frequency Response and Stability: Understanding of frequency response, cutoff frequencies, gain-bandwidth product, phase margin, and gain margin of operational amplifier circuits.

These outcomes collectively aim to develop practical skills in electronics, enhance analytical abilities, and prepare students for real-world applications and further academic pursuits in the field of Electronic solid state devices

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Syllabus

Semester-V

UG 0810-PHY-75T-301-Introductory Nuclear and Particle Physics

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
V	UG0810-PHY-75T-301	Introductory Nuclear and Particle Physics	7	4
Level of Course	**Type of Course**	**Delivery of the Course**		
Introductory	**Major**	**Lecture, Sixty Lectures (2 hrs in a week) including diagnostic and formative assessment during lecture hours.**		
Prerequisites	Introductory Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course	The objective of this course is to provide students with a comprehensive understanding of Nuclear Physics and particle physics. The course aims to focus on the properties of the properties of the nucleus, nuclear forces, various nuclear models, radioactive decays, nuclear fission and fusion, nuclear reactions, the interaction of heavy charged particles and gamma rays with matter, radiation detectors, elementary particles, and particle accelerators.			

Unit I : Basic Nuclear Characteristics

Basic Properties of nucleus: Nuclear mass, nuclear size and nuclear matter- The mass table, binding energy of nucleons, semiempirical mass formula, nuclear matter characteristics, theory of binding energy and the pairing energy, Nuclear stability and abundance of nuclides, Spin and parity of nuclear states, magnetic dipole and electric quadrupole moments of nucleus.
General nature of force between nucleons: Yukawa Meson theory, nuclear potential,scattering of neutrons by protons at low energy, two nucleons system, the deutron magnetic dipole and electric quadruple moments, non-central forces, p-p and n-n scattering at low energy, charge independence of nuclear forces and concept of iso-spin invariance.

Unit II : Nuclear Models, Fission and Fusion , and Interactions

Empirical evidence for the regularity of nuclear properties: nuclear mass and binding energy, magic numbers. Liquid drop model, Fermi gas model, evidence for nuclear shell structure, basic assumptions of the shell model, The single particle shell model, the average shell model potential.

Fission: Discovery of fission, Theory of fission, Energy release, criticality of a Reactor and four factor formula, types of fuels and types of reactors, Breader Reactor, Neutron cycle in a thermal Nuclear Reactor. Nuclear fusion, energy released in nuclear fusion, fusion in stars.

Unit III : Nuclear radiation interaction, Detection and Acceleration

Interaction of nuclear radiation: Passage of charged particle through matter, energy loss by collision, energy loss by radiative process, range - energy curve, range straggling, stopping power of heavy ions, Law of absorption for gamma ray interaction, photo electric effect Compton scattering, pair – production.

Radiation Detector: Modes of operation- current mode and pulse mode, Gas filled detectors- Ionization chamber, Proportional counter, Geiger - Muller counter, Scintillator detectors- Organic and Inorganic scintillation detector.

Particle Accelerators: Ion source, Van-de-Graff accelerator (Tandem Accelerator), Linear accelerator, Cyclotron, Synchrocyclotron, Betatron, Proton synchrotron.

Unit IV : Introduction of Particles and Conservation Laws

Introduction of electron, alpha particles, photon, positron, neutron, neutrino and the muons. Baryons and leptons. Discovery of pion and its characteristics, deltas, Strangeness and kaons etc, lambda and other hyperons. Introduction of charge conjugation, space parity and Gellman Nishijima Scheme. Patron, quark model- quark and gluons, quark composition of baryons and mesons J/Y particle, W and Z- particles and Higgs. Emphasis should be given on experimental discoveries and conservation laws while introducing the particles and resonances. Introduction of SU(3) symmetry.

Reference Books:

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

7. Introduction to Nuclear and Particle Physics, V.K. Mittal, R.C. Verma, S.C. Gupta, PHI.
8. Concepts of Modern Physics, A. Beiser, McGraw-Hill Book Company.
9. Introduction to High Energy Physics, Donald H. Perkins, 4th Edition,Combridge University Press.

Suggested E-resources:

1. https://archive.nptel.ac.in/courses/115/104/115104043/
2. https://ocw.mit.edu/cources/22-101-applied-nuclear-physics-fall-2006/pages/lecture-notes/

Course learning outcomes:

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

1. Discuss the nature of nuclear forces and their role in holding nucleons together.
2. Use the semi-empirical mass formula to evaluate nuclear mass and binding energy, and understand concepts such as nuclear spin, parity, and magnetic dipole moments.
3. Describe and compare models such as the liquid drop model, shell model, and Fermi gas model to explain nuclear structure and behavior.
4. Understand the significance of magic numbers and their implications for nuclear stability.
5. Explain the mechanisms and energy release associated with nuclear fission and fusion.
6. Describe the use of fission and fusion in energy production and stellar processes.
7. Understand nuclear reaction types, conservation laws, reaction kinematics, Q-values, and reaction rates
8. Explain alpha, beta, and gamma decay processes, including energy spectra and decay laws.
9. Analyze how heavy charged particles and gamma rays interact with matter, including energy loss, scattering, and absorption.
10. Discuss photoelectric effect, Compton scattering, and pair production as key radiation interaction processes.
11. Explain the operation and principles of various radiation detectors, such as gas-filled detectors, ionization chambers, proportional counters, and Geiger-Muller counters.
12. Use radiation detectors to measure and analyze radiation in different contexts, including experimental and practical applications.

13. Explain the functions and types of particle accelerators, such as Van de Graaff accelerators, linear accelerators, cyclotrons, synchrocyclotrons, betatrons, and proton synchrotrons.

14. Recognize elementary particles within the Standard Model and describe their interactions and historical discovery.

15. Understand and apply symmetries and conservation laws (C, P, and T invariance) to particle reactions and processes

16. Discuss flavor symmetries, the Gell-Mann-Nishijima formula, the eightfold way, and the role of quarks and gluons in particle physics.

Syllabus

Semester-V

UG 0810-PHY-75T-302-Numerical Methods and Computer Programming

Semester	**Code of the Course**	**Title of the Course / Paper**	**NHEQF Level**	**Credits**
V	**UG 0810-PHY-75T-302**	**Numerical Methods and Computer Programming**	**7**	**4**
Level of Course	**Type of Course**	**Delivery of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures (2 hrs in a week) including diagnostic and formative assessment during lecture hours.**		
Prerequisites	**Physics, Mathematics and computer programming 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 Numerical Methods and Computer Programming in C languages. The course aims to develop some efficient algorithms to process and analyse complex datasets in scientific and engineering disciplines.			

Unit-1

Algorithm development: Problem analysis, flow chart, decision tables; Examples of simple algorithms, Programme Design: Debugging syntax error, run-time error, logical error, programme verification and testing.

Data Representation: Representation of positive and negative numbers, fixed point representation, floating point representation. Arithmetic operations with normalized fleeting point numbers and its consequences, character representation, founding of numbers, absolute and relative errors, error detection and error correcting codes. **(15 Lecture)**

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Unit-II

Programming in Language C

Numeric constants, declaring variable names, character data type; Arithmetic operators, hierarchy of operations, assignment statements, Input/output statements; Library functions, Elementary Programmes in C for numeric and string processing

Conditional statements: relational operators; Arithmetic IF and Logical IF statements; Unconditional transfer: GO TO statement; Looping: DO loops, nested loops, Functions and subroutines; Subscripted variables: vectors and arrays; Writing and executing C programmes

Programmes in C to (i) compute magnetic field das to a current carrying coil (ii) compute electric field due to a system of point charges (iii) study frequency response of an LCR circuit (iv), Evaluate Bessel's function, Legendre function, Hermite Polynomial, Languerre's Polynomial by series expansion. Evaluation of simple functions by Taylor Series Expansion.

(15 Lecture)

Unit-III

Iterative Methods: Solution of algebraic and transcendental equations using bisection method, method of false position, Newton-Raphson method, Complex zeros, zeros of polynomials; Simple applications related Physics like programmes in C to evaluate zeros of simple functions.

Interpolation: Lagrange interpolation, Difference tables, truncation error in interpolation, Spline interpolation. **(15 Lecture)**

Unit IV

Least Square Approximation. Linear regression, Polynomial regression, fitting exponential and trigonometric functions, approximation of functions by Taylor' series and Chebyshev polynomials, curve fitting and polynomial fitting: Programmes in C related to physics on above topics

Numerical Integration: Trapezoidal rule, Simpson's rule, errors in integration formulas, Gaussian quadrature formulae. Programmes in C related to physics on above topics.

Numerical Solution of Ordinary differential equations: Taylor's method, Euler's method and Runge-Kutta methods; Programmes in C related to physics on above topics.

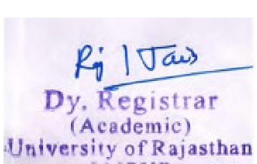
Numerical Solution of Partial Differential Equations

Finite Difference methods for solution of (i) The diffusion equation (ii) the wave equation and (iii) the Laplace equation; Programmes in C related to physic on above topics. **(15 Lecture)**

Reference Books:

1. Computer Science, R. DheenDayalue (Tata Mc Graw Hill)
2. Computer System Architecture, Morris-Mano (Prentice Hall of India)
3. Computer Oriented Numerical Methods, V. Rajaraman (Prentice Hall of India)
4. Mathematical Methods, Potter and Goldberg (Prentice Hall of India)
5. Computational Methods for Partial Differential Equations, M. K. Jain, S. R. K. lyenger, R. K. Jain, (New Age International)
6. LaforeRobert, "Object-Oriented Programming in C++", Waite Group's ,4th Edition.

Suggested E-sources:



1. http://www.nptelvideos.in/2012/11/numerical-methods-and-programing.html
2. http://www.nptelvideos.in/2012/11/numerical-methods-and-computation.html
3. https://nptel.ac.in/courses/122106033/
4. https://nptel.ac.in/courses/122106033/25

Course Learning Outcomes

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

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems. Apply numerical methods to obtain approximate solutions to mathematical problems.
2. Enhancement of algorithms and solving complex equations, numerical techniques are indispensable in addressing the challenges faced by computer scientists and engineers.
3. Understand importance and applications of numerical methods.
4. Obtain a spontaneous and working understanding of numerical methods for the basic problems of numerical analysis.
5. Knowledge in the implementation of numerical methods using a computer.
6. Trace error in these methods and need to analyze and predict it.
7. Implementation of numerical methods in computer programming using C language.
8. Apply mathematics in engineering problems.
9. By this, Possibility to find the real root of many equation (which is not possible to find out the real root by simple methods).

After course completion the students will have developed the learning outcomes such as Understanding a functional hierarchical code organization. Ability to define and manage data structures based on problem subject domain. Ability to work with textual information, characters and strings. The study of algorithms of numerical analysis in computer programming may be useful to solve and understand the many fields such as forecasting to financial markets. It has many applications in engineering to design safe building and vehicles.

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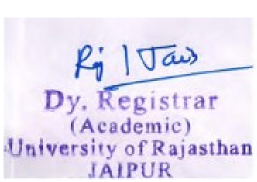
Syllabus
Semester- V
UG 0810-PHY-75P-303-Physics Lab-V

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
V	**UG 0810-PHY-75P-303**	**Physics Lab – V**	**7**	**4**
Level of Course	**Type of Course**	**Delivery of the Course**		
Introductory	**Major**	**Lecture, Sixty Lectures including diagnostic and formative assessment during lecture hours.**		
Prerequisites	**Practical, One Twenty hours (4 hours in a week) of practical including diagnostic and formative assessment during practical hours**			
Objectives of the Course	To provide hands-on experience to learn and execution of programming. To develop practical skills in using various programmes and algorithms for the execution of different programmes.			



	To reinforce theoretical concepts learned in the corresponding lecture course through practical applications. To enhance problem-solving and analytical skills by analyzing experimental data and interpreting results. To promote scientific inquiry, critical thinking, and the ability to design and execute various type of programmes of numerical methods. To foster teamwork and collaboration in conducting experiments and analyzing results. To develop skills for the execution of the programming to accurately measures and data recording.

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 center

Exam Scheme-

Students will have to perform two practicals in the exam. The duration of the practical exam will be conduct 2 days each day duration 4 hours.

Marks distribution

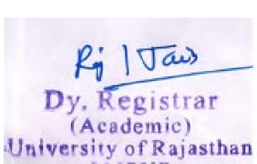
Experiment-I	Experiments-II	Viva-voice	Record	Maximum marks
30	30	10	10	80

Marking distribution in each practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	4	4	10	6	4	2

Writing and executing programmes in C

1. **Magnetic Field of a Current-Carrying Coil:** Develop a C program to calculate the magnetic field at a given point in space due to a current flowing through a coil with specified geometry (e.g., circular, rectangular) and dimensions.



2. **Electric Field of Point Charges:** Design a C program to compute the electric field at a specific location due to a system of point charges with known positions and magnitudes.

3. **LCR Circuit Frequency Response:** Write a C program to analyze the frequency response of a circuit containing resistors (L), capacitors (C), and inductors (R) by calculating quantities like impedance and phase shift across a range of frequencies.

4. **Legendre Function Evaluation:** Develop a C program to compute Legendre functions of a specific degree and argument using series representation.
5. **Hermite Polynomial Evaluation:** Design a C program to calculate Hermite polynomials of a particular degree and argument through series expansion.

8. **Taylor Series Expansion for Simple Functions:** Implement a C program to approximate the value of various mathematical functions at a specific point using Taylor series expansion.
9. **Fibonacci Sequence Generation:** Develop a C program to generate the Fibonacci sequence up to a specified number of terms.
10. **Root Finding with Newton-Raphson Method:** Design a C program that utilizes the Newton-Raphson method to find the roots of a given non-linear equation.
11. **Cubic Spline Interpolation:** Write a C program to perform cubic spline interpolation for a set of data points, enabling the estimation of values between known points.
12. **Function Approximation with Taylor Series:** Implement a C program to approximate a function by its Taylor series representation over a specified interval.

13. **Linear Regression for Experimental Data:** Develop a C program that performs linear regression analysis on a set of experimental data points, fitting a straight line and providing information about the slope and intercept.

14. **Ordinary Differential Equation Solver (Runge-Kutta):** Design a C program that employs the Runge-Kutta method to numerically solve ordinary differential equations.
15. **Trapezoidal Rule Integration:** Implement the trapezoidal rule in a C program to numerically approximate the definite integral of a function over a given interval.
16. **Simpson's Rule Integration:** Develop a C program that utilizes Simpson's rule for numerical integration, providing a more accurate estimate of the definite integral compared to the trapezoidal rule.
17. **Diffusion Equation with Finite Difference Method:** Write a C program that solves the diffusion equation using finite difference methods, simulating the diffusion process over a defined spatial and temporal domain.
18. To verify the inverse square law for gamma rays using a GM tube.
19. To measure the dead time of a GM tube using the (Cs^{137} & Co^{60}) two-source method.
20. To determine the linear attenuation coefficients (μ) of lead and aluminum for a gamma ray source using a GM tube.
21. To estimate the endpoint energy of beta particles from a beta-emitting source (Tl^{204} / Sr^{90}) using a GM tube .

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Suggested Books and Reference-
Suggested E-resources:

Course Learning Outcomes:

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

1. A skill to apply knowledge of mathematics and engineering.
2. A skill to design the algorithms, develop procedures and execute the programmes in C language, as well as to analyze and interpret data.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability.
4. Implementation of different numerical methods for problem solutions.
5. Understand the advantages and disadvantages in the use of alternative numerical methods.
6. Distinguish the importance of error estimates and use error criteria.

Syllabus

Semester VI

UG 0810-PHY-76T-304-Physics of Materials

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits

VI	UG 0810-PHY-76T-304	Physics of Materials	7	4
Level of Course	**Type of Course**	**Delivery of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures (2 hrs in a week) including diagnostic and formative assessment during lecture hours.**		
Prerequisites	**Introductory 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 Physics of materials. The course aims to focus on the properties of solid substances and explain how these properties affect their structure or composition.			

Unit-I

Introduction: Materials Science and Engineering, classification of engineering materials, levels of structure, structure-property relationships în materials.

Crystal Geometry and Structure Determination: Space lattices, Space lattices and crystal structures, Crystal directions and planes, Miller Indices, Bragg's law of X-ray diffraction, Powder method, structure determination. Extinction rules for cubic crystals.

Unit-II

Chemical Bonding in Solids: Bond energy, bond type and bond length, lonic bonding, Calculation of lattice energy of ionic crystals. Madelung constant, covalent bonding, Metallic bonding, Secondary bonding, Variation in bonding character and properties.

Structure of Solids: Crystalline and non-crystalline states, Discussion of solidification and crystallization, glass transition.

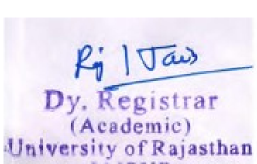
Unit-III

Band Theory of Solids: Formation of bands (qualitative discussion), Electrons in a period field of a crystal (Kronig-Penney Model), Brillouin zones, number of states in a band, Bloch Theorem and Bloch function, Dispersion relation inside a band, band shapes, effective mass of an electron, Distinction between metals, insulators and intrinsic semiconductors.

Optical Properties of Materials: Introduction, Classification of Optical Materials, Interaction of light with matter, Absorption in Metals, Insulators and Semiconductors, Reflection, Refraction, Transmission and Scattering, Traps, Excitons, Colour Centers, Tauc and Lambert Beer laws, Optical properties of Photonic material.

Unit-IV

Dielectric Properties: Polarization, Temperature and frequency effect. Electric break down, classical theory of electronic polarizability, Normal and anomalous dispersion, Complex dielectric constant and loss, Ferroelectric materials, Measurement of dielectric constant and loss. P-E hysteresis loop in ferroelectricity. Qualitative discussion of pyroelectric and piezoelectricity.



Phase diagrams Phase rule, Single component system, Binary phase diagram, Microstructure changes during cooling, Lever rule, Phase diagram rules, Applications of phase diagram.

Polymers: Classification of polymers, structure of long chain polymers, crystallinity of long chain polymers.

Suggested Books and References -

1. Materials Science and Engineering by V. Raghavan, Prentice- Hall Edition 1993.
2. 2. Solid State Electronic Engineering Materials by S.O. Pillai, Wiley Eastern Ltd.
3. 3. Solid state Physics by C. Kittel V. Edition.
4. 4. Introduction to Solid by L. Azaroff.
5. 5. Solid State Physics by N.W. Aschroft and N.D. Mermin CBS Publishing Asia Ltd.

Course Learning Outcomes:

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

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1. Students completing this course will get opportunities to become Material Engineers, material technicians, product testers, or metallurgists in various industries.
2. Students will demonstrate written and oral communication skills in communicating materials science- and physics-related topics.
3. Students will design and conduct an experiment (or series of experiments) demonstrating their understanding of the scientific method and process. Students will demonstrate an understanding of the analytical methods required to interpret and analyze results and draw conclusions as supported by their data.
4. Students will demonstrate a thorough understanding of the analytical approach to modeling of physical phenomena.
5. Students will demonstrate an understanding of the impact of physics and science on society.

Syllabus

Semester- VI

UG0810-PHY-76T-305-Atomic and Molecular Physics

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
VI	UG0810-PHY-76T-305	Atomic and Molecular Physics	7	4
Level of Course	Type of course	Delivery type of the course		
7	Major	Lectures, sixty lectures including diagnostic and formative assessments during lecture hours		
Pre-requisites	Physics and mathematics course of XII standard (senior secondary of CBSE/ RBSE or equivalent)			
Objectives of the course	The objective of the course is to provide the comprehensive view, insight, theoretical and experimental understanding, and application of atomic and molecular spectroscopy. The course aims to develop the strong understanding of spectroscopy in terms of governing principles, laws. By the use of these basics, the application parts are also explored in terms of instrumentations, and recording the spectra and its analytical assessment.			

Unit-I Monovalent and divalent spectra

Background of quantum theory: the four quantum numbers, vector model, s, p, d, f notation, spectral terms arising from L-S and J-J coupling, emission and absorption probabilities, half-life of exited states, ideal spectral line, width of spectral lines: natural and Doppler width.

Mono/di-valent Spectrum: spectra of mono-valent atoms (hydrogen and like atoms), doublet fine structure hydrogen lines, screening constant for mono-valent atoms, series limits, isotopic effect, deduction of m/M from hydrogen and deuterium spectra, spectra of helium, singlet and triplet series. **(15 Lectures)**

Unit-II Magnetic field and X-Ray spectroscopy

Effect of magnetic field on energy levels: Gyromagnetic ratios for orbital and spin moments, Lande's g factor, strong and weak magnetic field effects,illustrative cases of: H, Na and Ca.

X-ray spectra: X-ray, generation, continuous X-ray spectrum, characteristics X_ray spectrum,Duane-Hunt limit, H-like character of X-ray energy states, Moseley's Law doublet fine structure, X-ray absorption spectra, absorption edge, qualitative discussion of near edge and extended fine structure, determination of atomic number of atoms. **(15 Lectures)**

Unit-III Di-atomic and tri-atomic Molecules

Molecule formation:Sharing of electrons, formation of molecular orbital, qualitative discussion of H_2, $N_2$and O_2Molecule, electronic levels and quantum numbers for electronic states of diatomic molecules: singlet and triplet character.

Energy levels: di-atomic and tri-atomic molecules, classification and normal modes of molecules, rotational energy levels, inter-nuclear distance, vibrational energy levels, force constant, anharmonicity, dissociation energy, isotopic effect on rotational and vibrational energies.Spectra of di-atomic molecules: Pure rotation spectra, selection rules, vibration – rotation spectra, selection rules, P, Q, R branches, Frank Condon principle. **(15 Lectures)**

Unit-IV Experimental techniques

Emission spectroscopy: Basic block diagram of emission spectroscopy, emission sources; dispersive devices: prism, plane grating, concave grating, prism materials for UV, Vis and IR regions, constant deviation systems, monochromaters, mounting, resolution of prism and grating, Febry-perot and Lummer plate for high resolution.

Absorption spectroscopy: Basic block diagram of absorption spectroscopy, continuous source for absorption studies in X-ray, UV, Vis, and IR regions, single beam and double beam instruments, detection systems: photomultiplier tube, bolometer.

Raman spectroscopy: Raman Effect, Stoke's and anti-Stoke's lines, Raman shifts, selection rules for Raman spectra, selection rules for IR absorption, structure determination of H_2O, and CO_2 molecules from IR and Raman spectra, LASER as the intense source for Raman excitation

(15 Lectures)

Suggested Books and references:

1. Atomic spectra and atomic structure, G. Herzberg, 1944, Dover Publication, New York.
2. Introduction to Atomic spectra, HE White,1934, McGraw Hill Book Company, New York and London.
3. Atomic spectra, H.G. Kuhn, 1962, Academic press, University of California
4. Physics of Atoms and Molecules, BH Bransden and CJ Joachain, 2nd edition,2019, Pearson Education ltd.
5. X-ray spectroscopy, BK Agarwal, 2nd edition, 1931, Spriger series in Optical science.
6. Optics and atomic Physics, DP Khandelwal, 2015, Himalaya Publishing House, New delhi.
7. Fundamentals of Molecular Spectroscopy, CN Banwell, EM McCash, 4th edition, 1994, McGraw-Hill Education.
8. Atomic & molecular spectra: LASER, Raj Kumar, KNRM Publication, Meerut

Suggested E-resources:

Online lecture notes and course materials:

- Selected videos may be assessed fromNPTEL : NOC: Atomic and Molecular Physics, Co-ordinators : Prof. Amal Kumar Das. e.g*www.digimat.in/nptel/courses/video/115105100/L01.html,* here last L01 represents the lecture number lecture number 01. http://www.digimat.in/downloads/html-browser/physics.pdfpage number 93-94 by clicking the provided link.

- Selected Lecture notes may be assessed from NPTL website http://www.digimat.in/downloads/pdf-browser/physics.pdf, page number 93-94 by clicking the provided link.
- Selected hand written notes may be assessed from http://sites.iiserpune.ac.in/~bhasbapat/phy420.html

Course learning Outcomes:

By the end of the course, the student should be able to –

By the end of the course, the student will have developed a strong understanding of atomic and molecular spectroscopy which includes the governing principles and laws, various experimental techniques and its analytical approaches, limitations, and application for day to day investigation and elementary research .The student will also get flavour of wide scope of spectroscopy in fundamental research, in health science, in forensic science, in food science, in paint and drug industries.

Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR

Syllabus

Semester- VI

UG-0810-PHY-76P-306- Physics lab-VI

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
VI	**UG0810-PHY-76P-306**	**Physics Lab-VI**	**7**	**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:	1. To provide hands-on experience to learn and execution of programming. 2. To develop practical skills in using various programmes and algorithms for the execution of different programmes. 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 various type of programmes of numerical methods. 6. To foster teamwork and collaboration in conducting experiments and analyzing results. 7. To develop skills for the execution of the programming to accurately measures and data recording.			

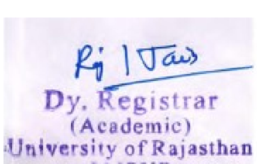
Exam Scheme-

Students will have to perform two practicals in the exam. The duration of the practical exam will be conduct 2 days each day duration 4 hours.

Marks distribution

Experiment-I	**Experiments-II**	**Viva-voice**	**Record**	**Maximum marks**
30	**30**	**10**	**10**	**80**

Marking distribution in each practical



Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	4	4	10	6	4	2

Practical List-

1. To draw the Hysteresis loop of the given specimen and to determine the Energy loss per unit volume per cycle of magnetization with Universal B-H curve Tracer.
2. To study crystal structures of a given specimen.
3. To study crystal imperfections in a given specimen.
4. To study microstructures of metals/alloys.
5. To prepare a solidification curve for a given specimen.
6. To study the thermo-setting of plastics.
7. To study the mechanism of chemical corrosion and its protection.
8. To study the properties of various types of plastics.
9. To study Bravais lattices with the help of models.
10. To study crystal structures and crystals imperfections using ball models.
11. Specimen preparation form microstructural examination cutting, grinding, polishing, etching.
12. To determine the Cauchy's constant for the material of a given prism using the spectrometer.
13. To determine the angle of a given wedge using given laser beam.
14. To determine the refractive index of water using hollow prism.
15. To study the Hall Effect and to calculate the different parameter like Hall Coefficient, carrier density & mobility.
16. To determine the wavelength of yellow line of sodium and the wavelength Difference between the two components of this line using Michelson Interferometer.
17. To draw the dispersion curve for the grating spectrograph using the Spectral lines of iron as standard and to determine the wavelength of the Bands of ALO and to compare them with the standard value given in the Chart.
18. To calibrate the given constant deviation spectrometer (CDS) with the help of mercury lines and to calculate the Rydberg constant and series limit of Balmer series using hydrogen lamp.

Learning outcomes -

This course covers a wide range of topics in physics. Upon completion, students will be able to: i. Quantify fundamental physical constants ii. Characterize material properties iii. Analyze radiation and its interactions iv. Investigate light polarization v. Develop proficiency in handling laboratory instrumentation.